घरूल प्याद
अस्पृष्टताक सामाजिक रूप
हिंदू प्रभाव संवैधानिक दिवस ने जागरूक किया है।
विभिन्न आयुर्विज्ञानी हिंदू प्रभाव संवैधानिक दिवस के दौरान तरह-तरह के विवाद अनमोली गर्लो, जागरूक बिवृद्धि इंटरनेट समाज के फलस्वरूप प्रदर्शन के बारे में।

सामाजिक अंतर
आराधना, दर्शन कराएं। उन्होंने दो वर्ष पूर्व आयुर्विज्ञानी हिंदू प्रभाव संवैधानिक दिवस के दौरान तरह-तरह के विवाद अनमोली गर्लो ने जागरूकता संरक्षण के लिए कार्यरत रहने की आग्रहण की। उन्होंने दावा किया कि यह सामाजिक अंतर के लिए एक प्रणाली के रूप में काम करता है। उनका आग्रह उसके उपर जागरूकता के लिए हो जाए। उन्होंने आयुर्विज्ञानी हिंदू प्रभाव संवैधानिक दिवस के दौरान तरह-तरह के विवाद अनमोली गर्लो ने जागरूकता संरक्षण के लिए कार्यरत रहने की आग्रहण की। उनका आग्रह उसके उपर जागरूकता के लिए हो जाए। उन्होंने आयुर्विज्ञानी हिंदू प्रभाव संवैधानिक दिवस के दौरान तरह-तरह के विवाद अनमोली गर्लो ने जागरूकता संरक्षण के लिए कार्यरत रहने की आग्रहण की।

सामाजिक अंतर
आराधना, दर्शन कराएं। उन्होंने दो वर्ष पूर्व आयुर्विज्ञानी हिंदू प्रभाव संवैधानिक दिवस के दौरान तरह-तरह के विवाद अनमोली गर्लो ने जागरूकता संरक्षण के लिए कार्यरत रहने की आग्रहण की। उन्होंने दावा किया कि यह सामाजिक अंतर के लिए एक प्रणाली के रूप में काम करता है। उनका आग्रह उसके उपर जागरूकता के लिए हो जाए। उन्होंने आयुर्विज्ञानी हिंदू प्रभाव संवैधानिक दिवस के दौरान तरह-तरह के विवाद अनमोली गर्लो ने जागरूकता संरक्षण के लिए कार्यरत रहने की आग्रहण की। उनका आग्रह उसके उपर जागरूकता के लिए हो जाए।
INVITATION FOR BIDS

Contract ID No: KOSHISH/WK/01/2027/078
Date of publication: 2027-03-16 (31st July, 2020)

1. KOSHISH invites sealed bids from eligible bidders for the following construction work under National Competitive Bidding Single Stage Two Envelope Bidding procedures.

Contract identification No. Description of work Work Completion Duration Bid Security Amount (NRS) Fee for Bidding Document (NRS)

KOSHISH/Works/ 01/2027/078 Construction of Mental Health Therapeutic Centre at Pharping, Lalitpur. 12 Months 12,000,000.00 5,000.00

2. Under the Single Stage, Two Envelope Procedure, Bidders are required to submit simultaneously two separate sealed envelopes, one containing (i) the Technical Bid and the other (ii) the Price Bid. Both envelopes must be enclosed in one sealed envelope as per the provision of FB 12 of the Bidding Document.

3. Eligible Bidders may obtain further information via KOSHISH’s Telephone No. 01-5190103 or email: koshishnepal.org

4. Bidding document can be obtained from KOSHISH’s central office, Bagdoi, Lalitpur Nepal before 14th Bhadra, 2077 (28th August, 2020) in office hour 9:00 AM. Bidders must deposit NPR. 5,000.00 (Non-refundable) as the cost of bidding document in the following Bank Account and present original deposit voucher.

Bank and Branch Name: Siddhurtha Bank Ltd. Kamarari Lalitpur Account No. 0181522310 Account Type: Saving

5. Pre-bid meeting shall be held at same as office address at 15th Bhadra 2077 (21st August, 2020) at 01:00 PM.

6. Bids must be valid for a period of 90 days after bid opening and must be accompanied by a bid security document (A Class Bank Guarantee) amount to a minimum of NPR. 12,000,000 (NPR Twelve Hundred Thousand only) which shall be valid for 30 days beyond the validity period of the bid.

7. Sealed Bids must be submitted to KOSHISH Central Office, Bagdoi, Lalitpur, Nepal before 14th Bhadra 2077 (28th August, 2020), 12:00 PM. Bids received after this deadline will be rejected.

8. The bids will be opened in the presence of Bidders representatives who choose to attend at 14th Bhadra 2077 (28th August, 2020), 1:00 PM at KOSHISH Central Office, Bagdoi, Lalitpur, Nepal.

9. If the last date of purchasing and/or submission of bid document fall on a government holiday, then the next working day shall be considered as the last date. In such case the validity period of the bid security shall remain the same as specified for the original last date of bid submission.

10. KOSHISH reserves the right to accept or reject, wholly or partly any or all of the bids without assigning any reason, whatever.
A: General Technical Specification
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PART I: GENERAL TECHNICAL SPECIFICATIONS

1. ITEMS OF GENERAL APPLICATION

1.1 GENERAL

1.1.1 Scope

These General Technical Specifications cover principles, responsibilities and requirements for items which are of general nature and which will be applicable to all civil engineering and building works pertinent to the project.

They shall be read in conjunction with the Part II: Particular Technical Specifications the Conditions of Contract, the Bill of Quantities (BOQ) and the Drawings.

1.1.2 Definitions

a) General

Acceptable/Approved (Approval) - Acceptable to/approved (approval) by the Engineer.

Agreed - Agreed in writing.

As detailed - As detailed on the drawings.

Authorized/ordered/rejected - Authorized/ordered/rejected by the Engineer.

Designated - Shown on the drawings or otherwise specified by the Engineer or, in relation to an item scheduled in the bid documents, descriptive of an item to be priced by a bidder.

Engineer - The person or institution designated to act as the (Residential Engineer / Supervision Engineer/ Consultant’s Engineer) in conditions of contract. It is also referred to as the Project Engineer (Residential Engineer / Supervision Engineer/ Consultant’s Engineer)

Indicated - Indicated in or reasonably to be inferred from the contract, or indicated in writing by the Engineer.

Instructed/directed/permitted - Instructed/directed/ permitted by the Engineer.

Satisfactory - Capable of fulfilling or having fulfilled the intended function.

Service - Any pipeline, cable, duct etc. for conveying or transmitting any fluid or other matter.

Submitted - Submitted with the tender or submitted to the Engineer, as appropriate.

b) Tolerances

Deviation - The difference between the actual (i.e., measured) size or position and the specified size or position.

Permissible deviation - The specified limit(s) of deviation.

Tolerance - The range between the limits within which a size or position must lie.

c) Measurement and Payment

Bill/schedule - The bill/schedule of quantities.

Billed/scheduled rate - The unit rate or price entered in the bill/schedule at which the Contractor undertakes to execute the particular work or to provide the required material, article or service, or to do any or all of these things, as set out in the item concerned.

Billed/scheduled - Listed in the bill/schedule of quantities.

Fixed charge - A charge for work that is executed without reference to time.
Method-related charge - The sum for an item inserted in the bill by the Contractor when tendering, to cover items of work relating to his intended method of executing the Works.

Time-related charge - A charge for work the cost of which, to the Employer, is varied in proportion to the length of time taken to execute the particular item scheduled.

Value-related charge - A charge that is directly proportional to the value of the contract.

1.2 FACILITIES FOR THE ENGINEER

1.2.1 Engineer’s Site Office

The Contractor shall provide, maintain, furnish, and equip for the Engineer 3 room site office required of the principal works and for the period of whole project period. The contractor should provide required no of furnitures for Engineer’s Site office with Tables, executive chairs, al mariha, carpets, file cabinets, curtains, meeting table with chairs.

1.2.2 Services and equipment to the Engineer

The Contractor shall be responsible for the proper maintenance of the above listed offices and equipment, which shall be available at all the site offices during the mentioned period. He shall keep the offices and toilets clean and shall provide adequate cleaning staff for this purpose throughout the contract period.

Similarly, the contractor shall provide 2 no of Laptop with lazer A3 size printer, photocopy machine with regular supply of tonner, printer papers with suitable size and maintenance of the equipments provided for the Engineers.

The contractor shall supply and provide stationary items to the Engineers for entire project period including papers and minor stationary tools and equipments.

The Contractor should assure the payment of the monthly rental fees (if any) including furniture, water supply, electrical supply telephone, internet, TV cable and other services for the above mentioned site offices.

The Contractor shall regularly, and when required, clean, repair, and maintain the Engineers’ offices and vehicles, shall carry out emptying of the septic tanks and supply water to the water tanks. All electricity, water and telephone charges, relating to the Engineers’ offices, including connection and disconnection fees and rental charges shall be paid by the Contractor.

1.2.3 Vehicles

The Contractor shall make available for the use of the Engineer and Engineer's staff the required two no of vehicles – 4 wheel at least Scorpio / double cab type throughout the contract period and shall cover all cost of fully comprehensive insurance, driver, fuel, oil, lubricants etc and maintenance at regular intervals for the vehicles. The vehicles except if it is rented, shall became the property of the contractor at the end of the contract.

1.2.4 Survey Assistance and Equipment

The Contractor shall make available to the Engineer suitably educated and trained survey assistants and labourers for use on and about the Site in sufficient numbers and at all reasonable times.

Necessary survey equipment shall be provided for the use of the Engineer's staff, and maintained in good condition throughout the Contract period:

1.2.5 Safety Equipment

The Contractor shall provide the Engineers with necessary safety equipment which shall become the property of the Contractor upon completion of the Contract.

1.2.6 Support Staff

The Contractor shall provide, for the sole use of the Engineer for the duration of the Contract, the services of necessary personnel.
1.2.7 Engineer's Laboratory

The Contractor shall provide and maintain a testing laboratory with furniture and equipment, required to carry out all tests specified. The Contractor shall employ full-time for the Contract period a qualified laboratory technician capable of carrying out the tests specified or implied for testing of materials. The laboratory technician shall assist and work under the direction of the Engineer's Representative. The Contractor shall supply all labour for assisting the technician.

The supplied laboratory equipment shall be maintained, repaired and replaced in the event of loss or damage for the duration of the Contract. The equipments shall become the property of the Contractor at the end of the Contract.

1.2.8 Measurement and Payment

No separate measurement and payment will be made for any of the above listed items under this Section 1.4, Site Installation. All associated costs are deemed to be included in the unit rates of the BOQ.

1.3 ACCESS TO AND POSSESSION OF SITE

1.3.1 The Site

The Site includes any designated areas and any temporary working areas described herein. Final Possession of the Site, or Parts thereof, for the purpose of carrying out the execution of the Works to be given by the Employer pursuant to Clause 42.1 of the Conditions of Contract shall be subject to any restrictions mentioned in the Contract. As such land acquisition is a slow process the Contractor shall himself obtain whatever temporary wayleaves are required by him.

1.3.2 Temporary Wayleaves, Access Costs

In accordance with Sub-Clause 42.3 of the Conditions of Contract the Contractor shall be responsible for obtaining temporary wayleaves.

The cost of obtaining wayleaves for temporary working areas and for any additional areas outside the Site required by the Contractor in connection with the Works as well as for the access to all of these shall be borne by the Contractor himself.

The Contractor shall at all times provide proper facilities for access and inspection of the Works by the Engineer, his assistants, inspectors, agents and representatives of Client/ public agencies having jurisdiction.

The Contractor shall reinstate any temporary working areas to the condition prevailing prior to his initial entry as soon as possible after the work in those areas has been completed so as to keep the period of occupation to a minimum. The Contractor shall in any event restore the areas to a tidy and workmanlike condition. Boundary walls, fences and other structures that have been damaged, removed or otherwise interfered with by the Contractor shall be restored to a condition at least equivalent to their original condition.

Prior to commencing work in the vicinity of overhead power lines the Contractor shall acquaint himself with all the regulations of the Nepal Electricity Authority governing such work.

The Contractor shall be responsible for ensuring that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes or other large masses of steel are in the vicinity of power lines.

1.3.3 Access to Adjoining Property

Convenient access to driveways, houses and buildings adjoining the work shall be maintained and temporary approaches to intersecting streets and alleys shall be provided and kept in good condition by the Contractor.

As soon as a section of surfacing, pavement, or a structure has been completed, it shall be opened for use by traffic at the request of the Engineer.
The Contractor shall not prevent the free access to public water valves, water hydrants, or utility valves.

In order that unnecessary delay to the travelling public may be avoided, the Contractor, when so ordered by the Engineer, shall provide competent flag men whose sole duty shall consist of directing traffic either through or around the work. Reference is made also to Sub-Section 1.5.2.

1.3.4 **Permanent Right-of-Way**

The Employer will make all statutory arrangements necessary for obtaining the final possession of the Site and the permanent right-of-way in the shortest possible time.

1.3.5 **Measurement and Payment**

Reference is made to Sub-Section 1.2.8.

1.4 **SITE INSTALLATIONS**

1.4.1 **Camp for Contractor's Staff**

In accordance with all stipulations of the Conditions of Contract the Contractor shall provide adequate housing with all necessary amenities and facilities for his staff and labour. The type of housing, such as accommodation containers, pre-fabricated or in-situ buildings or even rental is entirely up to him. Also the choice of one central camp or of various sub-camps is up to him as this depends greatly on the approved work programme.

During the whole period of existence, from setting up through operation to final removal upon completion of the Works, the Contractor shall be fully responsible for constantly carrying out all measures necessary for safeguarding the natural environment affected by his camp or camps.

He shall cause the least possible interference with existing amenities, whether man-made or natural. No trees shall be felled except as authorized by the Engineer (re clause 2.1 of this specification).

Latrine and ablution facilities and first-aid services shall be provided in sufficient type and numbers to the satisfaction of the Engineer and shall be maintained in a clean and sanitary condition at all times.

On completion of the Works or as soon as the facilities provided by the Contractor are no longer required, the Contractor shall remove such facilities and clear away all surface indications of their presence.

1.4.2 **Contractor's Offices, Stores and Services**

The Contractor shall provide, erect, construct, maintain and subsequently remove proper offices, stores, workshops, laboratories, storage and parking areas for his own use. Such facilities shall be sufficiently sized and equipped to enable him to manage his operations and those of his Subcontractors in a professional manner and to enable him to carry out all his obligations under the Contract.

Sheds for storage of materials that may deteriorate or corrode if exposed to the weather shall be weatherproof, adequately ventilated and provided with raised floors.

Within his offices a meeting room shall be available for site meetings with the Engineer and the Employer.

These Contractor's facilities shall be subject to the same stipulations regarding siting, interference with amenities and environmental protection as the Contractor's camp.

1.4.3 **Contractor's Plant**

When working in built-up areas, the Contractor shall provide and use suitable and effective silencing devices for pneumatic tools and other plant that would otherwise cause a noise level exceeding 85 dB (A) during excavation and other work. Alternatively, he shall, by means of barriers, effectively isolate the source of any such noise in order to comply with above requirement.
1.4.4 Water Supply

The Contractor shall make his own arrangements for the supply of all water for his camp, office and other temporary buildings as well as for the execution of the Works.

Temporary water connection may be arranged with NWSC at established rates. Water for testing of pipe sections, however, shall not be taken from the mains as stipulated in the relevant Section of the Technical Specifications.

When using other sources of water, such as stone spouts, etc. the Contractor shall have due regard to and coordinate with other users.

Water for drinking purposes shall be of drinking water quality.

1.4.5 Sanitation

The Contractor shall maintain the Site and all working areas in a hygienic conditions. In all matters of health and sanitation he shall comply with the requirements of the local Medical Officer of Health or other competent authority.

1.4.6 Sewage and Waste Disposal

The Contractor shall make provision for the discharge or disposal from his camp, offices and the Works of all water as well as of all liquid and solid waste products however arising. The methods of disposal shall be to the satisfaction of the Engineer and of any authority or person having an interest in any land or watercourse over or in which water and waste products may be so discharged.

1.4.7 Pollution

The Contractor shall take all reasonable measures to minimize any dust nuisance, pollution of streams and inconvenience to or interference with the public (or others) as a result of the execution of the Works.

1.4.8 Energy Supply

The Contractor shall install, operate, maintain and subsequently remove temporary supplies of electricity for power, heating, cooling, lighting and ventilation of all camps, offices, stores, laboratories and other temporary buildings used by the Contractor in addition to all electricity requirements in connection with the construction, testing and maintenance of the Works.

The Contractor shall ensure that all proposed electrical installations comply with the requirements of the Nepal Electricity Authority and shall be responsible for and shall bear all costs associated with obtaining the written approval of that authority for such installations and their operations.

Prior to placing orders for transformers, conductors, cables and associated equipment, the Contractor shall ensure by enquiry with the Nepal Electricity Authority that his proposed equipment is suitable for use with the existing or proposed medium/high tension electricity supply lines.

1.4.9 Supply of Fuel, Lubricants, etc.

The Contractor shall be responsible for arranging and ensuring that adequate supplies of petrol, diesel oil, motor oil, kerosene, lubricants and other petroleum products are available at all times to meet his requirements for the purpose of or in connection with the Contract; the Contractor's particular attention is drawn to this requirements as from time to time shortages and interruptions in the supply of fuel oils, etc., may occur.

He shall make his own arrangements for the supply of all other types of fuel required for the purposes of the Contract.

Firewood may be obtained on the open market. Under no circumstances shall the Contractor cut down trees for firewood.

With regard to the transportation, storage and handling of all his fuel requirements, including all electrical connections, he must strictly comply with all relevant safety codes and regulations.
1.4.10 Temporary TV, Telephone and Internet Connections

**Telephone**
The Contractor shall arrange at his own cost for temporary telephone connections to his offices and other installations.

He shall be responsible for all installations, connection and disconnection charges of all telephones for his and his Representative's offices.

Similarly, 2 Sets of new Mobile (Smart) Phone shall be provided to Engineers with post paid SIM card and necessary monthly cost and maintenance shall be borne by the contract till the end of Defect's Liability Period.

**Internet / WIFI**
A reliable unlimited Internet facility with necessary equipment and accessories shall be provided to the Engineers’ mobile sets and wifi system at the Engineer’s site office and at site residence including monthly bills shall be borne by the contractor till the end of Defect's Liability period of the Project.

**Television Sets**
The contractor shall provide a 32” LED Smart TV to the consultant’s Site residence with cable connections with monthly bills payments till the end of the project.

No separate payment shall be made against the facilities of Telephone, Internet and TV facilities provided to Engineers at the site.

1.4.11 First Aid

The Contractor shall make his own arrangements for treatment of casualties on the Site in such first-aid units as may be thought necessary. The Contractor shall be responsible for the construction of such first-aid units and their management and operation and the removal by ambulance of injured or sick employees to nearby hospitals. The first-aid service shall cover the Contractor’s own personnel as well as that of the Employer, the Engineer and all Subcontractors.

1.4.12 Fire Protection

No naked fire shall be used by the Contractor on or about the Site otherwise than in the open air without the permission in writing of the Engineer. If in the Engineer's opinion the use of naked fire may cause a fire hazard, the Contractor shall at no extra cost to the Employer take such additional precautions and provide such additional fire fighting equipment as the Engineer considers necessary.

The term "naked fire" shall be deemed to include electric arcs and oxyacetylene or other flames used in welding or cutting metals.

Compliance with the requirements of the Engineer shall not relieve the Contractor of any of his obligations under the Contract.

1.4.13 Contractor’s Canteen

The Contractor shall provide adequate facilities to comply with Sub-Clause 9.4 of the Conditions of Contract.

1.4.14 Site Safety

Reference is made to the relevant stipulations of Sub-Clause 9.4 of the Conditions of Contract.

The Contractor shall at all times in the conduct of his work and that of his Subcontractors adhere to the established rules and regulations concerning all safety matters at Site such as the recommendations contained in the "Manual of Accident Prevention in Construction", published by the Associated General Contractors of America, Inc., or other internationally recognized recommendations to the extent that such provisions do not conflict with the applicable laws. This is specially important wherever it is necessary to enable the free passage of the public through the Site.

The Contractor's Safety Officer shall have the qualification and the authority to issue instructions to the Contractor's personnel regarding protection measures to prevent accidents.
During construction the Contractor shall erect, maintain and subsequently remove sufficient barricades, guards, lighting, sheeting, shoring, temporary sidewalks and bridges, danger signals as well as temporary covering of potential accident areas.

If and where required the Contractor shall erect and maintain suitable and approved temporary fencing to enclose such areas of the works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under Clauses 13 of the Conditions of Contract. Where temporary fencing has to be erected alongside a public road, foot-path, etc., it shall be of the type required by and shall be erected to the satisfaction of the authority concerned.

All open excavations along pipe lines shall be protected sufficiently to keep out livestock, and ensure the safety of workmen and members of the public and be in accordance with the directives of the police and the other local regulations.

Where work is to be carried out in the proximity of buildings, bridges, tanks or other structures, the Contractor shall take all necessary precautions, including shoring and strutting, where necessary, to ensure the safety of the structures that are at risk.

The Contractor shall be responsible for all damages or injury which may be caused on any property by trespass by the Contractor's or his Subcontractor's employees in the course of their employment, whether the said trespass was committed with or without the consent or knowledge of the Contractor.

1.4.15 Protection of Overhead and Underground Services

The Contractor will be held responsible for any damage to known services (ie services that are within the Site and are shown on the drawings) and he shall take all necessary measures to protect them. All work or protective measures shall be subject to approval. In the event of a service being damaged, the Contractor shall not repair any such service unless instructed to do so.

Where no underground services are shown on the drawings or scheduled but the possibility of their presence can reasonably be inferred, the Contractor shall, in collaboration with the Engineer, ascertain whether any such services exist within the relevant section of the Site. The Contractor shall complete such an investigation well in advance of the start of construction work in the said section and he shall submit a report in good time to enable the Engineer to make whatever arrangements are necessary for the protection, removal or diversion of the services before any construction works commences.

As soon as any underground service not shown on the drawings is discovered, it shall be deemed to be a known service and the Contractor will be held responsible for any subsequent damage to it. If such service is damaged during the course of its discovery, the cost of making good such damage will be met by the Employer unless he establishes that the Contractor did not exercise reasonable diligence and that the damage was avoidable.

Where the authority concerned elects to carry out on its own account any alterations or protective measures, the Contractor shall co-operate with and allow such authority reasonable access and sufficient space and time to carry out the required work.

Permanent alterations to or permanent diversion of services necessitated by the execution of the Works and authorized will be paid for in terms of the conditions of contract, but no such work will be paid for if it has not been previously inspected and if proper written instructions have not been given.

1.4.16 Signboards

Signboards shall be placed at specified locations giving, in English and Nepali, information about the project and Employer, and the names of the Engineer and Contractor in a form and size to be agreed upon by the Employer and the Engineer. They shall be of durable construction capable of withstanding the effects of the climate until the end of the Defects Liability Period.

Besides these signboards the Contractor shall not, except with the written authority of the Engineer, exhibit or permit to be exhibited on the site any other form of advertisement.
1.4.17 **Site Roads**

The Contractor shall provide and maintain such access to the various sections of the Works as he requires for the proper execution of the work. Access roads shall be so arranged as to minimize inconvenience to adjoining landowners or occupants and to the general public. The site roads shall be of gravel or equivalent material providing a hard surface for vehicles. Temporary roads shall be removed when they are no longer required.

1.4.18 **Testing Facilities, Laboratory**

The Contractor shall provide a site laboratory equipped and furnished with all testing facilities required to perform all mandatory tests stipulated in the various specific clauses of these Technical Specifications (see Clause 1.2.7 above).

Other tests which may be required upon instruction of the Engineer and which cannot be performed in the site laboratory shall be carried out on behalf of the Contractor at other laboratories acceptable to the Engineer.

1.4.19 **Cleaning-up of Site**

Reference is made to Clause 55 and 56 of the Conditions of Contract.

Before application is made for the Employer to accept any substantially completed Section of the Works, all items shall be complete, ready to operate and in a clean condition. All trash, debris, unused building materials and temporary facilities shall have been removed from the Site. Tools, equipment and construction machinery not needed during the subsequent Defects Liability Period for repair and adjustment shall not remain on the Site. The temporary walkways, parking areas and roadways shall be completely swept and broomed.

1.4.20 **Site Drainage**

The Contractor shall keep each Section of the Works well drained until the Engineer certifies that it is substantially complete and shall ensure that, so far as is practicable, all work is carried out in the dry. Excavated areas shall be kept well drained and free from standing water except where this is impracticable having regard to methods of Temporary Works properly adopted by the Contractor.

The Contractor shall provide, operate and maintain in sufficient quantity such pumping equipment, well points, pipes and other equipment as may be necessary to minimize damage, inconvenience and interference and shall construct, operate and maintain all temporary coffer-dams, sumps, ditches, drains and other temporary works as may be necessary to remove water from the Works while construction is in progress. Such Temporary Works and plant shall not be removed without the approval of the Engineer.

Notwithstanding any approval by the Engineer of the Contractor's arrangements for the removal of water, the Contractor shall be responsible for the sufficiency thereof and for keeping the Works safe at all times and for making good at his own expense any damage to the Works.

The Contractor shall be responsible to keep the Works clear of water at whatever pump rate found necessary.

1.4.21 **Measurement and Payment**

No separate measurement and payment will be made for any of the above listed items under this Section 1.4, Site Installation. All associated costs are deemed to be included in the unit rates of the BOQ.

1.5 **TEMPORARY FACILITIES**

1.5.1 **Temporary Diversions of Utilities**

If in the opinion of the Engineer it is necessary to make temporary diversions of services in connection with the Works, the Contractor shall arrange with the relevant authority for the construction of diversions. The cost of these diversion shall be covered under the appropriate item in the Bill of Quantities.
The Contractor may at his own cost and subject to the approval of the Engineer and the authority concerned, make such temporary diversions as may facilitate the carrying out of the Works. These temporary diversions shall be reinstated to the full satisfaction of the Engineer and the relevant authority on completion of the Works.

1.5.2 Detours and Traffic Control

The Contractor shall program his work in such a way that, wherever the temporary closure of street sections to public thoroughfare cannot be avoided, the duration of traffic diversion can be kept as short as possible. No streets shall be closed and no detours shall be introduced and no traffic diverted until the Contractor's proposals have been approved by the Engineer and the appropriate Government authorities, such as the Roads Department.

Where work is to be carried out in public roads, the Contractor shall give notice to the Engineer sufficiently in advance of the date on which he wishes to commence such work.

The Contractor shall be responsible for obtaining the permission of the Employer, Road Department and the Police for works he intends to carry out in public roads. Two copies of the Contractor's proposals to the relevant authorities shall be submitted to the Engineer. One copy of all obtained approval shall be submitted to the Engineer.

The Contractor's attention is drawn to the fact that processing of the documentation required by the local authorities prior to the cutting of existing public roads takes approx. 30 days. During the Monsoon period (June to August) no road cuttings are normally allowed.

Detours shall be selected in such a way that the inconvenience to the affected traffic as well as to the inhabitants of the affected areas is kept to a minimum.

The Contractor shall furnish, install and maintain at all times during the execution of the Works all necessary traffic signs, barricades, lights, signals and other traffic control devices, including flagging and other means of guiding traffic through the work zone. Traffic control shall be managed in accordance with prevailing rules and regulations, and with the approval and to the satisfaction of the Engineer.

All devices mentioned above shall be in conformity with the requirements of the Roads Department. All traffic signs and control devices to be furnished and installed by the Contractor shall be approved by the Engineer for their location, position, visibility, adequacy and manner of use under specific job conditions.

All traffic control devices necessary for the initial stage of construction shall be properly placed and operational before any construction is allowed to start. When work of a progressive nature is involved, the necessary signs shall be moved concurrently where they are needed.

If the Engineer determines that proper provisions for safe traffic control are not being provided or maintained, he may restrict construction operations affected by such defective signs or devices until such provisions are established or maintained, or may altogether order suspension of the Work until a proper traffic control is achieved. In case of serious or willful disregard by the Contractor of the safety of the public or his employees, the Engineer may take necessary steps to rectify the situation and deduct the cost thereof from monies due or becoming due to the Contractor. The Contractor shall be responsible for all resulting delays.

The Contractor shall designate or otherwise employ personnel to furnish continuous surveillance of the traffic control operations. The designated personnel shall be available day and night to respond to calls involving damage due to vandalism or traffic accidents.

At sections where traffic is in operation and when ordered by the Engineer, the movements of the Contractor's equipment from one place of work to another shall be subject to traffic control. During rush hours movement of larger vehicles, such as trucks, cranes, dumpers, etc. through main thoroughfare are not permitted by the police. Spillage resulting from hauling operations along or across the road way shall be removed immediately at the Contractor's expense.

1.5.3 Provision of Temporary Services

When the rehabilitation or replacement of existing public utilities requires their temporary disconnection, the Contractor shall provide the affected users with temporary services in at least the same standard as the original services.
For water supply he may install temporary lines or arrange for regular supply by tankers.

When forced to disconnect existing sewers the Contractor shall install temporary pipes of adequate size to carry off sewage from any private sewer facilities cut off by construction work. Connections to temporary pipes shall be made immediately by the Contractor upon cutting off the existing facility. No sewage shall be allowed to flow from any severed facility upon the ground surface or into the trench excavation. Pipes used in temporary sewers may be plastic or approved flexible material.

Upon completion of work the Contractor shall replace all severed connections and restore to operating order the existing sanitary facilities.

No valve or other controls in public service facilities shall be operated by the Contractor without approval of the Engineer. All users affected by such operation shall be notified by the Contractor at least one hour before the operation and advised of the probable time when service will be restored.

1.5.4 Protection of Adjoining Property

The Contractor shall control the movement of his crews and equipment on right-of-way including access routes approved by the Engineer so as to minimize damage to crops and property and shall endeavor to avoid marring the lands. Ruts and scars shall be obliterated and damage to land shall be corrected and the land shall be restored as closely as possible to its original conditions before final taking-over of the Works.

The Contractor shall be responsible directly to the Employer for any excessive or avoidable damage to crops or lands resulting from his operations whether on lands adjacent to right-of-way or on approved access road and deductions will be made from payment due to the Contractor to cover the amount of such excessive or avoidable damage as determined by the Engineer.

1.5.5 Reinstatement Upon Completion

Temporary facilities shall be provided by the Contractor, only for as long as required after which he shall dismantle and remove the same from their place of use as speedily as possible. Re-usable components shall be safely stored by the Contractor in his yard.

The place of use shall be cleared and reinstated immediately to at least the condition existing before the temporary facilities were provided to the satisfaction of the Engineer.

1.5.6 Measurement and Payment

Ordered temporary diversions of utilities under Sub-Section 1.5.1 and provision of temporary services under Sub-Section 1.5.3 shall be covered by a provisional sum in the BOQ. Measurement will be at actual quantities. Valuation will be in accordance with Clause 40 of the Conditions of Contract.

1.6 COORDINATION WITH OTHER AUTHORITIES

1.6.1 Statutory Services

As far as possible the Contractor shall acquaint himself with the actual location of all existing public utilities such as sewers, water mains, drains, cables for electricity, telephone lines, lighting poles, masts, etc., before commencing any works likely to affect the existing utilities. The Contractor shall with the assistance of the Employer obtain such information directly from the responsible authorities as early as possible.

1.6.2 Notices, Permits

Well in advance of the programmed start of any work which may affect traffic or any existing utilities the Contractor shall give advance notice to the respective authority indicating the type, the exact location, the programmed starting time and the expected duration of the works and shall provide whatever particulars may be required by the authorities to issue any required permits and make all necessary arrangements. The Employer will provide whatever assistance possible to the Contractor to facilitate the permit procedure which, however, will remain the sole responsibility of the Contractor.
1.6.3 Witnessing and Post-Construction Clearances

It is expected that the issue of these permits will be tied to the requirement that the work may only be carried out in the presence of authorized inspectors from the authorities concerned. Their job will be to witness and assess any damage or interference with their respective utility. Should such disturbances occur it will be at their discretion to authorize either the Contractor to correct them or to arrange for specialized repairs through their own personnel.

Notwithstanding the provisions of Clause 11 of the Conditions of Contract, the Contractor shall be fully responsible for all costs whatever resulting from avoidable damages of or interferences with other utilities.

As proof that the works in question have been completed to the satisfaction of the authorities concerned the Contractor shall submit to the Engineer upon request official post-construction clearances issued by the respective authorities.

1.7 Submissions by the Contractor

1.7.1 Pre-Construction Surveys and Setting Out

Upon commencement of the Works the contractor shall carry out all additional survey work necessary for setting out the Works. He shall establish all setting out necessary for the performance of the Work to the approval of the Engineer including levels of the original ground surface at the Site and final surveys of the completed Works for the final measurement. Levels shall close within 25 mm times the square root of the length of the circuit in km.

Ground levels shall be taken jointly by the Contractor and the Engineer both prior to commencing and after completion of earthworks. The result of the survey shall be recorded in the manner agreed between the Engineer and the Contractor and be signed by both.

Where cross sections are ordered these shall be at 25 m intervals or at such other spacing as may be ordered by the Engineer. The location of the first cross section shall be approved by the Engineer and each cross section shall extend a minimum distance of 10 m beyond the limits of the Works.

From the center line and grades established, the Contractor shall furnish and place all additional stakes, templates and bench marks necessary for marking and maintaining points, lines and sections for layout of the Works. The Contractor shall give 2 working days notice in writing whenever he will require the assistance of the Engineer for laying out any portion of the Work.

The Contractor's methods of recording survey data shall be subject to approval and field books and tabulated data shall be well maintained and made available for inspection and checking by the Engineer when ordered.

Instruments and equipment for surveys shall be subject to rigorous inspection by both the Contractor and the Engineer and any item found to be defective, in the opinion of the Engineer, shall be promptly replaced, repaired or adjusted as directed. All surveying shall be done under the direct supervision of a qualified surveyor or engineer who, as an employee of the Contractor, shall be subject to the approval of the Engineer at all times during the progress of the work in accordance with Clause 9 of the Conditions of Contract.

1.7.2 Detailed Design of Temporary Works

In accordance with Clause 18 of the Conditions of Contract the Contractor shall submit for approval full particulars, including drawings of any of the site installations and Temporary Works. If required the Contractor shall also submit calculations of the stresses, strains and deflections which will arise in falsework or other Temporary Works and these calculations shall be accompanied by detailed Working Drawings to show the Contractor's proposals. Approval by the Engineer of the Contractor's proposals, calculations or drawings shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

1.7.3 Working Drawings

Working Drawings shall be submitted by the Contractor to the Engineer as called for by the Contract. Working Drawings shall include, but not be restricted to, reinforcement detail drawings and bending
schedules, shop drawings for structural steel and miscellaneous metal work, working drawings for mechanical equipment, architectural items and electrical work and drawings for other work for which the Engineer's approval is required.

It shall be the Contractor's own responsibility to prepare such Working Drawings as he may require for the proper setting out and construction of all structures and facilities. Work shall not commence on an individual structure or facilities until the relevant Working Drawings have been approved by the Engineer.

Within 28 days of the date of the letter of Acceptance, the Contractor shall submit to the Engineer a Drawings Submittal Schedule for the Working Drawings listing the anticipated dates upon which they will be submitted for approval by the Engineer. The submission dates shall be spaced at reasonable intervals to allow at least 14 days for the Engineer to duly check and to either approve them or to request changes or modifications, as the case may be.

All dimensions shall be in metric units and each drawing shall be properly identified by a drawing head and a numbering code in the form prescribed by the Engineer upon commencement of the Works. ISO or DIN standard size sheets shall be used.

Drawings shall not be smaller than 210 x 297 mm (DIN A4) or larger than 841 x 1189 mm (DIN A0).

Prior to submittal, the Contractor shall also check the drawings prepared by his Subcontractors for accuracy and completeness, especially that the relation to adjoining work is accurately shown.

The Contractor shall submit 3 (three) copies of all drawings for approval.

Any changes or modifications to the Working Drawings that the Engineer considers necessary shall be made by the Contractor promptly and the drawings resubmitted for approval.

Approval of Working Drawings will be given by the Engineer in the form of a stamp "RELEASED FOR CONSTRUCTION" together with the date and the authorized signature. Only those Working Drawings carrying the signed and dated stamp shall be used for execution.

Copies of all such approved Working Drawings together with one unreduced transparency shall be supplied to the Engineer by the Contractor immediately after approval. The cost of preparing and providing all Working Drawings shall be included in the Contract Rates.

Should it be found at any time after approval has been given by the Engineer to a Working Drawing submitted by the Contractor that the said Working Drawing does not comply with the terms and conditions of the Contract or that the details do not agree with the Working Drawings previously approved, such alterations and additions as may be deemed necessary by the Engineer shall be made therein by the Contractor and the work carried out accordingly without entitling the Contractor to extra payment on account thereof, except where such alternations and additions are to be made in direct consequence of written order by the Engineer to vary the Works in accordance with Clause 39 of the Conditions of Contract.

No examination by the Engineer of any document submitted by the Contractor or of the Contractor's Working Drawings, nor the approval expressed by the Engineer in regard thereto, either with or without modification, shall absolve the Contractor from any liability imposed upon him by any provision of the Contract. Notwithstanding the Engineer's approval of the Working Drawings the Contractor shall be responsible for any dimensional or other errors.

1.7.4 **As-Built Drawings**

Such approved Working Drawings as have been selected by the Engineer shall be correctly modified for inclusion in the As-Built Drawings incorporating such variations to the Works as have been ordered and executed. Such drawings shall show the actual arrangement of all structures and items of equipment installed under the Contract. The Contractor shall submit 1 (one) reproducible copy and 3 (three) prints of all As-Built Drawings clearly named as such to the Engineer for approval before applying for the Taking-Over Certificate for the respective Section of the Works.

During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the approval to facilitate easy and accurate preparation of the As-Built Drawing in accordance with Clause 58 of the COC.
Irrespective of the other contractual prerequisites stipulated in Clause 56 of the Conditions of Contract, no Section of the Works will be considered substantially completed until the respective As-Built Drawings have been approved by the Engineer.

1.7.5 **Progress Reports**

The Contractor shall furnish the Engineer, at no extra cost to the Employer, at regular monthly intervals, no. of copies and formats determined by the Engineer, with Progress Reports containing the following information:

(a) physical progress for the report month and estimated progress for the next month;
(b) completion schedules (target and actual) based on the approved construction programme as provided in Clause 27 of the Conditions of Contract;
(c) updated S-curves for physical progress at different sections of the Works any report which may be specifically requested by the Employer and/or the Engineer.quality management activities weather / daily report

These monthly reports shall be submitted not later than 7 days after the end of the report month.

1.7.6 **Record / Progress Photographs**

Out of these Record Photographs the Contractor shall select 10 characteristic ones as Progress Photographs attached to the Progress Reports.

Notwithstanding the obligations of the Contract or to provide cameras for the Engineer's site office, the Contractor shall arrange required number of photographs to be taken by a professional photographer monthly, or as ordered by the Engineer as Record Photographs and shall provide the negatives and 2 colour prints each on glossy paper unmounted and of a size not less than 210 mm x 297 mm (A4) in transparent plastic pockets contained in hard cover album. Each print shall contain upon its back the date and description of the view taken. The Contractor shall ensure that no use is made of any negative or print without permission from the Employer.

1.7.7 **Measurement and Payment**

No separate measurement and payment will be made for all Sub-Sections of Section 1.7, the cost of which shall be deemed to be included in other unit rates of the BOQ.

1.8 **QUALITY CONTROL**

1.8.1 **Quality Control Plan and Procedures**

The Contractor shall be responsible for establishing and maintaining procedures for quality control which will ensure that all aspects of the Works comply with the requirements of the Contract.

As soon as reasonably practicable prior to the commencement of Works the Contractor shall submit for approval a Quality Control Plan giving detailed proposals for control of quality of all aspects of work on the Site and at suppliers' workshops.

The Quality Control Plan shall include the following:

a list of the Contractor's staff engaged in quality control
a list of any outside testing agencies employed by the Contractor for work in connection with quality control
where a testing laboratory is to be established on Site under the Contract, a list of major items of equipment and a layout of the laboratory, together with details of the tests which will be carried out there
a list of manufactured items and materials, obtained by the Contractor for the Works, which require inspection at the suppliers' premises, and the proposed procedures for ensuring quality control
a list of materials and operations to be inspected by the Contractor at the various stages of construction work on Site, together with inspection procedures, test types and frequencies
sample of proposed quality control records, testing forms and reporting forms.
Standards of Testing to be followed i.e. testing procedures.
Unless the Engineer permits otherwise, the approved Quality Control Plan shall be followed throughout the construction of the Works. Any approval by the Engineer of the Contractor's plan and procedures shall not relieve the Contractor of his obligation to ensure that the Works comply with the requirements of the Contract.

The Contractor shall appoint a suitably qualified member of his staff to be responsible for all aspects of quality control and to maintain effective liaison with the Engineer.

1.8.2 Sampling and Testing

Reference is made to Clause 33 and 34 of the Conditions of Contract. The Contractor shall provide for the approval of the Engineer, samples of all construction materials and manufactured items required for the Permanent Works. All samples rejected by the Engineer shall be removed from Site. All approved samples shall be stored on Site by the Contractor for the duration of the Contract, and any materials or manufactured items subsequently delivered to Site for incorporation in the Permanent Works shall be of a quality at least equal to the approved sample.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer. Samples for testing will generally be selected by the Engineer from materials to be utilized in the project and all tests will be under the supervision of, and as directed by, and at such points as may be convenient to the Engineer.

Material requiring testing shall be furnished in sufficient time before intended use so as to allow for testing. No materials represented by tests may be used prior to receipt of written approval of said materials.

The Contractor shall give the Engineer at least 14 days notice in writing of the date on which any of the materials will be ready for testing or inspection at the suppliers' premises or at a laboratory approved by the Engineer and unless the Engineer shall attend at the appointed place and time the test may proceed in his absence. The Contractor shall in any case submit to the Engineer within 7 (seven) days after every test such number of certified copies of the test readings as the Engineer may require.

The provisions of this Clause shall also apply to materials supplied under any nominated subcontract.

After all construction at each Section is completed and before applying for taking-over, the Contractor shall perform field tests as called for in the Specifications. The Contractor shall demonstrate to the Engineer the proper operation of the facilities and the satisfactory performance of the individual components. Any improper operation of the system or any improper, or faulty construction shall be repaired or corrected to the satisfaction of the Engineer. The Contractor shall make such changes, adjustments or replacement of equipment as may be required to make the same comply with the Specifications, or replace any defective parts or materials.

In addition to any special provision made herein as to sampling and testing materials by particular methods, samples of materials and workmanship proposed to be employed in the execution of the Works may be called for at any time by the Engineer and these shall be furnished without delay by the Contractor at his own cost. Approved samples will be retained by the Engineer who will be at liberty to reject all materials and workmanship that are not equal or better in quality and character than such approved samples.

All costs incurred by the Contractor, in connection with sampling and testing of all materials and items required for the Works shall be deemed to be included and covered by the tendered Contract Rates.

Notwithstanding the provisions for payment in respect of testing given in Clause 34 of the Conditions of Contract, all costs in connection with conducting tests and delivery of samples to an approved laboratory shall be deemed to be included and covered by the Contract Rates for the following categories of tests:

a) tests conducted at the premises of the Contractor, Subcontractor, manufacturer or supplier which are normally or customarily carried out at such premises for the items or materials being supplied for the Works.

b) tests which are normally or customarily conducted on the items or materials being supplied for the Works by the Contractor, Subcontractor, supplier or manufacturer but which have to be conducted at an approved laboratory because the necessary testing facilities are not available on the premises of the Contractor, Sub-Contractor, supplier and manufacturer.
c) tests on locally obtained materials or items either on the Site or at an approved laboratory for the purpose of obtaining the approval of the Engineer to the classification, use and compliance with the Specifications of such items or materials.
d) routine quality control tests conducted by the Contractor to ensure compliance with the Specifications.
e) regular testing of concrete and other materials as specified in the relevant Chapters of the Technical Specifications.
f) standard shop and Site acceptance tests, including trial assemblies, of mechanical equipment.

1.8.3 Preservation of Approved Samples

Where samples, including samples of materials and workmanship constructed on the Site, are submitted as a reference for materials and workmanship to be provided as part of the Permanent Works, they shall, after approval by the Engineer, be carefully preserved for this purpose on site by the Contractor to the satisfaction of the Engineer until permission is given by the Engineer for their disposal.

1.8.4 Inspection and Acceptance

The Engineer may appoint Inspecting Engineers to inspect and test materials and articles on his behalf prior to their despatch to the Site. The Inspecting Engineer will examine, test and if necessary analyze all materials and articles to be used in the Works including all items of fabricated or finished work unless the Engineer shall direct otherwise. The Inspecting Engineer shall be granted free access at all reasonable times to the premises of the Contractor and/or any Subcontractor and shall be afforded every facility for making inspections, making tests, which it is normal or customary to undertake at the premises of the Contractor or Sub-Contractor and for taking samples for testing and analysis.

The Contractor and/or Subcontractor shall give adequate notice to the Engineer or the Inspecting Engineer as to when any materials, articles or fabricated work will be ready for inspection and shall take into account the possibility of delays in postal communication when giving such notice. Related requests by telephone or telex for an immediate inspection of particular items scheduled for shipment which cannot be met will not be sufficient reason for waiving inspection thereof and the Contractor shall be held solely responsible for all consequences arising out of any delay resulting from his failure to give adequate notice.

The Engineer and the Inspecting Engineer shall be kept properly informed of the progress of any work being carried out on materials and articles being prepared or supplied by the Contractor or any Subcontractor for use in the Works to enable them to make such arrangements for inspection, testing and analysis as they may consider appropriate.

The inspection of all items of fabricated or finished work will be carried out only against Working Drawings that have been approved by the Engineer and that bear his endorsement of approval.

Neither the Engineer nor the inspecting Engineer will undertake the inspection of any item of fabricated or finished work until such time as the Contractor shall have forwarded to the Engineer the approved Working Drawings covering the items to be inspected, together with four copies of the respective orders.

The Engineer may require to inspect work being prepared and to witness tests at supplier's premises. The Contractor shall give the Engineer adequate notice of the programmes of work and testing at suppliers' premises to enable the Engineer to arrange such inspections.

Manufactured items and materials delivered to the Site shall be inspected by the Contractor on arrival. Any defects shall be notified to the Engineer. Minor defects to surface finishes and the like in manufactured items shall be made good in an approved manner to the satisfaction of the Engineer. Items with more serious defects shall be returned to the suppliers for correction or replacement as appropriate.

Inspections or tests carried out by or on behalf of the Engineer shall not relieve the Contractor of his responsibilities in connection with quality control.

1.8.5 Materials/Equipment Certificates

Where certificates are required by the Specifications or relevant Reference Standard, the original and one copy of each such certificate shall be provided by the Contractor.
Certificates shall be clearly identified by serial or reference number and shall include information required by the relevant Reference Standard or Specification clause.

The timing for submittal of certificates shall be as follows:

(a) manufacturer's and supplier's test certificates shall be submitted as soon as the tests have been completed and in any case not less than 7 calendar days prior to the time that the materials represented by such certificates are needed for incorporation into the Permanent Works
(b) certificates of tests carried out during the construction or on completion of parts of the Permanent Works shall be submitted within 7 days of the completion of the test.

No materials, articles or items of fabricated or finished work to be supplied by the Contractor or Subcontractors which have been inspected and tested by the Engineer or the inspecting Engineer shall be despatched unless a Passing Certificate has been requested by the Contractor from the Engineer and subsequently been issued by the Engineer to the effect that the same are approved. Neither the Contractor nor Sub-Contractors shall make use of any materials or articles ordered by them for the purpose of fabrication until a Passing Certificate covering the said materials and articles shall have been issued by the Engineer or inspecting Engineer.

1.8.6 Site Records

Daily records of on-site testing and inspection shall be kept on forms of approved format. Test results shall be certified by the responsible member of the Contractor's staff. All test certificates and inspection records (including any from suppliers or other outside testing agencies) shall be clearly identified with the appropriate part of the Works to which they refer, and they shall be submitted to the Engineer together with the respective Passing Certificate.

Once each month, or at such longer intervals as the Engineer may allow, the Contractor shall submit in an approved form a summary of all quality control inspections and tests performed at Site and elsewhere in the intervening period.

Test results shall be summarized in tabular form or graphically or both in a way which best illustrates the trends, specific results and specification requirements. Where the tests show that the specified requirements were not achieved, the report shall describe the action which was taken.

Each report shall also contain a forecast of quality control work likely to be carried out during the period to be covered by the succeeding report.

The Contractor shall keep detailed and up-to-date inventories in an approved form of goods and materials already approved by the Engineer for which Passing Certificates have been issued as well as of all other goods and materials subject to quality control which are on order, delivered, found faulty, lost during the work or to be surplus to requirements. The Engineer shall have access to these records at all times.

1.8.7 Daily Log Book

The Contractor shall keep a Daily Log Book at each site. This Daily Log Book shall be in a form approved by the Engineer and shall contain, but not be limited to, the following major items of information:

a) name of Contractor and Package No.
b) date
c) weather conditions (max./min., temperature, hours and intensity of rainfall)
d) work carried out during the day per Section (description, quantities)
e) major equipment used per section (on contractual work, on extra work ordered, approximate operating time on either)
f) strength of labour force per Section (on contractual work, on extra work ordered, hours worked on either)
g) delays (cause, effects such as idle time etc.)
h) unusual events (earthquakes, floods, fires, storms, accidents, etc.)
i) visitors at Site.

Each daily log shall be signed by the responsible Site Manager of the Contractor and "noted" by the Engineer.
1.8.8 **Measurement and Payment**

No separate measurement and payment will be made for Section 1.8, the cost of which shall be deemed to be included in other unit rates of the BOQ. In fulfilling the obligation of Sub Clouse 1.8.4, the Contractor shall also take into account the cost associated with inspection visits by Engineer's Instructors to manufacturer's premises that are located outside Nepal in foreign countries.

1.9 **STANDARDS, CODES AND ABBREVIATIONS**

1.9.1 **Reference Standards and Codes**

The Works shall be carried out in accordance with the relevant quality standards, test procedures or codes of practice, collectively referred to as Reference Standards, listed in the relevant parts of the Specifications. The Contractor shall familiarize himself fully with the requirements of such standards. If no standard is indicated then the relevant ISO Standard or, in the absence of such standard, the relevant German, British, American or Indian Standards shall apply, or others, if so approved.

The Contractor may propose, at no extra cost to the Employer, the use of any alternative relevant authoritative internationally recognized Reference Standard which shall be no less exacting, in the opinion of the Engineer, than the corresponding standard quoted in the Specification. The Contractor shall demonstrate to the Engineer that the alternative standard is suitable and equivalent to the specified standard, as well as provide proof of previous successful use. The Engineer shall decide whether or not the use of such alternative will be allowed as a Reference Standard.

The Contractor shall obtain and keep on Site at least one copy of each approved Reference Standard and each Reference Standard referred to in the Specifications, and will make these accessible to the Engineer at any time upon request.

The Contractor shall obtain the Reference Standards from the addresses given below:

- ISO: International Organization for STANDARDIZATION, Rue de Varembe, Geneva, Switzerland
- DIN: Deutsche Industrie Norm (German Industry Standard) from Deutsche Normenausschuss, Beuth-Vertrieb, P.O.Box 1045, W-1000, Berlin 30, Federal Republic of Germany
- BSI: British Standards Institution, 101 Pantonville Road, London N1 9ND, England
- ACI: American Concrete Institute, P.O. Box 4754, Redford Station, Detroit, MI 48219, U.S.A.
- AISC: American Institute of Steel Construction, 101 Park Avenue, New York, NY 10017, U.S.A.
- AWS: American Welding Society, Inc., 2501 N.W. 7th St., Miami, FL 33125, U.S.A.
- IS: Indian Standards, Manak Bhawan - 9, Bahadur Shah Jafar Marg, New Delhi, 11002
- SIS: Swedish Standards

1.9.2 **Equivalency of Standards and Codes**

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be accepted subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations so not ensure equal or higher quality, the Contractor shall comply with the standards specified in the documents.
1.9.3 Metric Units

S.I. units of measurement shall be used throughout the Contract. All information and data originating in another system shall be transferred by the Contractor into the S.I. system.

1.9.4 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>Ampere</td>
</tr>
<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
</tr>
<tr>
<td>AC</td>
<td>asbestos cement, alternating current</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Industry</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standard Institute</td>
</tr>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<tr>
<td>BB</td>
<td>Bansbari</td>
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<tr>
<td>BH</td>
<td>Bhaktapur</td>
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<tr>
<td>BOQ</td>
<td>Bill of Quantities, Schedule of Quantities</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>CBR</td>
<td>California Bearing Ratio</td>
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<tr>
<td>Cl-</td>
<td>chloride ion</td>
</tr>
<tr>
<td>cm</td>
<td>centimetre</td>
</tr>
<tr>
<td>cm²/g</td>
<td>square centimetre per gram</td>
</tr>
<tr>
<td>CO₂</td>
<td>carbon dioxide</td>
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<tr>
<td>d</td>
<td>day(s)</td>
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<tr>
<td>Cu</td>
<td>copper</td>
</tr>
<tr>
<td>DC</td>
<td>direct current</td>
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<tr>
<td>dia</td>
<td>diameter</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsche Industrie Norm (German Standard)</td>
</tr>
<tr>
<td>DN</td>
<td>diameter nominal (=ND)</td>
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<tr>
<td>DK</td>
<td>Dhobi Khola</td>
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<tr>
<td>EC</td>
<td>electro-conductivity</td>
</tr>
<tr>
<td>g/cm³</td>
<td>gram per cubic centimeter</td>
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<tr>
<td>g/m²</td>
<td>gram per square meter</td>
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<tr>
<td>GK</td>
<td>Gokarna</td>
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<td>h</td>
<td>hour</td>
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<tr>
<td>HDPE</td>
<td>high density polyethylene</td>
</tr>
<tr>
<td>HMG</td>
<td>His Majesty's Government of Nepal</td>
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<tr>
<td>HP</td>
<td>horse power</td>
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<tr>
<td>IDA</td>
<td>International Development Association</td>
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<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
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<td>Indian Standard</td>
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<td>ISO</td>
<td>International Standard Organization</td>
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<tr>
<td>km</td>
<td>kilometre</td>
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<tr>
<td>kN</td>
<td>kilo newton</td>
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<tr>
<td>KVA</td>
<td>kilo volt amp, re</td>
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<tr>
<td>l</td>
<td>litre</td>
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<tr>
<td>m</td>
<td>meter</td>
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<tr>
<td>m²</td>
<td>square meter</td>
</tr>
<tr>
<td>MCB</td>
<td>miniature circuit breaker</td>
</tr>
<tr>
<td>MCCB</td>
<td>moulded case circuit breaker</td>
</tr>
<tr>
<td>m³</td>
<td>cubic metre</td>
</tr>
<tr>
<td>mg/l</td>
<td>milligram per litre</td>
</tr>
<tr>
<td>MH</td>
<td>Manohara</td>
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<tr>
<td>min</td>
<td>minute</td>
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<tr>
<td>mm</td>
<td>millimetre</td>
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<tr>
<td>m/min</td>
<td>metre per minute</td>
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<tr>
<td>m³/d</td>
<td>cubic metre per day</td>
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<tr>
<td>m³/min</td>
<td>cubic metre per minute</td>
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<tr>
<td>m/s</td>
<td>metre per second</td>
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<tr>
<td>MPa</td>
<td>Mega Pascal</td>
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<tr>
<td>mm/s</td>
<td>millimetre per second</td>
</tr>
<tr>
<td>MVA</td>
<td>mega volt ampere</td>
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2. CIVIL ENGINEERING WORK

2.1 SITE CLEARANCE

2.1.1 Scope

This specification covers the removal of vegetation, boulders of size up to 0.2 cum, surface obstructions, and the demolition and removal of structures including their basements (if any) not directly associated with or incidental to any excavation.

2.1.2 Interpretations

2.1.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and be read in conjunction with this specification:

a) General
b) Earthworks, as applicable.

2.1.2.2 Application

This specification contains stipulations that are generally and particularly applicable to site clearance.
2.1.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Cleared surface - The natural surface of the ground after clearing of surface vegetation has been completed.

Designated site/area - A site or an area the position of which in relation to the work to be carried out is shown on the drawing or is described in the specification and is therefore known to the Contractor at the time of tendering.

Finished level - The level of the finished earthworks as shown on the drawings or stated in the project specification.

Grubbing - The operation of digging out the roots of vegetation.

Original ground level - The level of the surface of an area before the commencement of clearing.

2.1.3 Material

Material obtained from clearing and grubbing and from the demolition of structures shall be disposed of in borrow pits or other suitable places indicated by the Engineer and shall be covered with soil or gravel. Where no such place is indicated by the Engineer, the Contractor shall make his own arrangements for the provision of a suitable place.

For the disposal or burning of combustible material reference shall be made to clause 1.4.12 of this specification.

The Contractor shall not clear the Site of or damage any living tree having a girth more than 0.5 m (measured 1 m above the ground level) situated on the parts of the Site not subsequently to be occupied by the works without the written permission of the Engineer. All trunks and branches of such trees shall be stripped of secondary branches, sawn into transportable lengths and stacked at designated sites. Such timber shall not be used by the contractor for any purpose, and shall remain the property of the Employer.

Fencing wire shall be neatly wound into rolls or coils and all such wire, together with all fence posts and other re-usable material from structures, etc., shall be stacked at designated sites.

2.1.4 Plant and Equipment

The Contractor shall provide saws for cutting of trees and branches as ordered, and plant that is suitable for grubbing roots and for digging out and removing other obstructions on the Site.

2.1.5 Construction and Workmanship

2.1.5.1 Areas to be Cleared and Grubbed

The Contractor shall clear the parts of the Site subsequently to be occupied by the Works and shall maintain them clear of vegetation. Areas such cleared shall include but not be limited to borrow areas, portions of the Site where excavations are to be carried out and embankments and structures constructed, however, the Contractor shall not commence clearing and grubbing until the Engineer has designated, in writing and in detail, the exact areas to be cleared or grubbed and the time at which the work is to be started.

The Contractor shall ensure that the general shape, profile, and levels of the area are not materially altered during clearing and grubbing operations.

2.1.5.2 Cutting of Trees

The Contractor shall take the necessary precautions to prevent injury to persons and animals and damage to structures and other private and public property. Where necessary, trees shall be cut in sections from the top downwards.

No tree shall be cut down until the Engineer has given written authorization for such work to commence.
If possible, trees shall be felled in such a manner as to allow removal of the root together with the trunk. Individual trees indicated and marked by the Engineer as trees to be preserved shall be left standing and uninjured. An amount of **NRs 100,000/- shall be deducted** from monies due to the Contractor as a penalty in respect of every such tree that is damaged or removed unnecessarily or without the authorization of the Engineer.

2.1.5.3 Clearing

Clearing shall consist of:

a) the removal of all trees and bushes (complete with roots), other vegetation, rubbish, fences, and all other material that may interfere with the construction of the works.

b) the disposal of all material resulting from the clearing

c) the removal and disposal of structures that encroach upon or may otherwise obstruct other work on the Site and that can be cleared by means of a bulldozer of approximately 130 kW (structures that cannot be so cleared shall be broken down)

d) the removal of all rocks and boulders of size up to 0.2 m3 that are lying on the surface to be cleared or exposed during the clearing operation.

e) where fences have to be taken down, the sorting, coiling, and stacking of the material, and

f) the removal and stacking of other re-usable materials as scheduled.

The moving of a certain amount of soil or gravel may be inherent in or unavoidable during the process of clearing. No extra payment will be made for the removal of such soil or gravel.

2.1.5.4 Grubbing

All stumps and roots larger than 75 mm in diameter shall be removed to a depth of at least 600 mm below the finished level and at least 100 mm below original ground level. Where a road bed or other area has to be compacted, all stumps and roots included matted roots shall be removed to a depth of at least 200 mm below the cleared surface.

Except in borrow areas, cavities resulting from grubbing shall be backfilled with approved material and compacted to a density at least equal to that of the surrounding ground.

2.1.5.5 Re-clearing of Vegetation

If during the contract period vegetation should again grow on any portion of the Site, borrow area, or other areas that have been cleared in accordance with this specification, the Engineer may, if he considers it necessary, order that such area(s) be re-cleared.

Such re-clearing shall include the removal and disposal of grass, shrubs, and other vegetation, as in the first clearing operation.

2.1.5.6 Conservation of Topsoil

The removal of stumps and roots as specified under clause 2.1.5.4 above shall be done in such a manner that the topsoil is at least disturbed.

2.1.5.7 Demolition of Structures

Before moving plant onto the Site and commencing operations the Contractor shall establish to the Engineer’s satisfaction that the method of demolition proposed by the Contractor is such that he can keep any nuisance arising from dust, noise, and vibration to an acceptable level and ensure the safety of structures adjacent to those to be demolished.

The materials obtained from demolition shall be reserved for further use when considered suitable by the Engineer, all rubbish and material unsuitable for further use shall at the cost of the Contractor be destroyed or removed from the Site.

Prior to the start of any work, the Contractor should lay-out the right-of-way, work areas, clearing, and pavement cuts to insure a proper recognition and protection of the adjacent properties.
All lay-out work must be approved by the Engineer before any demolition, rehabilitation or construction begins.

Demolition of reinforced concrete structures shall be carried out using approved methods and in accordance with any safety regulations enforced by the local municipality or Kathmandu Valley Town Development Committee or relevant thereto. The Contractor should note that a Building Permit is required for demolition work.

Except as noted below, debris arising from demolition shall be removed from the site promptly and disposed of in a place and in a manner acceptable to the local municipality.

The area shall be spread with approved fill material and graded to original levels, or such other levels as the Engineer may direct.

Demolition of walls, tanks, plates inside building to be rehabilitated will be performed with the required care, without damaging the stability of the structure.

Where required or directed by the Engineer, the existing structure will be temporary reinforced to assure the stability. The Contractor will submit to the Engineer's approval the methods applied for demolishing and the proposed temporary safety measures. The Engineer's approval shall not relieve the Contractor of any of his responsibilities under the Contract.

2.1.6 Measurement and Payment

2.1.6.1 Basic Principles

The items scheduled for clearance and demolition will be classified according to the nature of the materials involved and the methods of their disposal.

Only those areas designated to be cleared in terms of 2.1.5.1 will be measured for payment. The area of surfaced roads, structures, and paved areas falling within such designated areas will be deducted from such measurements.

Where conservation of topsoil without prior clearing is ordered, the removal of topsoil from the specified area will be measured as excavation and no payment will be made for clearing and grubbing but the contract has to pay to the client for the reusable materials collected from the demolition works. The total cost of the reusable material and cost of the dismantling works should be calculated and necessary claim or payable amount should be quote in the Bid.

2.2 EARTHWORKS

2.2.1 Scope

This specification covers earthworks carried out with light or heavy plant or by hand, for general excavations, terracing, landscaping etc. It covers the requirements for siteworks, excavations for foundations for buildings, bridges and general structures and reinstatement of surfaces.

2.2.2 Interpretations

2.2.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a)  1 General
b)  2.1 Site Clearance
c)  3.1 Pipe Trenches, as applicable.

2.2.2.2 Application

This specification contains clauses that are generally applicable to earthworks. Interpretations, additions, and variations of this specification (if any) are set out in the Particular Technical Specification.
2.2.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Average haul - The average distance that material is transported along the designated or shortest route.

Backfill - Approved material placed in an excavation after specified operations have been performed.

Borrow - Material obtained from various sources such as borrow pits.

Borrow pit - An excavation made for the purpose of procurement of material.

Catchwater drain - An open drain or mound intended to intercept water and to lead it to suitable discharge points.

Freehaul - Haul of which the cost is included in the scheduled rate for the material excavated or backfilled.

Overbreak - Excavation carried out in excess of the designated profile.

Overhaul - Haul in excess of freehaul and measured separately.

Pass - In regard to compaction, a movement of an approved compacting machine from one end of the layer being compacted to the other end.

Restricted excavation - An excavation so restricted in area or width as to preclude removal of material by a bulldozer.

Specified density - The ratio of field density to laboratory-determined modified AASHTO maximum density.

Spoil - Unsuitable or excess material removed to waste.

Stockpile - A pile of material that has been selected, loaded, transported and unloaded in a heap outside the confines of a borrow pit or of an excavation that forms part of the works.

2.2.3 Materials

2.2.3.1 Classification for Excavation Purposes

The Engineer will decide on the classification of the materials, which will be based on inspections and criteria given below.

The excavation of material will be classified as follows:

a) Soft excavation. Material that can be efficiently (ie in a manner that can reasonably be expected of an experienced contractor, having regard to the production achieved) removed or loaded, without prior ripping.

b) Intermediate excavation. Material that can be efficiently ripped by a bulldozer of up to about 220 kW flywheel power.

c) Hard rock excavation. Material that cannot, before removal, be efficiently ripped by a bulldozer specified above, but can be removed only after blasting.

d) Boulder excavation. Material containing more than 40 % by volume of boulders in the range 0.05 to 20 m³, in a matrix of soft material or smaller boulders.

2.2.3.2 Classification for Placing Purposes

a) Material for embankments, terraces, etc. Such materials shall, generally, have a CBR of at least 3 % (compacted at OMC), a PI not exceeding 18, and a maximum dimension of 300 mm, unless otherwise specified in the Technical Specifications.

b) Material for replacement of overbreak. Where replacement of overbreak with backfill is authorized, the material shall be an approved graded material having a PI not exceeding 10, a CBR of at least 10 %, and a maximum dimension of 150 mm or two-thirds of the thickness of the layer being compacted.
2.2.3.3 Selection

Topsoil, if required for later use on the Site, as well as any other material excavated that is suitable for backfilling or for filling against the finished structures, shall be selected and stockpiled in the vicinity of the structures.

All other material from excavation, being excess material or unsuitable for re-use shall be disposed of on the Site or within the freehaul distance.

Any material that is below the finished level of an excavation and that the Engineer considers to be unsuitable, shall be excavated and disposed of as directed. The resultant space shall be refilled with backfill and compacted as specified.

2.2.4 Plant and Equipment

Plant shall be suitable for obtaining the end result required under the conditions applicable to the Site.

Compaction plant used for applying the dynamic load, controlling the moisture content, and grading or mixing, shall be capable of achieving the compaction specified with the material available.

Any vehicle or item of plant provided by the Contractor for the transport of materials shall conform to the requirements of the applicable road traffic ordinance if the vehicle or plant is required to operate on any public road, street, or area that has been surfaced.

Where any of the Contractor’s operations or the movement of any of the Contractor’s vehicle or plant has caused damage to the surface of any area normally open to the public, the Contractor shall repair such surface as a matter of urgency, and at his own expense.

The Contractor shall provide and use, where applicable, equipment that is suitable for the detection and location of underground service pipes and cables.

2.2.5 Construction and Workmanship

2.2.5.1 Precautions

Safety and safeguarding

Every excavation that is accessible to the public shall be adequately protected by barriers or fences, provided with lighting at night and watched to ensure that barricades and lights are effective at all times. Reference shall be made to clause 1.4.14 of this specification.

The Contractor shall suitably safeguard excavations if the depth of an excavation or the nature of the material excavated render the sides of the excavation liable to movement that might endanger the Works or the workmen engaged on the excavation.

This safeguarding may consist of supports by timber or sheeting adequately strutted and braced, or, if approved by the Engineer, by a reduction of the slope of the excavated face or faces so that any danger to the Works or the said workmen is removed.

The Contractor shall make good any fall of earth or rock due to insufficient safeguarding at his own expense, as directed and by approved means.

Without relieving the Contractor in any way of his responsibility, the Engineer may order additional lateral support for, or the sloping or reduction of the slope of, the sides of any excavation. During the progress of each excavation, the Contractor shall report to the Engineer the presence of bedding planes inclined towards the excavation, seepage water and any other feature that may affect the stability of the excavation, as soon as the presence of such feature or features is known. All timbering and sheeting shall be removed from the excavation at the completion of the work, unless the written permission of the Engineer allowing any portion to remain is obtained.
Should blasting be necessary, the Contractor shall obtain the permission from the Engineer and the local authority well in advance and in writing and shall take every precaution to protect the Works and persons, animals and property in the vicinity of the Site. The Contractor will be held responsible for any injury or damage caused by any blasting operations and shall, at his own expense, make good such damage. A copy of the blasting permit(s) issued to the Contractor to cover the purchase, storage, and handling of explosives, shall be handed over to the Engineer.

When blasting to specified profiles, the Contractor shall so arrange the holes and charges that the resulting exposed surfaces are as sound and stable as the nature of the material permits. The Contractor shall make good at his own expense any additional excavation necessitated by the shattering of rock in excess of the overbreak allowance specified.

**Existing services**
The tender drawings as well as the Contractor's working drawings show positions of existing services based on the best information available.

The Contractor shall, before commencing work in any particular area, verify the position of all services and all other obstacles and existing works on the Site.

The Contractor shall have the equipment referred to in clause 2.2.4 above available on the Site for as long as is necessary to detect and locate such services and, if so ordered, he shall excavate by hand to expose such services in areas and in a manner and at a time agreed upon with the Engineer.

The Contractor shall advise the Engineer at least 5 days in advance of the actual date on which he proposes to excavate near any cable. He shall not use mechanical equipment to excavate within 3 m of the assumed position of any cable and shall, if necessary, expose the cable by means of hand excavation carried out under proper supervision. When so ordered, the Contractor shall backfill such observation trenches with approved material to the compaction density ordered.

Where a service is damaged because of the Contractor's negligence, he shall make good such damage or bear the cost of the repairs, as applicable.

**Stormwater and groundwater**
The Contractor's responsibility in terms of clause 1.4.20 will be held to include the provisions of adequate protection against flooding by stormwater, flow from springs, and seepage, and to include provision for repair, at his expense, of any damage to the works that may arise as a result of the inadequacy of the protection provided by him. Except where the use of tremies has been approved, foundation excavations for structures shall be kept free of water at all times until they have been expected and approved and concrete footings or foundations have been cast.

**Nuisance**
Wherever dust from the works, haul roads, borrow pits or road deviations becomes a nuisance to the public the Contractor shall, when so ordered by the Engineer, apply sufficient water or take other measures to lay the dust.

All excavated material shall be so deposited as not to interfere with or endanger the works, other property or traffic. The Engineer may order the Contractor to remove, at his expense, any material that the Engineer considers liable to endanger or to interfere with the Works, private property, traffic or pedestrians, and to place such material at some other approved location.

**Roads**
The Contractor shall reinstate and maintain the surfaces of all roadways through which trenches or other excavations have been made. Should any subsidence occur at the site of such trench or excavation, the Contractor shall immediately restore the road surface to its correct level. Where immediate restoration is impracticable, the Contractor shall provide protection as specified under clause 2.2.5.1.1 above. The Contractor shall follow the requirements of the Department of Roads.

**Traffic control**
Where work affects the operation or safety of public road traffic, the Contractor shall, in addition to complying with the requirements of clause 2.2.5.1.1, provide, erect and maintain traffic signs, warning lights etc. in positions agreed to or ordered by the Engineer.
Site preparation
Before carrying out any work on any site, the site shall be inspected where necessary together with the Engineer.

The Contractor shall request in writing such site inspections where in his opinion the situation shown in the Drawings has changed and/or is incorrect.

Before the commencement of any earthwork, the site shall be surveyed in conjunction with the Engineer's representative to establish existing ground levels, and these agreed ground levels shall form the basis for the calculation of quantities of any subsequent excavation and filling.

Should work commence in the absence of this joint survey, the Engineer's statement shall be final.

Prior to the start of excavation proper, if and as scheduled, all areas in which excavation is to take place or that are to be covered by banks, structures etc., shall be cleared as specified under clause 2.1 above.

Where so ordered, the Contractor shall remove and conserve the topsoil for later use in a manner approved by the Engineer. The Contractor will not be required to remove topsoil from any area in which the average depth of topsoil is less than 150 mm.

Excavation
Excavation shall be carried out to the depth indicated or to such greater depths as may be required by the Engineer to ensure a satisfactory foundation.

Except where otherwise specified, shown on the drawings, ordered or dictated by the requirements for safeguarding, excavation shall be so carried out and so trimmed to the outline of the concrete work shown on the drawings that the excavated surfaces will act as forms for the concrete works. Such surfaces as well as the bottom of excavations shall be cleaned by hand, air or other effective means to remove all loose, soft or otherwise unsuitable material and as required by the Engineer.

Should the Contractor excavate to dimensions in excess of those stipulated or permitted, he shall fill in the excess at his own expense in the manner specified or approved by the Engineer. Excavated surfaces that will remain permanently exposed shall be finished off in a neat and workmanlike manner and shall be graded to provide adequate drainage.

When the Contractor is required by the Engineer to open up borrow pits, he shall maintain them so that they do not become a danger to persons and livestock. On completion of borrowing, the sides of the pits, if not filled with unused material, shall be graded 1:2, or as the Engineer may direct. The Contractor shall not spoil, stockpile or waste any material without approval. He shall dispose of surplus and unsuitable material in areas designated. Spoil heaps shall be flattened to present a neat level or graded surface.

The Contractor shall not sell any materials arising from excavations, demolitions and the like carried out on the Site unless permission is obtained from the Engineer.

Placing and compaction
Where approved material from excavations is insufficient to form designated embankments, terraces etc., the Contractor shall, unless otherwise ordered, obtain the additional material, as directed, from borrow pits at sites approved by the Engineer. Where it is necessary to use clay or clayey material in embankments, such material shall be placed not less than 1 m and not more than 5 m below the finished surface. Rock having a maximum dimension exceeding 600 mm shall not be placed in embankment fills. The material of each embankment shall be deposited in layers of thickness, before compaction, not exceeding 300 mm. The material shall be spread to form a layer that is of approximately uniform thickness, and graded over the whole area of the embankment. Each layer shall be compacted at OMC to a density of at least 90 % of modified AASHTO maximum density in the case of cohesive soil or 98 % in the case of non-cohesive soil. Should the material be too wet, owing to rain or any other cause, it shall be harrowed and allow to dry out to the correct moisture content before compaction is undertaken. The Contractor shall ensure that stormwater will at all times be discharged uniformly over the full area of each embankment or through specially prepared and protected drainage ditches to prevent scouring of the slopes.
Where backfilling or filling around or against structures has been authorized by the Engineer, such filling shall be placed, and shall be compacted approximately simultaneously on both sides of the structure to minimize unequal loading. All excavations shall be carefully refilled with approved material in layers of thickness not exceeding 250 mm before compaction, and to a density equal or better than that of the adjoining undisturbed material. Each layer shall be completed before the next is added. Except with the consent of the Engineer, filling shall not be deposited in water.

**Finishing**

On completion of earthworks to the finished level, the whole surface shall be graded, shaped and compacted to final grades and levels. The surface shall be lightly watered as the Engineer may direct.

If ordered by the Engineer, topsoil shall be placed on level and slightly graded areas and shall be lightly compacted by tamping, and trimmed neatly to required lines, grades and levels. the final thickness of topsoil after compaction shall be at least 100 mm.

If ordered by the Engineer, grass or other vegetation shall be planted after topsoiling has been completed. Such planted areas shall be neatly trimmed and well watered, and the Contractor shall ensure that planted areas are not permitted to dry out. Any grass or vegetation planted that fails to grow shall be replaced by the Contractor, at his expense.

**Transport for earthworks**

All haul of material imported from borrow pits or from commercial sources selected by the Contractor shall be regarded as freehaul. The freehaul distance within which the Contractor will be required to move material without separate compensation shall be 10 km.

Transportation of earth material beyond the freehaul distance will be regarded as overhaul. Each overhaul distance is 10 km and is the distance beyond the end of the freehaul by the shortest practicable route.

The Contractor shall not incur overhaul expenses without prior approval of the Engineer.

### 2.2.6 Tolerances

#### 2.2.6.1 Positions, dimensions, levels, etc.

The work shall be finished to and within the limits (permissible deviation = PD) given below:

- **a) Excavations**
  - (i) position on plan, ie PD in plan of any point measured from nearest grid line: +35 mm
  - (ii) dimensions on plan, ie PD from the designed dimensions: +50 mm
  - (iii) foundation level, ie PD in level of surface of excavation trimmed to receive concrete: +50 mm
  - (iv) level (other than foundation level), ie PD from designed levels with reference to nearest transferred bench-mark: +15 mm

- **b) Embankments, terraces etc.**
  - (i) position of top edge, ie PD from designated position of any point, measured from nearest grid line: +300 mm
  - (ii) alignment of top edge, ie PD from a line joining any two points 30 m apart on top edge of embankment: +100 mm
  - (iii) finished levels, ie PD from designated levels with reference to nearest transferred bench-mark: +50 mm
  - (iv) slopes of top surfaces, ie PD from rate of fall: + 5 %

#### 2.2.6.2 Moisture content and density

The permissible deviations (PD) shall be as given below:

- **a) OMC in field during compaction:** +1% and -2%
- **b) specified density:** +(no top limit) and -0
2.2.7 Testing and Acceptance

To determine founding conditions or for other purposes, the Engineer may require the Contractor to drill, auger or excavate holes in advance of the start of construction. When so requested by the Engineer, the Contractor shall provide labour, tools, machinery and equipment for sinking such exploratory holes and for refilling them. Such operations will be paid as daywork.

The Contractor shall carry out sufficient tests to satisfy himself about the consistency of material placed in embankments and as backfill.

The Engineer may carry out check tests as he deems necessary, at any depth or at any layer. Where these tests reveal that the material used does not comply with the applicable requirements of the specification, or that the compaction specified has not been attained, the Contractor shall rectify the work to the satisfaction of the Engineer.

2.2.8 Measurement and Payment

2.2.8.1 Basic principles

Rates tendered for excavation shall cover the cost of excavating and re-use of the excavated material in backfilling, forming embankments, terraces, etc., and the cost of disposal of any surplus and unsuitable material within the freehaul distance.

Excavations which are required to be backfilled will be measured as if taken out with vertical sides regardless of whether they have been taken out with sloping sides. They will be measured from the net plan of the finished concrete footing, foundation, building or concrete structure except that, in the case of conical-bottomed tanks or other such structures, the volume will be measured from the finished outline of the concrete as shown on the drawings.

2.3 CONCRETE

2.3.1 Scope

This specification covers the requirements for plain and reinforced concrete, either cast-in-situ or precast, for civil engineering and building construction applicable to this project.

2.3.2 Interpretations

2.3.2.1 Supporting specifications

The following specifications shall, inter alia, form part of and be read in conjunction with this specification:

a) 1 General
b) 2.2 Earthworks, as applicable.

2.3.2.2 Application

This specification contains clauses that are generally applicable to concrete and structural precast concrete work. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification.

2.3.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

a) General
Adverse weather. Cold weather, or weather in which the ambient temperature is above 25°C, or the relative humidity is low, or the wind velocity is high, or weather in which any combination of the latter three conditions occurs, and which tends to impair the quality of fresh or hardened concrete or otherwise causes concrete to have abnormal properties.

Approved laboratory - A laboratory suitably equipped and staffed for purposes of concrete testing and as such approved by the Engineer.
Cold weather - Weather conditions in which the ambient temperature is 5º C or less.

Concrete cover - The thickness of concrete between the face of the concrete and the outside of reinforcing steel nearest this face as cast.

Cool weather - Weather conditions in which the ambient temperature is higher than 5º C but not higher than 15º C.

Fixture - An item such as a bolt, anchorage, bearing, or the like that is cast or grouted into concrete.

Formwork - Temporary works that is required to support and shape the concrete for a structure.

Hot weather - Weather conditions in which the ambient temperature is higher than 32º C.

Normal weather - Weather conditions in which the ambient temperature is higher than 15º C and less than 32º C.

b) Quality
Class of concrete - See grade of concrete.

Consistency - The extent, as measured by the slump test, to which fresh concrete resists flow or deformation.

Grade of concrete - An identification number for the concrete, the number being numerically equal to the specified strength at 28 days expressed in MPa.

Prescribed mix - Concrete for which the Engineer has prescribed the mix proportions.

Ready-mixed concrete - Concrete complying with the relevant requirements of the specification and delivered to the Site in a plastic state.

Sample (of concrete) - The minimum volume of uncompacted freshly mixed concrete required for a designated test (eg 16 dm³ for the compressive strength test for 3 cubes of nominal side 150 mm).

Strength concrete - Concrete designed primarily for strength.

Target slump - The average value for the slump of concrete aimed at to ensure compliance with the slump required in terms of the specification.

Workability - The property of fresh concrete that determines the ease with which it can be placed and compacted without segregation of the constituent materials.

c) Strength
Characteristic strength - See specified strength.

Specified strength - The required concrete strength (or the strength corresponding to the required concrete grade) stated on the drawings or in the Technical Specification, and which in all cases represents the strength below which not more than 5% of valid 28 d test results obtained on cubes of concrete of the same grade can be expected to fall.

Strength concrete - A strength concrete is designated by its specified strength followed by the size of stone used in its manufacture, eg 30 MPa/19 mm refers to a Grade 30 mix made with 19 mm stone.

Target strength - An average value of the strength of concrete that is higher than the specified strength and is aimed at to ensure that the specified strength is attained. (Note: If the standard deviation can be determined, the value of the target strength is at least equal to the specified strength plus 1.64 times the standard deviation of valid 28 d test results.)

Valid test result - The average result obtained from the testing of three test cubes of concrete.

d) Exposure conditions
Mild conditions - Conditions under which the concrete is protected from the weather and is exposed only to air.
A: General Technical Specification

Moderate conditions - Conditions under which the concrete is sheltered from severe rain and is not subject to freezing when wet, or buried in non-aggressive soil, or continuously under fresh water.

Severe conditions - Conditions under which the concrete is exposed or subject to any of the following: driving rain, alternate wetting and drying out, freezing when wet, fresh water at the water line, splashing or spraying with fresh water, corrosive fumes or heavy condensation of water, aggressive soil, salt-laden air.

Very severe conditions - Conditions under which the concrete is exposed to any of the following: water containing sulfates or chlorides, highly corrosive fumes.

e) Joints
The location of joints is controlled by design requirements and construction limitations. All joints are "construction joints" within the general meaning of the term. Joints shown on the drawings or otherwise specified are "designated joints". The Engineer may, in collaboration with the Contractor, approve further joints before the casting of concrete, which joints will then become "designated joints". The terms "construction joints", "movement joints", "contraction joints", and "expansion joints" are used to identify various types of designated joints. The term "unforeseen joint" is used to identify a joint formed during concreting when plant failure, inclement weather, or some other unforeseen event has enforced a halt in the placing of concrete and has thus created a situation in which a construction joint has to be made in a location that was neither designated nor approved before the commencement of concreting.

2.3.4 Abbreviations

For the purpose of this specification, the abbreviation for reinforced concrete shall be RCC and the abbreviation for plain concrete shall be PCC.

2.3.3 Materials

2.3.3.1 Approval of materials

The Contractor shall supply in good time to the Engineer for his approval, samples of the aggregates and, if so ordered, of the water, that he proposes to use for the concrete and shall furnish evidence that the water and aggregates comply with the requirements of clause 2.3.3.3 and 2.3.3.4 below. Evidence shall be in the form of a statement from an approved laboratory of the results of tests, or an authoritative report or record of previous experience.

2.3.3.2 Cement

Cement and blends of Portland cement and milled granulated blastfurnace slag shall comply with the relevant ISO, DIN (eg DIN 1164), BS (eg BS 12, BS 1370, BS 4027), or ACI standards and shall be either Ordinary Portland Cement (OPC), Low Heat Portland Cement, Rapid-hardening Portland Cement (RHPC), Sulphate-resisting Portland Cement (HS), or Portland Blastfurnace Cement (PBFC). Any type of cement or any other standard than those referred to above shall be used only when specifically authorized, in writing, by the Engineer.

Within eight weeks of the award of the Contract a report on proposed cement sources shall be submitted to the Engineer. The report shall propose primary and secondary sources of supply and shall give each manufacturer's full analysis of chemical composition and physical properties determined in accordance with DIN 1164 or similar.

The report on cement sources shall be submitted at least four weeks in advance of the commencement of work on trial concrete mixes.

Separate storage facilities shall be provided on the Site for each type of cement used. Cement shall be fresh when delivered to Site and the consignments shall be used in the order of their delivery. The Contractor shall mark the date of delivery on each consignment and each consignment shall be stored separately in such manner as to be easily accessible and identifiable. No cement in bags or other container shall be used unless these and the manufacturer's seals are intact at the time of mixing. If the cement is delivered in bags it shall be stored under cover and on elevated floors that provide proper protection against moisture and other factors that may promote deterioration. Bulk cement may be used providing it is stored in approved weather-proof silos or similar containers provided that the cement drawn for use is measured by mass and not by volume.
The Contractor shall not use cement which has hardened into lumps, but subject to removal of the lumps by screening, the Engineer may allow such cement to be used in non-structural concrete mixes.

2.3.3.3 Water

Water shall be clean and free from injurious amounts of acids, alkalis, organic matter, and other substances that may impair strength, durability, or appearance of the concrete.

The Contractor shall take samples of the water from the proposed source and shall carry out such tests as required. The results of the test shall be submitted to the Engineer in the form of a report on the proposed source of water. Use of water with physical or chemical characteristics which lie outside the limits given below will not be permitted. In addition to the tests listed below, tests shall be carried out if directed by the Engineer to compare initial setting times and compressive strengths of cement pastes prepared with water from the proposed source, and with distilled water.

- Sulfate content (as SO3) max. 500 mg/l
- Chloride content (as Cl) max. 500 mg/l
- Bicarbonate content (as HCO3) max. 1000 mg/l
- Total dissolved solids max. 1500 mg/l

2.3.3.4 Aggregates

Both the coarse aggregate (stone) and the fine aggregate (sand) shall comply with the relevant applicable and approved standards (e.g., DIN 4226 or similar).

Aggregates of different nominal sizes shall be delivered to the Site and stored separately and in such a way that segregation is minimized and intermixing of different materials and contamination by foreign matter is prevented.

Fine aggregate shall be natural sand, manufactured crushed rock sand, (excluding crushed rock fines which are by products/rejects of coarse aggregate production) or a combination of both.

A combination of different materials will only be permitted where the two materials are separately batched and where each material separately complies with the requirements of this specification. In addition the evidence of full scale comparative site trials shall clearly demonstrate that a combined fine aggregate provides improved concrete relative to the use of either material as a sole fine aggregate. Except where otherwise approved on the basis of evidence of acceptable performance in concrete the grading of a fine aggregate, or of combined fine aggregate, shall comply with the grading limits for groups of 0/1, 0/2 and 0/4 in accordance with DIN 4188.

Fine aggregates shall be free of clay lumps and friable particles. The amount of hollow shells likely to form voids or remain partially unfilled and present in material retained on a DIN 2.0 mm sieve, determined by direct visual separation, shall not exceed 3% by weight of the entire sample.

Fine aggregate shall not contain considerable amounts of flaky and or elongated particles. The water absorption of fine aggregate, determined in accordance with DIN 4226 Part 3, shall not exceed 2.0% by weight.

The total acid soluble Sulfate content of fine aggregate, expressed as sulphur trioxide (SO3), shall not exceed 0.40% by weight. The total acid soluble chloride ion (Cl) content of fine aggregate, expressed as calculated equivalent (Cl x 1.6 = NaCl) sodium chloride (NaCl), shall not exceed 0.05% by weight.

Coarse aggregate shall be natural gravel, or crushed gravel, or crushed rock, complying with the requirement of DIN 4226 or similar approved.

Where an aggregate comprises a mixture of natural and crushed material the proportion of natural (uncrushed) particles shall not vary by more than ±5% from the proportion contained in the aggregates used in the full scale trial mixes which had been approved. The proportion of decomposed or weathered particles in the aggregates shall not exceed 0.5% by weight as determined in accordance with DIN 4226 Part 3.

All coarse aggregates shall be produced, stockpiled and batched as single-sized materials complying with the grading limits in groups 2/8, 4/32, 8/32 of DIN 4226 Part 1, or as may be otherwise approved by the Engineer on the basis of evidence of acceptable performance in concrete.
The amount of materials passing a 0.063 mm nominal sieve in each size of single-sized aggregates shall not exceed the percentages by weight given in DIN 4226 Part 1 as determined by the Test Method given in DIN 4226 Part 3.

The proportion of flaky particles shall not exceed 20 % by weight, nor elongated particles exceed 35 % by weight in each of the fractions of single-sized aggregates as determined in accordance with DIN 4226 Part 3.

The water absorption of each size of coarse aggregate, determined in accordance with DIN 4226 Part 3, shall not exceed 2.0% by weight.

The total acid soluble Sulfate contents of coarse aggregates expressed as sulphur trioxide (SO₃), shall not exceed 0.4% by weight.

The total acid soluble chloride ion (Cl) contents of coarse aggregates, expressed as calculated equivalent (Cl x 1.6 = NaCl) sodium chloride (NaCl), shall not exceed 0.02% by weight as determined in accordance with DIN 4226 Part 3. In the case of mass concrete this percentage may be increased at the Engineer's discretion.

Sources of aggregate for concrete, extraction procedures and production methods shall be to the approval of the Engineer.

Aggregate deposits or existing aggregate production at the proposed sources shall be sampled and tested to assess their potential suitability for use in the works. The results of the sampling and testing shall be reported to the Engineer.

The method of sampling shall be by agreement with the Engineer, and shall be carried out in the presence of the Engineer's Representative.

2.3.3.5 Admixtures

Admixtures shall not be used in any concrete without the approval of the Engineer, who may require tests to be made before they are used. To facilitate approval, the Contractor shall provide the following information:

a) the trade name of the admixture, its source, and the manufacturer's recommended method of use
b) typical dosage rates and possible detrimental effects of under-dosage and over-dosage
c) whether compounds (such as those containing chloride in any form as an active ingredient) likely to cause corrosion of the reinforcing steel or deterioration of the concrete are present, and, if so, the chloride content (expressed as chloride ions or as equivalent anhydrous chloride) by mass of admixture
d) the average expected air content of freshly mixed concrete containing an admixture which causes air to be entrained when used at the manufacturer's recommended rate of dosage.

If the use of air-entraining agent is permitted by the Engineer, test measurements shall be carried out on Site by the Contractor, as and when required by the Engineer, to determine

a) the percentage of air entrained in the concrete, and
b) the density of concrete.

The Contractor shall provide equipment to permit measurement of entrained air at such frequencies as are required by the Engineer.

2.3.3.6 Reinforcement

Reinforcing bars and welded steel fabric shall comply with the relevant applicable and approved standards (e.g. DIN 488).

All reinforcement shall be hot rolled, high tensile steel with a minimum yield strength of 420 MPa. Where shown on the drawings or provided for in the bending schedule, or approved by the Engineer, mild steel reinforcement may also be used, but only in exceptional cases.
Reinforcing steel shall be so stacked on Site as to make identification (with regard type and sizes) easy and off the ground as to prevent distortion, and shall be protected from aggressive environments and contamination.

2.3.3.7 Storage capacity

The storage capacity provided and the amount of material stored (whether cement, aggregates, steel, or water) shall be sufficient to ensure that no interruption to the progress of the work is occasioned by lack of materials.

2.3.3.8 Deteriorated material

Material that has deteriorated, or that has been contaminated or otherwise damaged, shall not be used in the concrete. Such material shall be removed from the site without delay.

2.3.3.9 Waterstops

The Contractor shall supply and fix waterstops in all joints in members which are to be water-retaining and where shown on the drawings.

Waterstops built into joints shall be made of PVC, rubber or similar approved material and shall have a hollow centre bulb. They shall be obtained from manufacturers approved by the Engineer and shall be stored, fixed and jointed in accordance with the manufacturer's instruction. They shall be fabricated into the longest practicable units complete with angles and junctions at the manufacturer's works and shall be made continuous throughout the structure below highest water level and where shown on the drawings. The number of joints in the waterstop made on Site shall be kept to a minimum.

Where waterstop joints are vulcanized site jointing shall be performed strictly in accordance with the supplier’s instructions and recommendations. The tensile strength of the spliced waterstop at a factory-made splice shall be at least 90% of the waterstop's tensile strength, when tested according to BS 703 with the spliced joint in the middle portion of the dumb-bell test specimen and the tensile force applied normally in the direction of the splice. The tensile strength of a waterstop spliced at the site shall be 80% of the original strength of the waterstop.

The edge bulb section shall be circular. The webs shall be plain without separations.

The Contractor shall supply the manufacturer's test certificates for each consignment of waterstops delivered to Site and shall, in addition, supply to the Engineer sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure, if ordered.

The rubber for waterstop shall satisfy the following requirements in accordance with BS 903:

a) Minimum tensile strength 20 N/mm²
b) Minimum elongation at break 500%
c) BS Hardness (BS 903/Part A7/1957) 60 to 65º
d) Maximum compression set 20%
e) Max. water absorption after 2 d at 20°C 5%

2.3.3.10 Joint filler

Unless otherwise specified, joint filler shall be of expanded polystyrene, resin or bituminous bonded cork, or similar (e.g. "Flexcel"). The filler shall be obtained from a manufacturer approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions. The Contractor shall supply the manufacturer's certificate for each consignment of joint filler delivered to Site and shall, in addition, supply to the Engineer sufficient of each consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure, if ordered.

2.3.3.11 Joint sealant

Unless otherwise shown on the drawings or ordered by the Engineer, an elastomeric two part polysulphide sealer shall be used. Only such joint sealers and the requisite priming materials shall be obtained from manufacturers which have been approved by the Engineer. They shall be used in
accordance with the manufacturer’s instructions and recommendations. The application of joint sealer shall not be commenced without the contractor having first obtained the approval of the Engineer.

The Contractor shall supply the manufacturer’s test certificate for each consignment of each type of joint sealer delivered to Site and shall, in addition, supply to the Engineer sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure, if ordered.

Where the drawings show a layer of bituminous paint between concrete faces, the Contractor shall clean and dry the face to which the bitumen is to be applied and shall then paint the bitumen on in two separate applications. The bitumen shall be a straight run bitumen, grade 40/50 penetration, or other approved by the Engineer.

2.3.4 Plant and Equipment

2.3.4.1 General

All plant and equipment shall be maintained in good working order at all times during concrete work.

2.3.4.2 Batching plant

The Contractor shall ensure, by regular examination, calibration, and tests, that the batching system functions efficiently and accurately and that hoppers and cement containers are kept dry and clean. The batching plant shall be such that cement may be batched to an accuracy of within 2 % of the mass required, that water be measured to an accuracy of within 2 % of the quantity required, and that aggregate be batched to the accuracy of 3% of the mass required.

In the case of an automatic plant, the weighing scales shall be so interlocked that a new batch of materials cannot be delivered until the weighing hoppers have been completely emptied of the previous batch and the scales are in balance. Where discharge of materials from the hoppers is manually controlled, a method of signalling shall be employed to ensure that ingredients are not omitted, or are not added more than once, when a batch of concrete is being made up.

Admixtures shall be used in liquid or powder form and shall be measured by volume or weight in the case of liquids and by weight only if in powder form and shall be dispensed through equipment capable of measurement within the tolerance specified. Tanks or drums containing liquid admixtures shall be clearly labelled for identification purposes and stored in such a way as to avoid damage from contamination. Agitation shall be provided for liquid admixtures which are not in stable solutions.

2.3.4.3 Mixing plant

The type and capacity of mixing machines shall be such that the rate of output of concrete is suitable for the rate of concreting. Each machine shall be capable of producing a uniform distribution of the ingredients throughout the batch and shall comply with the specification to which the manufacturer claims it has been manufactured. Worn or bend blades and paddles shall be replaced. The inner surfaces of the mixer shall be clean and free from hardened concrete. The mixers used shall be specially suited to the production of low slump concrete.

2.3.4.4 Vibrators

Vibrators shall be capable of fully compacting each layer of concrete. At least one standby vibrator shall be available at all times during concreting for every three vibrators necessary to maintain the rate of placing.

Vibrating equipment used for the production of PCC elements, whether in the form of a vibrating table, an external vibrator attached to the mould, or an immersion vibrator, shall have the frequency that is suitable for the compaction of low slump concrete.

2.3.4.5 Formwork

Formwork shall be so designed and constructed that the concrete can be properly placed and compacted and that, subject to the tolerances specified, the required shapes, finishes, positions, levels, and dimensions shown on the drawings are maintained. The formwork and joints shall be capable of resisting the dead load, including the pressure exerted by the wet concrete, wind forces, and all other
superimposed loads and forces. If not otherwise directed, forms shall be made of steel where practicable.

The types of ties used and their position shall be such that the required finish is achieved and will not be marred by subsequent corrosion of the ties.

Unless otherwise shown or directed, formwork shall be such that exterior corners of finished concrete are provided with 20 mm chamfers and re-entrant corners without fillets.

2.3.4.6 Casting beds and moulds

All casting beds for PCC shall be properly aligned and levelled. Adequate weather protection shall be provided should this be necessary to achieve the standards specified below.

2.3.4.7 Plant and equipment for handling, lifting, and stacking

The Contractor shall provide adequate equipment for so handling, lifting, and stacking precast units that they do not become discolored and are protected from permanent damage due to stresses induced during handling or stacking or due to the use of slings, chains, and hooks.

2.3.5 Construction and Workmanship

2.3.5.1 Reinforcement

Reinforcing bars shall be bent to the shapes and dimensions shown on the drawings and bending schedules. All bars shall be bent cold and bending shall be done slowly, a steady, even pressure being used without jerk or impact.

Steel shall, at the time of the placing of the concrete, be free from loose or powdery rust, scale, oil, or other coatings that may reduce the bond between steel and surrounding concrete, affect the durability of the concrete, or initiate corrosion of the reinforcement. If any substance other than water is used for lubricating the formwork, every precaution shall be taken to avoid contamination of the reinforcing steel by such substance.

Reinforcing steel shall be positioned as shown on the drawings or as directed and maintained in those positions within the tolerances specified. It shall be secured against displacement by tying at intersections with annealed wire of nominal diameter 1.25 or 1.6 mm, or by the use of acceptable clips or, if permitted by the Engineer, by welding. Reinforcing bars shall be supported and aligned in their correct position by means of hangers, chairs, spacers or saddles of approved design.

Unless otherwise shown on the drawing or directed by the Engineer, the minimum cover of concrete over reinforcing bars, measured from the outside of the most outer bar or stirrup, shall be 25 mm for mild exposure conditions, 35 mm for moderate exposure conditions, and 50 mm for severe exposure conditions or the diameter of the bar to which the cover is measured, whichever is greater.

The Contractor shall ensure that reinforcement including stirrups, links, and tying wire does not encroach into the specified cover. Splices or joints in reinforcing bars shall be made only as and where shown on the drawings or as otherwise approved.

If left exposed for future bonding of extensions to the Works, reinforcing steel shall be protected from corrosion as directed. For PCC units, reinforcement shall, where practicable, be preformed into rigid cages. For this purpose spot welding of bars shall be carried out only by skilled and experienced welders.

2.3.5.2 Formwork

Formwork will be classified in accordance with the surface conditions required on the finished concrete, as shown on the drawings or as directed. Such finishes will be as follows:

a) Rough. No treatment of the surface of the concrete will be required after the striking of the formwork. The finish of the concrete need not be more accurate than Degree of Accuracy III as defined in terms of Clause 2.3.6.
b) Smooth. Imperfections such as small fins, bulges, irregularities, surface honeycombing, and slight surface discolorations shall be made good and repaired by approved methods. The finish of the concrete shall be accurate to Degree of Accuracy II.

c) Special. Special finishes shall be as specified in the Technical Specification.

Forms shall be erected with joints tight enough to prevent leakage of cement mortar.

Surfaces of forms (regardless of the material of which they are made) that are to be in contact with fresh (wet) concrete shall be treated with a coat of non-staining mineral oil or other approved material, or, in the case of timber forms, by thorough wetting of the surfaces with water, so as to ensure easy release and prevent adhesion of the formwork during stripping.

Before re-use, all formwork shall be reconditioned, and all form surfaces that are to be in contact with the concrete shall be thoroughly cleaned.

Where necessary for the proper placing of the concrete, temporary openings for cleaning, inspection, or placing and compaction purposes shall be provided and, subsequently, so closed as to provide the finish specified and to conform to the applicable tolerances specified.

Formwork shall not be removed before the concrete has attained sufficient strength to support its own weight and any loads that may be imposed on it. For this purpose, the formwork shall remain in place, after placing of the concrete, as follows:

a) Concrete cast with OPC, in hot or normal weather
   (i) Beam sides, walls, and unloaded columns 1 d
   (ii) Slabs with props left underneath 4 d
   (iii) Beam soffits with props left under 7 d
   (iv) Slab props, including cantilevers 10 d
   (v) Beam props, including cantilevers 14 d

b) Concrete cast with RHPC, in hot or normal weather
   (i) Beam sides, walls, and unloaded columns 1 d
   (ii) Slabs with props left underneath 2 d
   (iii) Beam soffits with props left under 3 d
   (iv) Slab props, including cantilevers 5 d
   (v) Beam props, including cantilevers 7 d

c) Concrete cast with PBFC, in hot or normal weather
   (i) Beam sides, walls, and unloaded columns 2 d
   (ii) Slabs with props left underneath 6 d
   (iii) Beam soffits with props left under 10 d
   (iv) Slab props, including cantilevers 10 d
   (v) Beam props, including cantilevers 14 d

d) Concrete cast with OPC, in cold weather
   (i) Beam sides, walls, and unloaded columns 1.5 d
   (ii) Slabs with props left underneath 7 d
   (iii) Beam soffits with props left under 12 d
   (iv) Slab props, including cantilevers 17 d
   (v) Beam props, including cantilevers 21 d

e) Concrete cast with RHPC, in cold weather
   (i) Beam sides, walls, and unloaded columns 1 d
   (ii) Slabs with props left underneath 4 d
   (iii) Beam soffits with props left under 5 d
   (iv) Slab props, including cantilevers 9 d
   (v) Beam props, including cantilevers 12 d

f) Concrete cast with PBFC, in cold weather
   (i) Beam sides, walls, and unloaded columns 4 d
   (ii) Slabs with props left underneath 10 d
   (iii) Beam soffits with props left under 17 d
   (iv) Slab props, including cantilevers 17 d
   (v) Beam props, including cantilevers 21 d
In cool weather, stripping times shall be determined by interpolation between the periods specified for normal and cold weather.

If the Contractor can prove to the satisfaction of the Engineer that a period shorter than the appropriate minimum given above is sufficient to enable the concrete to comply with its requirements, the formwork may be removed after such shorter period.

Formwork shall be removed carefully so that shock and damage to the concrete are avoided.

Notwithstanding the provisions above, the Contractor shall be responsible for making good any damage to the concrete arising from the removal of formwork and its supports.

2.3.5.3 Holes, chases, and fixing blocks

No holes or chases, other than those shown on the drawings or approved by the Engineer, shall be cut or otherwise formed in the concrete. The manner of attaching fixtures to be embedded in the concrete shall be subject to approval by the Engineer.

2.3.5.4 Pipes and conduits

2.3.5.5 Concrete

Quality
Concrete shall comply with the requirements for strength concrete or for prescribed mix concrete of DIN 1045.

For precast concrete, the mix shall be of Grade B25 unless another grade is shown on the drawings or specified in the Technical Specification.

The types of aggregates and cement shall not be altered during the period of the contract. The slump, in mm and for vibrated concrete, shall be within the limits given below, or within such other limits as are laid down in the Particular Specification, by the Engineer in respect of prescribed mix concrete, or by the Engineer after receipt of the Contractor's design for strength concrete, if any Slump, mm

a) Paving and precast units
   max 50 min 30
b) Heavy mass construction
   max 50 min 20
c) Walls, footings, slabs, beams, columns
   max 80 min 30
d) Plain concrete in substructures
   max 60 min 20
e) Heavy duty industrial floors
   max 80 min 50

The concrete shall be of such workability that it can be readily compacted into the corners of the formwork and around reinforcement without segregation of the materials or excessive bleeding of free water from the surface.

Mainly for reasons of durability, the following maximum water/cement ratios shall apply, for different conditions of exposure:

a) mild and moderate exp. cond. max. w/c-ratio: 0.55
b) severe exposure conditions max. w/c-ratio: 0.50
c) very severe exposure conditions max. w/c-ratio: 0.45

The cement content for any structural concrete shall not be less than 280 kg/m3. The requirements for different classes of concrete are given in the table below.

The Contractor will be responsible for the design of prescribed mix concrete and for proportioning of the constituent materials. The Contractor shall provide, on the Site, concrete of the specified materials and in the proportions approved by the Engineer.

The Contractor shall specify the sources of supply of the materials for such concrete and will make available, when required, samples of each aggregate together with information on their origin. He will also specify the following in respect of prescribed mix concrete for each section of the work:

a) the maximum nominal size of coarse aggregate, in millimeters, and its proportions in the mix
b) the proportion of fine aggregate in the mix
c) the type and proportion of cement in the mix
d) the slump, in millimeters, or the w/c-ratio.
The Contractor shall be responsible for the design of strength concrete, and the submission of test cubes to an approved laboratory, and for the measurement of the constituent materials to produce concrete that complies with the requirements specified by the Engineer.

The Engineer will specify the following in respect of strength concrete for each section of the work:

- the grade of concrete and position on the Works
- the maximum nominal size of coarse aggregate, in millimeters.

**Batching**

The mass of cement supplied in a standard sack shall not be less than 50 kg. All cement taken from bulk storage containers and from partly used sacks shall be batched by mass with additional 2% of mass required.

Mixing water for each batch shall be measured. The amount of water measured shall be adjusted to allow for the moisture content of the aggregates.

If batching is by mass, the mass of the aggregate of each size shall be determined and a correction made for the moisture content of the aggregates.

If batching is by volume, the fine and the coarse aggregates shall be measured separately in suitable measuring boxes of known volume and of such capacity that the quantities of aggregates for each batch are suitable for direct transfer into the mixer. Bulking tests on the fine aggregate shall be conducted regularly and the results used for adjustment of the batch volume of the fine aggregate to give the true volume required.

The Engineer shall be permitted to require additional tests for bulking to be done after rain has fallen or if, in his opinion, any other cause of variation in the moisture content of the aggregate has arisen.

**Mixing**

The following requirements shall apply to the mixing of concrete at the construction site:

- Mixing of materials for concrete shall be conducted by an experienced operator.
- The sequence of charging the mixing plant shall have been approved before mixing commences and, unless otherwise directed, the approved sequence shall be maintained.
- The total volume of material per batch shall not exceed the rated capacity of the mixer.
- Before any concrete is mixed, the inner surfaces of the mixer shall be cleaned and all hardened concrete shall be removed. A slurry of cement, sand, and water containing cement and sand in a ratio of 1:2 and in sufficient quantity to cover the entire inside surface of the mixer shall be produced in the clean mixer and discharged immediately before the charging of the mixer with materials at the commencement of each concrete production run.
- The period of mixing shall be measured from the time when all the materials are in the drum or pan to the commencement of discharge. Subject to the provisions of (f) below, the mixing period for each batch of 1.5 m³ or less shall be at least 1.5 min and 1 min for drum-type and pan-type mixers respectively, and shall be increased by 20 sec and 15 sec respectively for each additional cubic metre or part thereof. During this period, the drum or pan shall be rotated at the speed recommended by the manufacturer of the mixer. The maximum continuous mixing times at the recommended mixing speed shall not exceed 10 min and 6 min per batch for drum-type and pan-type mixers respectively.
- In the event of delay in the concreting operations, concrete may be retained in the mixer for a maximum period of 2 h provided that the slump is checked frequently and that only enough water to maintain the target slump is added to the mixer. During this period the mixer shall be restarted and run for about 2 min every 15 min. The Engineer may order that the period of 2 h be reduced if, in his opinion, the ambient temperature, or any other factor, will tend to produce early setting.
- Discharge shall be so carried out that there is no segregation of the materials in the mix. The mixer shall be emptied completely before it is recharged. If the mixer has been out of use for longer than 30 min, it shall be thoroughly cleaned out, particular attention being paid to the removal of any built-up of materials in the drum, in the loader, and around the blades or paddles.

The Engineer will advise whether the production of concrete at a central concrete production facility other than on the construction site is permitted and whether the test results obtained by such a production facility as part of its quality control system are acceptable.
**Transportation**
Mixed concrete shall be discharged from the mixer and transported to its final position in such a manner that segregation, loss of ingredients, and adulteration are prevented and that the mix is of the required workability at the point and time of placing.

**Placing**
The Contractor shall give the Engineer 24 h notice of his intention to place concrete. The concrete shall be placed within 1 h (DIN Standard for Cement Initial Set) of the time of its discharge from the mixer. Concrete shall not be retamped by the addition of water or any other material. The forms to be filled shall be clean internally. All excavations and other surfaces of an absorbent nature that are to come into contact with the concrete shall be dampened with water. There shall be no free water on the surfaces against which concrete is to be placed.

Wherever possible, the concrete shall be deposited vertically into its final position to avoid segregation and displacement of reinforcement and other items that are to be embedded.

Deposited concrete shall not be so worked (whether by means of vibrators or otherwise) as to cause it to flow laterally in such a way that segregation occurs. Where possible, the concrete shall be brought up in horizontal layers of compacted thickness not exceeding 450 mm and heaping should be avoided.

Where a chute is used to convey the concrete, its slope shall be such as will not cause segregation, and a suitable spout or baffles shall be provided for the discharge of the concrete.

Concrete shall not be allowed to fall freely through a height of more than 3 m, unless otherwise approved.

Placing of concrete under water will be permitted only under exceptional circumstances when it is, in the opinion of the Engineer, not practicable to dewater before placing. No concrete shall be placed in flowing water. When the placing of concrete is permitted, it shall be placed by means of a tremie. During placing, the lower end of the tremie shall be continuously immersed in the concrete being deposited. To maintain the desired properties of the concrete the quantity of cement in the concrete mix shall be increased by 20 %. Full details of the method proposed and of the adjusted concrete mix proportions shall be submitted to the Engineer for his approval before placing commences. During and after concreting under water, pumping or dewatering operations in the immediate vicinity shall be suspended.

Waterstops shall be carefully maintained in the position shown on the drawings and properly protected from damage and the harmful effects of light and heat during all stages of construction. The stop-boards on each side of the waterstop shall be accurately wrought to match the profile of the waterstop. The concrete shall be carefully compacted under and around the waterstop so as to leave no cavities.

Joint filler material of the thickness specified shall be cut to shape and fixed to fill the whole space between the concrete faces of the joint which is not otherwise filled by waterstop and joint sealer. Abutting pieces shall be placed in close contact and the joints covered on each side to prevent the passage of cement grout.

Recesses at movement joints on both faces of the concrete work except on the underside of continuously supported work and on faces backfilled with earth shall be accurately formed to the lines and dimensions shown on the drawings. The Contractor shall prepare the surfaces of the recesses and shall supply a joint sealer and fill or caulk the recess completely with it, all in accordance with the manufacturer's instructions.

The placing of concrete by pumping in any section of the Works shall be subject to the written approval of the Engineer. The Contractor shall furnish the Engineer with full details regarding the mix proportions of concrete that he intends to place by pumping.

**Compaction**
The concrete shall be fully compacted by approved means during and immediately after placing. It shall be thoroughly worked against the formwork and around reinforcing steel and other embedded items without displacing them. The concrete shall be compacted in a way to avoid honeycombing and planes of weakness of the hardened concrete. Successive layers of the same lift shall be thoroughly worked together. To achieve this, the compaction tool shall penetrate through the new layer to the lower layer which shall still be sufficiently plastic to permit interknitting.
Compaction shall be carried out by mechanical vibration or (if approved) by spading, rodding, or forking.

Over-vibration resulting in segregation, surface laitance, or leakage, or any combination of these, shall not be permitted. The rate of concrete placing shall be commensurate with the available compaction equipment and only skilled operators shall be permitted to undertake compaction by vibration.

Concrete for precast elements shall be so placed in moulds and vibrated that concrete surfaces are smooth and even and all arrises are true and clean.

Where precast units having architectural finishes are required, the Contractor shall ensure that duplicate samples are submitted to and approved by the Engineer with regard to both colour and quality before full scale production is commenced. One sample will be retained by the Engineer and the other shall be retained by the Contractor at the place of manufacture. The Contractor shall not commence manufacture until acceptable samples have been lodged.

**Construction joints**

Concreting shall be carried out continuously up to the locations where construction joints are shown on the Contractor's working drawings or up to approved or directed locations. The method adapted for forming such joints and unforeseen joints shall be one of the following:

a) Construction joints when concrete is more than 24 h old. The surface of the concrete shall be brushed with a steel wire brush before new mortar and concrete are placed as specified in (b) below.

b) Construction joints when concrete is more than 24 h but not more than 3 d old. The surface of the concrete shall be sand-blasted or chipped with a light hammer, swept clean, and thoroughly wetted and covered with a 10 mm thick layer of mortar composed of cement and sand mixed in the same ratio as in the concrete. This mortar shall be freshly mixed and placed immediately before the new concrete is placed.

c) Construction joints when concrete is more than 3 d old. The procedure specified in (b) above shall be followed, except that the old surface shall be prepared and kept continuously wet for at least 24 h before the mortar and the new concrete are placed.

d) Construction joints at top of columns. The procedure for brushing and cleaning as specified in (a) or (b) above, as applicable, shall be followed before the steel reinforcement of the slab or floor to be cast on the columns is placed in position.

**Curing and protection**

After formwork has been removed and as soon as it is practicable in the opinion of the Engineer, all concrete shall be protected from contamination and loss of moisture by one or more of the following methods:

a) Ponding the exposed surfaces with water

b) covering the concrete with sand, or mats made of a moisture-retaining material, and keeping the covering continuously wet

c) continuously spraying the exposed surface with water

d) covering the concrete with waterproof sheeting firmly anchored at the edges

e) the use of an approved curing compound applied in accordance with the manufacturer's instructions.

When the ambient temperature is 5º C and higher, the curing period shall be at least 6 d for concrete made with Portland cement, at least 3 d for concrete made with rapid-hardening Portland cement, and at least 8 d for concrete made with Portland blastfurnace cement. When the ambient temperatures is below 5º C, the curing periods shall be extended by 72 h, 36 h, and 72 h, respectively.

For precast units, the curing period shall be at least 8 d for concrete made with OPC (instead of 6 d) and at least 10 d for concrete made with PBFC or OPC/slag (instead of 8 d), and curing shall start not earlier than 6 h after the concrete has been placed.

Provided that the curing temperature does not exceed 60º C and that the rate of increase does not exceed 20º C/h, precast concrete may be steam cured at atmospheric pressure or curing may be accelerated by casting the concrete in heated moulds.

When the ambient temperature is above 32º C, the temperature of the concrete when deposited shall not be allowed to exceed 32º C. Under adverse hot weather conditions, the Contractor shall take all reasonable steps to reduce to a minimum the placing temperature of the concrete. Stockpiles of
aggregates and all metal surfaces in contact with aggregates and concrete shall be shielded from the
direct sun and/or cooled by being sprayed with water, and windbreaks shall be erected, if necessary, to
prevent the initial rapid drying-out of the concrete which would otherwise occur before normal curing
procedures can be undertaken.

Concrete shall not be placed during periods of heavy or prolonged rainfall.

**Concrete surfaces**
Exposed surfaces of concrete not finished against forms (such as horizontal or slightly sloping surfaces)
shall be brought up to a plane, uniform surface with suitable screed boards.

Where a wood-, steel-, or power-floated finish is required in terms of the Technical Specification, the
concrete shall be finished to the tolerances specified for Degree of Accuracy II in terms of 2.3.6.

Finished concrete shall have a neat, smooth, even, and uniform finish free from any honeycombing. If
the finish of any formed or floated concrete surface is, to the opinion of the Engineer, unsatisfactory and
does not conform to that specified, the Contractor will be required, at his own expense, to rub down such
surface while it is still green, or, alternatively, to grind it down with Carborundum or other suitable
material when it has hardened or to take other approved measures to give the specified finish.

For precast elements, moulds shall be removed without any shock or vibration that might damage the
crunch or have any other detrimental effect on the units and on their surfaces.

**Watertight concrete**
Each section of the Works that is required, in terms of the Technical Specification, to hold or exclude
water shall be watertight, and special care, particularly at construction joints, shall be taken by the
Contractor to ensure watertightness. Should any such section of the Works fail to pass the tests for
watertightness as required in terms of the Technical Specification or as ordered, or show any sign of
water leakage or penetration after being taken into use, it shall be deemed defective and the provisions
of 2.3.5.5.14 shall apply.

**Concrete in wet ground**
Wherever concrete is to be placed in wet ground, shallow drains shall be excavated below the ground
formation, filled with broken stone, and connected to suitably placed sumps.

A concrete carpet, the top of which will form the foundation level for the structural concrete, shall then be
laid.

The layout and dimensions of the dry-stone drainage channel and the thickness of the carpet will be
determined by the Engineer in every case, whether or not these details are given on the drawings, and
their construction will be dealt with as daywork.

**Grouting**
Where the Contractor is required to grout holding-down bolts, or to place grout under column bases or
bedplates for equipment, he shall first prepare the relevant concrete surfaces by scrubbing and cleaning
them. The mortar grout shall consist of an approved mixture of cement, sand, water, and admixture, and
shall be so rammed into each HD-bolt pocket or under each base or bedplate (as applicable) that all
voids and pockets are completely filled around the bolt or between the top of the concrete and the
underside of the metalwork, and, in the case of a base or a bedplate, that the grout projects beyond the
base or bedplate. After the void has been completely filled, the edges of the mortar grout shall be
trimmed at an angle of 45° outward from the bottom edges of each base or bedplate and the trimmed
edge wood-floated to a neat finish.

**Concrete pumping**
Where approved by the Engineer, the Contractor may use a suitable concrete pump for transporting the
concrete from the batching plant or transport vehicle to the point where it is to be deposited, in which
case the specified mix proportions shall be adjusted and agreed with the Engineer at the time of
submission of the relevant method statement. The concrete shall be fed directly from the batching plant
or transport vehicle into the hopper of the pump. Once concreting has commenced the rate of the flow
and mixing must be such as to ensure continuous movement of the concrete in the pipework, which
shall have as few bends as possible. Frequent slump tests (eg in accordance with BS 1881) shall be
carried out at the delivery end to ensure the consistency and workability at the point of placing. All
equipment must be thoroughly cleaned at the end of each operation.
Defects
The concrete shall be homogeneous and free from honeybombed, interstices, and planes of weakness. If, after removal of the forms, the concrete shows any defect, the Contractor shall immediately report such defect to the Engineer, and he shall not carry out any patching or remedial work until authorized to do so by the Engineer.

After thorough inspection and investigation of the quality and strength of the defective work and after due consideration of the possible consequences of such defect, the Engineer will either specify the extent and method of repair or order the demolition and reconstruction of the whole of the defective work to the extent that he considers necessary.

The cost of all such investigation, repair, and remedial work and of any demolition and reconstruction of defective work shall be borne by the Contractor and all repair, remedial, and reconstruction work shall be executed to the satisfaction of the Engineer.

Handling and erection of precast units
The Contractor shall ensure that lugs, slots, holes, etc., provided for handling units and moving them from the point of manufacture to the place where they are erected, are adequate and are so arranged that excessive stresses do not occur in any unit during handling, movement, or erection. Without the Contractor’s responsibility being limited in any respect, the position of lifting and supporting points, the method of lifting, and the type of equipment and transport used shall be subject to approval by the Engineer.

The Contractor shall place indelible identity, location, and orientation marks on each unit, as and where necessary.

Packing pieces shall be such that they do not discolour or otherwise permanently damage the units.

Precast units shall be so stacked that the accumulation of trapped water and dirt is prevented, that, in the case of small units, deformation is minimized during the curing process, and that large units such as bridge beams have complete freedom of movement during the curing process.

The method of assembly and erection agreed to with the Engineer shall be adhered to on the Site. Immediately after the unit is in position and before the lifting equipment is removed temporary supports or temporary connections between units shall be provided as necessary. The final structural connections shall be completed as soon as is practicable.

No-fines concrete
No-fines concrete, eg for use in subsoil drainage, shall consist of a 1:8 cement/aggregate mix by volume. Aggregate shall be 18 mm to 10 mm graded. Only sufficient water shall be added to ensure complete coating of the aggregate. One half of this water shall be placed into the mixer first, after which the aggregate and cement shall be admitted. After partial mixing the balance of the water shall be added until a suitable consistency of mix is achieved.

Concrete for benching
Concrete for benching in manholes and similar structures shall consist of Grade 15 concrete unless otherwise specified. It shall be placed with low workability to the approximate shape required, and, while still green, shall be finished with not less than an average of 20 mm of cement screed to a steel trowelled finish and to the contours indicated on the drawings.

Air-entrained concrete
Concrete, where specified, shall include an approved air-entraining agent capable of producing a 5% air-entrainment with a tolerance of 0.5%.

The mix shall be properly designed, having regard to the nature and grading of the aggregate and air-entraining agent being used.

The Engineer reserves the right, at any time, to sample and test the air-entraining agent used in the Works.

Preference shall be given to the use of air-entraining agents which can be administered in fixed calibrated amounts through a dependable mechanical dispenser or cachet, and which are added to the mixing water.
No air-entraining agent shall be used in the Works without the written approval of the Engineer.

**Records**
The Contractor shall maintain written records that provide the following information:

a) The date on which each section was concreted
b) the position of the section within the Works
c) the nature of samples taken and the dates they were taken
d) the curing history
e) the daily weather conditions
f) the curing history
g) the type (mix) and grade of concrete
h) the date of removal of formwork

**2.3.6 Tolerances**

**2.3.6.1 General**

Permissible deviations (PD) appropriate to the degree of accuracy will be applied to linear dimensions, position, plumb (verticality), level, squareness, and bow.

Where precast units are to fit on or between cast-in-situ concrete units, the tolerances applicable to the cast-in-situ concrete shall be compatible with the tolerances applicable to the precast units.

The Degree of Accuracy may be one of the following:

a) Degree of Accuracy III for use where a high degree of accuracy is unnecessary, eg mass foundations
b) Degree of Accuracy II for what is normally considered "good work"
c) Degree of Accuracy I where the use of special, as opposed to normal, methods or materials (or both) is warranted, eg prefabricated units or where such are to fit in.

Deviations will be measured as set out below:

a) Any deviation from flatness of a plane surface will be measured as the maximum deviation of the surface from any straight line of length 3 m joining two points on the surface, determined by means of a straight-edge the ends of which are supported on identical blocks of suitable thickness placed over each of the points.

b) Any abrupt change in a continuous surface, including a local depression or peak in a floor or wall and any abrupt change caused by a joint in formwork will be measured as specified in (a) above.

c) Out-of-squareness of a corner or an opening or an element such as a column will be measured by taking the longer of two adjacent sides as the base line, and determining any departure from the perpendicular of the side at either end of the base line.

**2.3.6.2 Permissible Deviations**

If no Degree of Accuracy is specified in the Technical Specification, Degree of Accuracy II shall apply. The Permissible Deviations are:

a) for the Degree of Accuracy III:

(i) reinforcement
   spacing between two adjacent bars + 25 mm
   location of ends of bars + 40 mm
   cover to reinforcement - 0, + 20 mm

(ii) foundations
   position in plan from grid or centre line + 50 mm
   linear dimension in plan cast against excav. + 60 mm
   linear dimension in plan cast against formw. + 30 mm
   level of underside of concrete - 40, + 20 mm
   surface level - 30, + 15 mm

(iii) elements above foundation
   position in plan from grid or centre line + 25 mm
   linear dimensions + 30 mm
   cross-section dimension - 10, + 20 mm
<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of any element or component</td>
<td>-20, +10 mm/mm</td>
</tr>
<tr>
<td>Plumb, per metre of height</td>
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<tr>
<td>Plumb, maximum of any point, at any height</td>
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<td>Out-of-squareness, for short sides &lt; 0.5 m</td>
<td>+10 mm</td>
</tr>
<tr>
<td>Out-of-squareness, for short sides &lt; 2.0 m</td>
<td>+20 mm</td>
</tr>
<tr>
<td>Out-of-squareness, for short sides &lt; 4.0 m</td>
<td>+25 mm</td>
</tr>
<tr>
<td>Flatness of or abrupt changes in expansive surface</td>
<td>10 mm</td>
</tr>
<tr>
<td>Flatness of surface to be plastered</td>
<td>15 mm</td>
</tr>
<tr>
<td>Abrupt changes in surfaces to be plastered</td>
<td>10 mm</td>
</tr>
<tr>
<td>Cover to reinforcement</td>
<td>0 mm</td>
</tr>
<tr>
<td>Location in plan or elevation of HD-bolts</td>
<td>+5 mm</td>
</tr>
<tr>
<td>Constituents in the concrete mix</td>
<td>+5 %</td>
</tr>
</tbody>
</table>

b) for the Degree of Accuracy II:

(i) Reinforcement
   - Spacing between two adjacent bars: +20 mm
   - Location of ends of bars: +30 mm
   - Cover to reinforcement: -0,+15 mm

(ii) Foundations
   - Position in plan from grid or centre line: +35 mm
   - Linear dimension in plan cast against excavation: +40 mm
   - Linear dimension in plan cast against formwork: +20 mm
   - Level of underside of concrete: -30,+15 mm
   - Surface level: -20,+10 mm

(iii) Elements above Foundation
   - Position in plan from grid or centre line: +15 mm
   - Linear dimensions: +20 mm
   - Cross-section dimension: -5,+10 mm
   - Level of any element or component: -15,+5 mm
   - Plumb, per metre of height: 4 mm
   - Plumb, maximum of any point, at any height: 50 mm
   - Out-of-squareness, for short sides < 0.5 m: +5 mm
   - Out-of-squareness, for short sides < 2.0 m: +15 mm
   - Out-of-squareness, for short sides < 4.0 m: +20 mm
   - Flatness of or abrupt changes in expansive surface: 5 mm
   - Flatness of surface to be plastered: 10 mm
   - Abrupt changes in surfaces to be plastered: 5 mm
   - Cover to reinforcement: 0 mm
   - Location in plan or elevation of HD-bolts: +3 mm
   - Constituents in the concrete mix: +5 %

c) for the Degree of Accuracy I:

(i) Reinforcement
   - Spacing between two adjacent bars: +15 mm
   - Location of ends of bars: +20 mm
   - Cover to reinforcement: -0,+10 mm

(ii) Foundations
   - Position in plan from grid or centre line: +20 mm
   - Linear dimension in plan cast against excavation: +20 mm
   - Linear dimension in plan cast against formwork: +10 mm
   - Level of underside of concrete: -20,+10 mm
   - Surface level: -10,+5 mm

(iii) Elements above Foundation
   - Position in plan from grid or centre line: +5 mm
   - Linear dimensions: +10 mm
   - Cross-section dimension: +5 mm
   - Level of any element or component: -10,+0 mm
   - Plumb, per metre of height: 2 mm
plumb, maximum of any point, at any height 30 mm
out-of-squareness, for short sides <0.5 m + 3 mm
out-of-squareness, for short sides <2.0 m + 10 mm
out-of-squareness, for short sides <4.0 m + 15 mm
flatness of or abrupt changes in exp. surface 30 mm
flatness of surface to be plastered 5 mm
abrupt changes in surfaces to be plastered 3 mm
cover to reinforcement 0 mm
location in plan or elev. of HD-bolts + 1.5 mm
constituents in the concrete mix + 5 %

d) for precast beams
the deviation from the intended line measured on a part of or on the overall length of the beam
shall not exceed 3 mm for the length of up to 3 m, and for each additional metre in length a
deviation of 1 mm will be allowed up to a maximum of 10 mm. In addition, the rate of deviation
from the intended line shall not exceed 1:300.

2.3.7 Tests and Acceptance

2.3.7.1 Facilities and frequencies of sampling

For the purposes of taking samples and carrying out tests, the Engineer shall have free access to the
Works, and the Contractor shall provide all equipment required for the sampling (eg cones, moulds) as
specified and render any assistance necessary. If so required, the Contractor shall provide storage and
protection for such samples on the Site.

While concrete of a particular grade is being placed under the same conditions, sets of samples (each
sample being sufficient for 3 cubes, cylinders, beams, or prisms, as applicable) shall be taken.

The sets of samples shall be taken as close as is practicable to the start of placing and at appropriate
intervals thereafter, or from one particular batch and then from subsequent batches chosen at
appropriate intervals.

At least one set of samples shall be taken from each day's casting and from at least every 90 m3 of
concrete of each grade placed.

Only one sample shall be drawn from any one batch of concrete, and, except where otherwise ordered,
no sample shall be taken of any grade until at least 3 batches of such grade have been mixed and
discharged.

2.3.7.2 Testing

All testing shall be carried out in accordance with the relevant applicable standards or as directed by the
Engineer.

The Contractor shall ensure that Site testing is carried out by a competent technician or by a person
deemed by the Engineer to be sufficiently experienced.

The Contractor shall ensure that laboratory testing is carried out by a recognized testing institution or an
approved laboratory or a firm approved by the Engineer.

Where early-strength testing is desired by the Contractor (eg for determination of the 7 d strength), plans
for such testing and interpretation of results shall be as agreed between the Contractor and the
Engineer.

2.3.7.3 Acceptance criteria for strength concrete

Should any test result obtained on concrete of a specific grade show that the strength is more than 3
MPa below the specified strength, the concrete will be deemed not to satisfy the requirements of the
specification. Should an examination carried out as described below satisfy the Engineer that the
structural adequacy and durability of the part of the structure in which the concrete has been used is not
impaired, the concrete shall be accepted and the mix design and other factors influencing the quality
shall be reviewed in order to ensure that further concrete cast will be of the quality as specified.
The following are the criteria to be applied with regard test results:

a) The average of any three consecutive test results obtained on concrete of a specific grade shall exceed the specified strength by at least 2 MPa.

b) If the criterion given in (a) above is not met but the said average is at least equal to the specified strength, the concrete cast shall be accepted but the mix design and standard of control shall be reviewed and adjusted as necessary.

Should the said average result be less than the specified strength, the Engineer will investigate, as described below, the part of the structure in which concrete represented by such result has been used.

If, after evaluation of the test results an examination of the concrete in the structure is indicated, one or more of the procedures in the sequence given below may be adopted at the discretion of the Engineer to determine the acceptability or otherwise of concrete in particular sections of the structure:

a) An assessment of the stress level in the structure concerned in relation to the test result obtained

b) non-destructive testing, subject to similar concrete of proved acceptable quality being available in comparable members in the same construction as a reference (impact hammers and ultrasonic testing are two examples of such test techniques that may be used, provided the apparatus has been previously calibrated)

c) the testing of drilled cores in accordance with relevant applicable standards under terms and conditions agreed upon between the Engineer and the Contractor.

Where load tests are, in the opinion of the Engineer, unsuitable or impractical, and if an examination described above does not show the concrete strength to be acceptable, or if a portion of the structure fails to pass the test, the Contractor shall, on the instructions and directions of the Engineer, either replace or strengthen by approved means each that failed or contains concrete that failed, as relevant; and any section, irrespective of strength, the functional purpose of which is affected by the section or concrete referred to in (a) above.

The Contractor shall bear the cost of any replacement or strengthening referred to above as well as any other remedial measures that may be ordered to restore the durability of the concrete to that achievable by concrete of the strength required in terms of the specification.

2.3.7.4 Individual load tests on precast units

If so directed by the Engineer, the unit to be tested shall be supported at its designed points of support and loaded for 5 min with a load equal to the sum of the characteristic dead load plus 1.25 times the characteristic imposed load, and the deflection shall then be recorded. The maximum deflection measured after application of the load shall be checked for compliance with the applicable requirements of the relevant applicable standards.

The recovery shall be measured 5 min after the removal of the applied load and the load shall then be re-imposed. The percentage recovery after the second loading shall be at least equal to that determined after the first loading and at least 90 % of the deflection recorded during the second loading. At no time during the test shall there be, in the opinion of the Engineer and in the light of a reasonable interpretation of the relevant data, any sign of weakness or faulty construction in the unit under test.

If destructive tests for beam units are ordered, the unit to be tested shall be supported at its design points of support, and loaded to its ultimate design load. The unit shall not fail within 15 min after the application of the test load. A deflection exceeding 1/40 of the span shall be regarded as failure of the unit.

For units not amenable to the tests described above, details of the testing arrangements shall be agreed between the Engineer and the Contractor before such units are cast.
2.3.8 Measurement and Payment if not otherwise specified in the B.O.Q.

2.3.8.1 Principles

Formwork
Formwork will be measured as the net area of the face of the concrete. No deduction will be made for fillets and splays of size up to 100 x 100 mm or for openings of diameter up to 0.7 m or of area up to 0.5 m².

Formwork in continuous lengths of narrow width of up to 300 mm will be measured by length, the width or range of width being stated in the schedule.

Boxing-out, the forming of holes, and other such operations will be measured by number, basic dimensions, perimeters, or drawing references, as stated in the schedule.

Separate items will be scheduled
a) for each class of finish required
b) for the different angles of inclination of formwork as given below:
   (i) horizontal: >85° up to 95°
   (ii) sloping: >10° up to 85°
   (iii) battered: up to 10°
   (iv) vertical: 0°
c) for each type of structural element, such as walls, beams, slab, etc.
d) for formwork to curved surfaces
e) for voids or openings classified as follows:
   (i) large: >0.1 up to 0.5 m²
   (ii) small: up to 0.1 m²

Reinforcement
Steel for reinforcement will be measured net by mass of all bars, including supporting steel detailed on the bending schedules. No allowance will be made for cutting, waste, spacer devices, or binding wire.

Welded mesh will be measured by area to be reinforced by means of mesh, no allowance being made for cutting, waste, laps, or deductions for end cover.

Steel offcuts resulting from the cutting and bending of reinforcing steel in accordance with the bending schedule shall be deemed to be the property of the Contractor.

Concrete
The volume or area of concrete, in which unit the payment is intended, will be computed from the measurements net to the dimensions shown on the drawings or to the dimensions cast, whichever is the smaller. Structural elements that are undersized will be measured for payment only if they are accepted by the Engineer.

No allowance will be made for concrete required to make up overbreak in soft excavation, but payment will be made for additional concrete or formwork, ordered in writing by the Engineer to replace unsuitable material or overbreak in hard rock or in intermediate excavation.

Subfoundation carpets and blinding layers will be measured to the plan size of the concrete structure resting on it, and measured on the mean thickness as cast, provided that the Engineer is satisfied that the excavation has not at any point been taken deeper or wider than necessary.

Separate items will be scheduled, as applicable, for each type and each grade of concrete, for each unit or element in the structure (where these would materially influence the pricing), such as
a) slabs that are horizontal, sloping, conical or off different thickness
b) concrete deposited under water
c) small quantities each less than 0.5 m³ of formed surfaces, and
d) different surface finishes, other than just striking-off and levelling.
3 PIPELINES AND RELATED WORKS

3.1 PIPE TRENCHES

3.1.1 Scope
This specification covers earthworks for trenches for all types and sizes of pipes. It covers excavation, the preparation of a trench bottom, backfilling and the reinstatement of surfaces.

3.1.2 Interpretations

3.1.2.1 Supporting Specifications
The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) General
b) Site Clearance
c) Earthworks

3.1.2.2 Application
This specification contains clauses that are generally applicable to earthworks for pipe trenches. Interpretations, additions, and variations of this specification (if any) are set out in the Particular Technical Specification.

3.1.2.3 Definitions
For the purpose of this specification the following definitions shall apply (re also drawing 3.2):

Backfill (Main fill) - The approved filling material placed in a pipe trench after the pipe has been laid, bedded and surrounded by the blanket that has been compacted at the sides and over the top of the pipe.

Bedding - The material, and the operation of placing it, of the bedding cradle and blanket, up to the underside of the backfill.

Blanket - The bedding zone in which material is placed and compacted on or from the top of the cradle up the sides and over the top of the pipe in such a manner that the barrel of the pipe is supported continuously and firmly on the sides and protected over the top by a dense cushion of material.

Cradle - The bedding zone in which material is placed firmly and without voids under and up the sides of a pipe in such a manner that for all practical purposes the pipe cannot move or deflect.

3.1.3 Materials
Except that material will not be classified as boulder excavation, the excavation of material will, for purpose of measurement and payment, be classified as specified in clause 2.2.3.1 above.

For selected fill material, the requirements given in 3.2 Pipe Bedding shall apply.

Backfill material shall be material excavated from trenches, provided only that it contains no organic material, that it excludes stones of average dimension exceeding 150 mm, and that it can be so compacted as to avoid significant settlement, and shall have a PI not exceeding 12, a minimum CBR of 15 % at specified density if placed in the upper 200 mm of the subgrade, and a minimum CBR of 7 % if the backfill is to be placed lower in the subgrade. Material containing more than 10 % of rock or hard fragments that are retained at a sieve of nominal aperture size 50 mm, and material containing large clay lumps that do not break up under the action of the compaction equipment being used, will be regarded as unsuitable for use in backfilling.

Where trenches cross or run along surfaced roads and paved areas of which the surfaces are ordered by the Engineer to be reinstated, the Contractor shall obtain prior approval for subbase and base materials that may be required to supplement such materials lost during excavation. Materials for
Technical Specification

A: General Technical Specification

bituminous or asphalt construction shall comply with the applicable standards of the Roads Department of the Ministry of Transport.

The Contractor is not required to use selective methods of excavation but may, if he so wishes, screen, wash or otherwise treat excavated material in order to produce material suitable for the bedding. He shall take positive steps to avoid burying or contaminating materials which otherwise would be suitable for use as different types of fill, topsoil, or road material, as applicable.

3.1.4 Plant and Equipment

The Contractor shall use trenching plant that will excavate to a width such that the side allowance does not exceed the appropriate values specified in 3.1.5.2 below by more than 50%.

The Contractor shall use appropriate techniques or provide plant such as pumps, well points and sheeting or close timbering for keeping the trenches sufficiently free from water to enable him to lay pipes true to line and level and to bed them soundly.

The Contractor may use mechanical compaction equipment but he shall select such equipment and operate it in such a manner that the pipeline is not stressed or damaged. Machine compaction shall not be used directly above the pipe until sufficient backfill has been placed to ensure that machine compaction loads transmitted to the top of the pipe are not greater than would be imposed by normal road traffic over a pipeline with cover of depth 600 mm.

3.1.5 Construction and Workmanship

3.1.5.1 Precautions

With regard dealing with water, the requirements of clause 1.4.6 and 1.4.20 shall apply in addition to the stipulations below.

In the case of a trench on sloping ground, the Contractor shall take approved measures (such as the construction of cross-embankments) to minimize erosion in the trench and adjacent ground.

With regard accommodation of traffic and access to properties, the Contractor shall, in addition to the requirements of clause 1.5.2, construct or put in order such bypass(es) as may be required to deviate traffic from portions of the road that are to be affected by the construction; or where half-width construction is ordered or approved, so arrange his work that the traffic will at all times have free one-lane access to at least half the width of the roadway; or ensure, wherever possible, that the whole road is open at night and left in a trafficable condition, complete with traffic signs and protection facilities as specified.

He shall also ensure, wherever possible, that the usable width of the road is at least 3.5 m and he shall provide and allow reasonable access to persons occupying properties that fall within or adjoin the area over which he is working. If, for any reason, such access has to be closed during the construction period, the persons affected shall be given reasonable notice for each such period of closing.

With regard existing services that intersect or adjoin trenches, the requirements of clause 1.5.1 shall apply.

3.1.5.2 Minimum base width

Unless otherwise shown on the drawings, specified in the Particular Technical Specifications, or as directed, the base width of a trench shall be not less than the external diameter of the pipe barrels plus twice the side allowance as shown below:

<table>
<thead>
<tr>
<th>ND</th>
<th>up to 125 mm</th>
<th>125 mm</th>
<th>side allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ND</td>
<td>over 125 mm</td>
<td>up to 700 mm</td>
<td>300 mm</td>
</tr>
<tr>
<td>ND</td>
<td>over 700 mm</td>
<td>up to 1000 mm</td>
<td>300 mm</td>
</tr>
<tr>
<td>ND</td>
<td>over 1000 mm</td>
<td>up to 2000 mm</td>
<td>400 mm</td>
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<tr>
<td>ND</td>
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<tr>
<td>ND</td>
<td>over 2000 mm</td>
<td>up to - mm</td>
<td>600 mm</td>
</tr>
</tbody>
</table>

The minimum base width for pipes not exceeding 125 mm and laid at a depth not exceeding 1.5 m may be less than 600 mm for flexible continuous piping that, in terms of the specification or schedule, require no bedding or jointing in the trench. Where two or more pipes are to be placed in one trench, the base...
width of the trench shall be no less than the sum of the external diameters of the pipes barrels plus the side allowance for each outer pipe plus, between each pair of adjacent pipes, the average of the side allowance for each pipe.

3.1.5.3 Site clearance

The Contractor shall clear, in accordance with clause 2.1, an area of sufficient width along the route of the pipeline to ensure that his selection operations are not hampered.

3.1.5.4 Excavation

Pipe trenches shall be excavated in lengths approved by the Engineer, to widths that provide at least the appropriate side allowance (within trench supports, if any) as specified in clause 3.1.5.2 above, and such that half of the base width is on either side of the designated centre-line of the pipe.

The sides of each trench from the bottom up shall be as nearly vertical as possible for at least the height of the bedding.

When cutting through bituminous surfaces, the edges of the existing bitumen base and/or wearing courses shall be cut back vertically to straight lines.

In densely built-up areas with restricted and confined space, such as in the old town areas, the stockpiling of excavated material adjacent to the trench for use as backfill material may not always be possible. In such cases the Contractor shall make allowance in his rates for transporting such material to and stockpiling it at a distance away from the point of excavation, at locations suitable and approved by the Engineer.

3.1.5.5 Trench bottom

Material that the Engineer considers to be unsuitable at the bottom of the trench shall be excavated to the depths and disposed of in the manner described. The resulting space shall be refilled, as ordered, with approved material and compacted as directed.

The depth of the trench shall be such that the depth of the cradle can be placed under the pipeline, and the trimming and grading of the bottom of the trench shall be such that the barrel of each length of pipe can be uniformly supported over its full length, free at the joints, and at the correct grades and levels.

Where the trench excavation is in rock or in material containing hard objects or boulders that may adversely affect the uniformity of the pipe foundation, such rock or material shall be removed to a depth of 100 mm below the specified trench bottom.

Where the bottom of the trench has been loosened during excavation, it shall be compacted at OMC to 90 % of modified AASHTO maximum density prior to bedding and pipelaying.

The bottom of pipe trenches shall be sufficiently straight to enable the pipe to be laid without reduction of the side allowances given in 3.1.5.2 above and in conformity with the applicable tolerances specified.

3.1.5.6 Backfilling

Backfilling of pipe trenches shall commence as soon as possible after the pipe has been laid and firmly bedded in the specified cradle and the blanket has been placed and adequately compacted at OMC around, under the overhang and over the top of the pipe to the height of blanket cover specified.

Backfilling shall be carried out as described below and over the full extent of the actual trench excavation and to original ground level, except where otherwise directed.

Unless the Contractor is authorized by the Engineer to use other material, the material for backfilling above the bedding (cradle and blanket) shall be obtained from trench excavations.

Unless prior approval has been obtained, no filling shall be placed in water.

Hard and rock material shall be incorporated in the backfill above the bedding only to the extent approved. Depending on the quality of the material, the Engineer may direct that it be suitably mixed with other backfill material.
In areas subject to road traffic loads and where the available backfill material has a PI higher than 12, the Contractor shall obtain specific instructions from the Engineer before proceeding with the placing of the backfill.

Excavation material from the trench, which is unsuitable or has become surplus because of bulking, displacement by the pipe and importation, shall be disposed of along the trench servitude within the freehaul distance from the source of such excavation material, unless otherwise ordered by the Engineer.

Any deficiency of backfill material from trench excavations because of removal of organic or other unsuitable material shall be made up from suitable surplus material from other excavations on the Site within the freehaul distance. If, in the opinion of the Engineer, insufficient or no suitable material is available for this purpose from such excavations, and the shortage of such material has not been caused by the methods used by the Contractor, the Engineer shall authorize the Contractor to import sufficient suitable material. The Contractor shall so arrange his work that the importation of backfill material is kept to a minimum in respect of both quantity and overhaul.

The Contractor shall complete backfilling of trenches expeditiously and in reasonable lengths.

Where trenches are in roads or paved areas, the Contractor shall clean the road surface or paved area adjacent to the trench.

With regard transport for earthworks for trenches, the requirements of clause 2.2.5.2.5 shall apply.

### 3.1.5.7 Compaction

In areas subject to traffic loads, trenches shall be backfilled in layers of thickness (after compaction) not exceeding 150 mm and the material shall be compacted to 93% of modified AASHTO maximum density in the case of cohesive soil or 98% in the case of non-cohesive soil, up to the top of the subgrade level as shown in the Drawings.

### 3.1.5.8 Reinstatement of surfaces

In all cases, the Contractor shall, if ordered, reinstate surfaces over the full extent of the top of the actual excavation.

On private properties or other unsurfaced areas, the top 300 mm layer of each trench that will not be subject to road traffic loads shall be of such topsoil as is available in addition to soft material from excavations. The finished surface of backfilling that is left proud of the surrounding ground to allow for initial settlement shall be not more than 150 mm above the surrounding ground. Any settlement below original ground level that occurs during the execution of the contract or the period of maintenance shall, as soon as is practicable, be made good by the Contractor with material of the same quality as that adjacent to the trench.

In the case of gravel roads or similar surfaced areas, the Contractor shall, immediately after completion of the backfilling to the top of the subgrade level, reinstate the road surface by filling the reminder of the trench with a well-graded and approved hard-wearing gravel surface of thickness at least 150 mm, and of quality equal to that of the existing road surface compacted to at least 95% modified AASHTO. The gravel layer shall be finished with a slight camber in order to allow for initial settlement but shall not be left so far proud of the adjacent road surface or shall not be shaped such as to cause excessive jolting of any vehicle proceeding with normal speed.

The Contractor shall maintain the gravel surface to a standard suitable for normal traffic until the bitumen surfacing has been reinstated.

If the surface of a road with a stabilized base has been disturbed, the base shall be replaced with crusher run base compacted with sufficient moisture to give a density of at least 98% modified AASHTO maximum density.

Except where immediate reinstatement of the bitumen surface is ordered, the Contractor shall reinstate the bitumen surface after sufficient time has elapsed to show up inadequately compacted areas and after such areas have been made good.

Except if otherwise ordered by the Engineer, the surface of a bitumen road shall be reinstated with asphalt of at least the thickness used in the original state. The base material shall be graded to a level sufficiently below the final road surface to allow the bitumen surfacing to be accommodated, and the
edges of the existing bitumen wearing course shall be cut back vertically to a straight line. Before the bituminous construction is commenced, all loose materials and dust shall have been removed and the surface shall have been approved and prime coated at 1.0 l/m² of MC30 cutback bitumen. The bituminous surface will have a tolerance of -0+6 mm after compaction. The Contractor shall maintain the reinstated surfaces and shall make good, at his expense, any damage due to any subsidence, pothole or other unevenness immediately after it occurs during the period of the contract or during the maintenance period.

Where, during the execution of the works, any road or paved surface adjacent to a trench has been damaged in any way whatsoever by the Contractor's equipment, he shall, at his own expense and as soon as is practicable, repair and restore such surface to a condition at least equivalent to that previously existing, and to the satisfaction of the Engineer.

3.1.6 Tolerances

3.1.6.1 Alignment and grade

The deviation from the specified level of the invert and the specified dimensions of a trench and (for a height equal to at least the diameter of the pipe) of the lower part of the sides of the trench shall be such that the pipe may be laid and bedded in the trench within the tolerances specified for the pipeline.

3.1.6.2 Moisture content and density

The requirements for moisture content and density given in clause 2.2.6.2 shall apply.

3.1.7 Testing and Acceptance

The Contractor shall prove the CBR, Marshall and their specified properties of reinstatement materials before use at a rate of one test per 200 m³ of material. In-situ density test/maximum dry density of non-bitumenous materials, and Marshall compaction / in-situ caring of bitumenous materials will be carried out for every 200 linear meter of trench or part thereof by the Contractor in the presence of the Engineer, or by an independent laboratory approved by the Engineer. The cost of all testing will be included in the Contractor's rates. In the event of failure results, the Engineer will order any necessary re-testing and remedial works at the Contractor's expense.

3.1.8 Measurement and Payment

3.1.8.1 Basic principles

Rates tendered for excavation shall cover the cost of excavating and re-use of the excavated material in backfilling and the cost of disposal of any surplus and unsuitable material along the route of the pipeline within the freehaul distance of the source.

Excavations for trenches will be measured as if taken out with vertical sides regardless of whether they have been taken out with sloping sides. The length used for computation will be the total through-length of the pipeline from end to end or from structure to structure, and no deduction will be made for valves, manholes, catchpits and the like. The volume will be computed from the depth determined in accordance with clause 3.1.5.5 and the width in accordance with clause 3.1.5.2.

3.2 PIPE BEDDING

3.2.1 Scope

This specification covers the bedding, consisting of the bedding cradle and the selected fill blanket, for buried pipes for carrying fluids under pressure or gravity.

3.2.2 Interpretations

3.2.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
3.2.2.2 Application

This specification contains clauses that are generally applicable to the bedding of pipes. Interpretations, additions, and variations of this specification (if any) are set out in the Particular Technical Specification.

3.2.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Bedding - The material in the bedding cradle and fill blanket up to the underside of the main fill, and the operation of placing and compacting bedding in the manner specified.

Bedding cradle - The zone in which bedding is placed firmly and without voids under and up the sides of a pipe in such a manner that for all practical purposes the pipe cannot move or deflect.

Evenly graded - Descriptive of a particulate material that is such that the sizes of approximately 90 % by mass of the grains are evenly distributed between stated limits.

Expansion joint - A joint in concrete bedding in which two concrete surfaces are separated by resilient filler of thickness at least 15 mm.

Flexible pipe - A pipe of which the diameter is reduced by more than 1 % under external radial force before the appearance of cracks.

Joint hole - A depression formed in the bedding cradle to accommodate a joint in a pipeline.

Main fill - The approved filling material placed in a pipe trench after the pipe has been laid, bedded, and surrounded by selected fill blanket up to 150 mm cover above the top of the pipe.

Rigid pipe - A pipe of which the diameter is reduced by not more than 1% under an external radial force before the appearance of cracks.

Selected fill blanket - Material placed and compacted to form a blanket on or from the top of the bedding cradle up the sides and over the top of the pipe in such a manner that the barrel of the pipe is supported continuously and firmly on the sides and is protected over the top by a dense cushion of material.

Selected fill material - Material that complies with the requirements of clause 3.2.3.2 below.

Selected granular material - Material that complies with the requirements of clause 3.2.3.1 below.

Singularly graded - Descriptive of a particulate material in which over 90 % by mass of the grains is retained on a single sieve of any specified size aperture between stated limits.

3.2.3 Materials

3.2.3.1 Selected granular material

Selected granular material shall be material of a granular, non-cohesive nature that is singularly graded between 0.6 and 19 mm and is free draining.

3.2.3.2 Selected fill material

Selected fill material shall be material that has a PI not exceeding 6 and that is free from vegetation and from lumps and stones of diameter exceeding 30 mm.

3.2.3.3 Bedding

Bedding for rigid pipes shall be of Class A, B, or C and bedding for flexible pipes shall be selected granular material and selected fill material. The bedding cradle for Class A bedding shall be concrete. Bedding cradles for Class B and C bedding shall be of selected granular material. The material for the selected fill blanket shall in all cases comply with the requirements of clause 3.2.3.2.
3.2.3.4 Selection

The Contractor may screen, wash, or otherwise treat excavated material from pipe trenches or other excavations in order to produce material suitable for bedding or covering the pipeline. The Contractor shall take every reasonable precaution to avoid burying or contaminating material that is suitable and is required for bedding or covering the pipeline.

When material suitable for use as selected fill material or selected granular material is not readily available from trench or other excavation within a distance not exceeding 1 km, the Contractor shall, subject to the Engineer’s approval for each material, obtain suitable material to replace the shortfall by opening up borrow pits at approved areas located at intervals along the route of the pipeline or by importing from commercial or other sources.

3.2.4 Plant and Equipment

Adequate equipment shall be provided by the Contractor for the placing and compacting of bedding as specified in clause 3.2.5.1.3 and 3.2.5.1.4 below.

The Contractor shall also provide the necessary test equipment for performing on Site the tests referred to in clause 3.2.7.1 and 3.2.7.2 below.

3.2.5 Construction and Workmanship

3.2.5.1 General

No bedding shall be laid until the Engineer has approved the trench, measured the depth if necessary, and authorized pipelaying to proceed.

Except in the case of Class A bedding, the joint holes shall be refilled with fine granular material and lightly compacted to prevent the migration of adjacent pipe bedding material into the holes and to obviate the forming of hard spots under joints.

In the placing of bedding, all voids under the overhang of the pipes shall be filled and the compaction shall be carried out uniformly on each site of the pipes so as not to cause any lateral or vertical displacement of the pipe.

Bedding shall be carried out as pipelaying proceeds, and shall be completed before the acceptance test is carried out.

The degree of compaction attained for bedding (other than concrete and the material over the top of the pipeline) shall be 90% modified AASHTO maximum density.

3.2.5.2 Placing and compacting of rigid pipes

In addition to complying with the requirements listed above, the Contractor shall construct the bedding for rigid pipes in accordance with the following requirements:

a) **Class A.** The pipes shall be supported on a continuous cradle of concrete having a 28 d compressive strength of at least 20 MPa. During pipelaying and before the placing of the concrete bedding, the pipes shall be suitably supported. Care shall be taken during the placing of the concrete to prevent movement or flotation of the pipes. In the case of pipes with flexible joints, concrete shall not be allowed to enter the joints during casting of the bedding and a positive vertical expansion joint in the bedding cradle shall be formed at each pipe joint. The selected fill blanket shall not be placed in any section until a period of 24 h has elapsed after placement of the bedding cradle in that section. The main fill shall not be placed in any section until the bedding cradle in that section has achieved a compressive strength of at least 15 MPa.

b) **Class B.** The pipes shall be bedded on a continuous bed of selected granular material, the material being placed in accordance with the details, as relevant, and the bedding constructed in the manner shown, as relevant. To ensure that each pipe will be fully supported throughout the length of its barrel on the bedding cradle, joint holes shall be formed in the bedding cradle for pipe sockets and couplings.
c) **Class C.** The pipes shall be placed directly on the trench bottom after this has been hand-trimmed to ensure that each pipe will be fully supported throughout the length of its barrel. Joint holes shall be formed in the trench bottom for pipe sockets and couplings.

Any material that is used to support a pipeline temporarily during construction or does not comply with the requirements for bedding cradle shall be removed before the selected fill blanket for Class B or C is placed.

### 3.2.5.3 Placing and compacting of flexible pipes

In addition to complying with the requirements of clause 3.2.5.1 above, the Contractor shall construct the bedding for flexible pipes in accordance with the following requirements:

Flexible pipes shall be supported on a continuous bed of selected granular material of compacted depth of at least 100 mm and covering the full width of the trench. The granular material shall be compacted to the density specified in clause 3.2.5.1.4. Additional selected granular material shall then be placed carefully and evenly between the sides of the trench and the pipeline, in layers of uncompacted thickness approximately 100 mm and in accordance with the construction details. Each layer shall be compacted individually to the density specified in clause 3.2.5.1.4. Particular care shall be exercised to prevent damage, deflection, or displacement of the pipeline.

After completion of the bedding cradle, selected fill blanket shall be placed carefully in layers of 100 mm uncompacted thickness over the full width of the trench and shall be compacted to the density specified in clause 3.2.5.1.4 up to a height of at least 300 mm above the crown of the pipeline.

### 3.2.5.4 Concrete casing

In special cases, and where ordered by the Engineer, pipes shall be encased in concrete of the specified grade, generally of at least 15 MPa. The lower part of the encasement shall be constructed in the manner specified for Class A bedding. Once the pipeline has been tested and approved, the pipes shall be covered with concrete to the specified depth and expansion joints shall be cut or constructed in the upper part to coincide with those in the lower part. No earthfilling over the concrete shall be commenced until at least 5 d after the concrete has been placed or until the concrete has attained a strength of at least 10 MPa.

### 3.2.6 Tolerances

The permissible deviations shall be as follows:

| (i)   | OMC in field during compaction | -2, +1 % |
| (ii)  | Density when bedding rigid pipes | -0, +5 % |
| (iii) | Density when bedding flexible pipes | -0, +3 % |

### 3.2.7 Testing and Acceptance

The Engineer may order density tests to be carried out to determine the density and grading of the bedding.

The tests may be carried out by the sand replacement method or, where the grading of the bedding is such that the particle size is not less than 0.075 and not more than 2 mm, by use of a dynamic cone penetrometer.

If the results of such density tests show that the material has been compacted to a density equal to or in excess of the applicable specified value (see clause 3.2.5.1), the compaction will be accepted and the Employer shall bear the cost of the tests. If the density is found to be below the specified value, the Engineer may order removal and recompaction at the Contractor's expense, and the cost of the testing shall be borne by the Contractor.

### 3.2.8 Measurement and Payment

#### 3.2.8.1 Basic principles

The operation of bedding (see clause 3.2.2.3) will not be measured separately, but the provision alongside the trench of bedding materials will be measured separately. The rate for laying a pipeline
shall cover the cost of handling, placing, and compacting the bedding materials up to the underside of the main fill, in addition to any other cost associated with laying the pipeline.

The volume of bedding materials will be computed from the dimensions of the pipe and the side allowance and the depth of each bedding section, as applicable.

No allowance will be made for bulking of material.

Separate items are scheduled for material for the bedding cradle and for the selected fill blanket to provide for the probability the excavated material from the trench is more likely to comply with the requirements for the latter than for the former.

Material displaced by the pipeline and by importation of material from sources other than trench excavation, shall be disposed of along the pipeline within a distance of 1 km from source unless otherwise ordered by the Engineer.

Freehaul as well as overhaul, if the latter is ordered, of such disposed material shall be covered as specified in clause 2.2.5.2.5.

3.3 PRESSURE PIPELINES

3.3.1 Scope

This specification covers the supply and installation of pipelines of diameter not exceeding 1000 mm, complete with ancillary works, for transporting water or sewage under working pressures not exceeding 2.5 MPa.

It also covers the construction of connections from a water reticulation main to the boundaries of (or other specified points on) individual plots or properties, and covers the pipework, meters, and the making of the connections.

3.3.2 Interpretations

3.3.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks
d) 3.1 Pipe Trenches
e) 3.2 Pipe Bedding
f) 2.3 Concrete
g) 4.1 Brickwork

3.3.2.2 Application

This specification contains clauses that are generally applicable to the construction of medium pressure-pipelines and plot connections. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification.

3.3.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Ferrule - A short metal tube that is screwed or plugged into the wall of a pipe or into a saddle to form a connection.
Fitting - A special or a valve, or a process of jointing (except welding) straight pipes to one another and to specials and valves.
Leading connection - A short pipeline used for conveying water from a reticulation main to a domestic meter.
Saddle - A metal ring split into two semi-circular halves that are clamped round a pipe and used together with or has a built-in ferrule to form a connection.
Special - Any pipe other than straight pipe, such as bends, tees, reducers, etc.
Stop tap - A shut-off device (stop valve) installed in a pipeline to control the flow of water.
Straight pipe - A straight pipe of uniform bore and of standard or non-standard length.

3.3.2.4 Abbreviations

For the purpose of this specification the following abbreviations shall apply:
AC Asbestos cement
CI Cast iron
CID, DN Constant internal diameter
COD Constant outside diameter
GI Galvanized iron (steel)
DCI, DI Ductile cast iron
HDPE High density polyethylene
IRHD International rubber hardness degree
PTFE Polytetrafluoro ethylene
PVC Polyvinyl chloride
uPVC Unplasticized polyvinyl chloride

3.3.3 Materials

Pipes and fittings shall be of the types specified in the Particular Technical Specification and, unless otherwise required in terms of the Technical Specification, they and their couplings shall be capable of withstanding the applicable test pressure specified in clause 3.3.7.3.1 below. All pipes and fittings shall be supplied complete with couplings and jointing material.

Satisfactory temporary end covers shall be provided for the protection of threads, flanges, and prepared ends of plain-ended pipes and fittings, and to prevent damage to internal lining during transportation and during handling on Site.

Pipeline materials shall be so transported, stored, and handled that pipes are not overstressed at any time and fittings are not damaged in any way. Pipes damaged or cracked in any way shall be removed from the Site.

Materials for manholes and surface boxes shall be as specified in the relevant Particular Technical Specifications. Ferrules shall be manufactured from leaded gunmetal and shall be of a standard pattern screw-in or plug-in type, as directed. The outlets of the ferrules shall be such that they are compatible with the pipes used for the connections. Saddles shall be of malleable or ductile iron with an ultimate strength of 310 MPa, PE or PVC, or as directed. Stop taps shall, unless otherwise directed by the Engineer, be of screw-down pattern, clockwise closing, and shall be fitted with a crutch for hand operation.

Non-domestic water meters shall be of the type, size, and manufacture specified in the Technical Specification. Domestic water meters will be provided by the Employer.

Should the Contractor proposes to use pipes and fittings of material other than those specified, he shall submit for approval detailed specifications including details of the types of couplings he proposes to use with such pipes and fittings. The Contractor shall not use pipes or fittings of such other material unless and until he has obtained written approval for their use from the Engineer.

Bedding shall be a light sandy material.

Bricks and mortar for valve and meter chambers shall be in accordance with the requirements of specification 4.1.

Surface boxes and covers may be of CI or other material approved by the Engineer. All CI surface boxes shall have been hot dipped in an acceptable bituminous or similar compound before despatch from the manufacturer's works.

3.3.4 Plant and Equipment

The plant and rigging equipment used by the Contractor for the handling and placing of pipes shall be subject to the approval by the Engineer and shall be such that no pipe is overstressed during any operation covered by the specification.
The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment and laying of the pipeline.

The Contractor shall provide all the equipment, materials, tools, and fittings required for the performance of the tests given in clause 3.3.7 below.

### 3.3.5 Construction and Workmanship

#### 3.3.5.1 Laying

The trench bottom shall be prepared as specified in 3.1.5.5. Trenches shall be kept sufficiently dry to allow proper and safe bedding, laying, and jointing of pipes and kept dry until the pipeline has passed the required tests and construction of the selected fill blanket over the pipes has been completed.

A pipeline shall be laid and bedded to even grades and to levels and alignments shown on the drawings or as directed. It shall be laid centrally in the trench and with the manufacturer's class and quality identification marks visible from the top of the trench, if possible.

Control of laying and bedding shall be by means of boning rods and sight rails or an acceptable laser beam device. Sight rails shall be painted black and white and shall be fixed securely and accurately.

Each pipe and each fitting shall be thoroughly cleaned and carefully examined for damage and defects immediately before laying. Should any damaged or defective pipe or fitting be laid, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

Every reasonable precaution shall be taken to prevent the entry of foreign matter and water into the pipeline. At the close of each day's work or at any time when work is suspended for a significant period, the last laid pipe shall be plugged, capped, or otherwise tightly closed until laying is recommenced.

During laying and jointing of pipes and until the pipeline(s) has/have passed the required acceptance tests and the trenches have been backfilled, all trenches shall be kept in a state which, in the opinion of the Engineer, is reasonably dry.

Unless otherwise shown on the drawings or specified in the Technical Specification, or ordered, the depth of trenches for pressure pipelines shall not exceed 3 m and shall be such that the cover over the top of the pipeline will be at least 0.9 m.

Where so required, the cover or the alignment of a pipeline may change gradually by deflection at pipe joints, but this deflection shall not be greater (and should generally be less) than the deflections permitted by the manufacturer of the pipe.

The minimum clearance between the outside of a pipeline being laid and the outside of any other pipe that it crosses shall be 150 mm. Where this requirement conflicts with the requirements for cover over the pipeline the Contractor shall ask the Engineer for written instructions and shall carry out the work in accordance with those instructions.

The Contractor shall record all relevant data (e.g., street name, number of plot, location measurements and distances in relation to boundary peg(s), size of connection, depths at connecting point etc.) for the preparation of "as-built" drawings, and shall make these records available to the Engineer.

#### 3.3.5.2 Jointing

All pipelines shall be jointed in accordance with the manufacturer's instructions and to the approval by the Engineer.

Each end of pipes being jointed with detachable couplings shall be thoroughly cleaned by brushing and wiping immediately before being jointed. All rubber rings and seals shall be carefully inspected after being placed in position and before the joint is closed, to ensure that they have not suffered any cuts, tears, or other damage, and are not in any way defective. Only the lubricants (if any) recommended by the manufacturer of the pipe shall be used for sleeve-type couplings and rubber insertion rings.

Joints of uPVC pipes shall be lubricated with soft soap or similar material approved by the manufacturer. Grease derived from petroleum products shall not be used in uPVC joints.
In the jointing of pipes with flanges, special care shall be taken to align, grade, and level the pipes, specials, and valves to avoid straining of the flanges. All bitumen and paint shall be removed from the mating face of each flange immediately before jointing. Bolts shall be tightened up evenly in opposite pairs to ensure uniform bearing.

Care shall be taken to avoid damage to the internal surface of the pipes during assembly of the pipeline.

Wherever loose flanges are welded onto pipelines, the Contractor shall ensure that the inner lining is restored to the thickness specified and that the new lining is soundly jointed to the existing one.

3.3.5.3 Setting of valves, specials, and fittings

Unless otherwise specified in the Technical Specification, or directed, gate valves shall be set upright and butterfly valves shall be set with the main shafts horizontal. All valves, specials, and fittings, if to be placed in urban, industrial, or similar built-up areas, shall be located in the exact positions shown on the drawings or otherwise directed (and not merely to suit standard pipe lengths) but in all other (open) areas they may be located to suit the pipe lengths. After cutting a pipe to suit the position of a valve, special, or fitting, the Contractor shall, by means of an approved method, prepare the ends to suit the coupling sleeve etc.

3.3.5.4 Concrete casing

Where the Engineer requires pipes to be encased, a concrete of strength 15 MPa/37.5 mm shall be used.

No part of the concrete casing shall be closer than 150 mm to any flexible joint of a concrete encased pipeline.

The pipe trench for a concrete-encased pipeline shall be excavated to the depth below the bottom of the pipe, as ordered or shown on the drawings, and to sufficient width to allow for the concrete to be placed to the full specified width. The bottom of the trench shall be trimmed true to line and grade. A light concrete screed shall be placed on the bottom of the trench, concrete saddles or pads of the requisite thickness spaced suitably, and the pipeline laid on them true to line, grade, and level. After being jointed the pipes shall be tested in accordance with the applicable tests given in clause 3.3.7, care being taken to ensure that the pipes do not move during testing. After the pipeline has been tested, suitable formwork shall be erected and concrete carefully placed and vibrated in position underneath the pipe and up both sides. The concrete level shall be raised equally on both sides of the pipe until encasement is complete and a cover over the surface of the pipe is provided that is nowhere less than that ordered or shown on the drawings. No earth filling over the concrete shall be commenced until at least 5 d after the concrete has been placed or until the concrete has attained a strength of at least 10 MPa.

3.3.5.5 Anchor/thrust blocks and pedestals

At tees, bends, terminal valves, end caps, and where otherwise directed, anchor/thrust blocks shall be constructed to dimensions ordered or shown on the drawings. Unless otherwise specified in the Technical Specification, anchor/thrust blocks and pedestals shall be constructed of strength 15 MPa/37.5 mm concrete. The concrete shall be well panned around the pipe, if in trenches, against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces will not be permitted. Excess excavation shall be replaced with the prescribed mix concrete given above at the Contractor's expense.

Care shall be taken to leave all joints accessible. No anchor/thrust block and pedestals shall be concreted until the approval of the Engineer has been obtained.

3.3.5.6 Valve and hydrant chambers

Unless otherwise specified in the Technical Specification, shown on the drawings or directed by the Engineer, all gate and scour valves, hydrants, and air valves in reticulation pipelines of nominal diameter up to and including 275 mm shall be housed in a chamber. Such chambers shall be of standard design and are normally made of brickwork in 1:3 mortar or of concrete.
3.3.5.7 Manholes

Unless otherwise specified in the Technical Specification, shown on the drawings or directed by the Engineer, all gate and scour valves, hydrants, and air valves in reticulation pipelines of nominal diameter 300 mm and greater shall be housed in a manhole made of brickwork, reinforced in-situ concrete, or precast concrete.

3.3.5.8 Brickwork in chambers and manholes

Unless otherwise specified in the Technical Specification, shown on the drawings or directed by the Engineer, the walls of chambers and manholes shall be constructed in an approved bond comprising header and stretcher courses with the fare face on the inside. No false headers shall be built in and only whole bricks shall be used except where closures are required to form bond.

For further requirements, reference is made to specification 4.1-Brickwork.

3.3.5.9 Lifting and relaying of existing pipelines

Existing pipes and fittings that are to be removed shall be lifted and the material recovered as far as is practicable. The pipes and couplings shall be removed from the trench and placed in the Contractor's site store where they shall be cleaned, sorted, and listed. A copy of the list of undamaged material recovered shall be handed to the Engineer.

Where recovered pipes are directed to be relaid, rubber rings, insertion packings, damaged joints, and rusted bolts shall be replaced.

Before recovered pipes are relaid, all pipes shall be tested for compliance with the requirements of the applicable specification and to pressures as directed by the Engineer. For this purpose the Contractor shall provide and install, at a location convenient to him and approved by the Engineer, a suitable test bench and provide and install all the ancillary equipment necessary to perform these tests.

3.3.5.10 Disinfection of potable water pipelines

On completion of the laying and testing, each potable water pipeline shall be disinfected as follows:

(i) During the wet season
   a) The pipeline shall be flushed out with clean water until all sediment and other foreign matter have been removed.
   b) The pipeline shall then be filled with water containing 0.15 g/l of calcium hypochlorite. The solution shall be allowed to flow slowly into the pipeline until it is filled completely and shall be left there for at least 24 h.
   c) The pipeline shall then be thoroughly and repeatedly flushed with clean water until a sample of the washwater drawn from the pipeline complies with the requirements for potable water set out by NWSC.

(ii) During the dry season
   a) Flushing as above, except that water shall be reused after it has been allowed to settle out sediments etc.
   b) Desinfection as described above.
   c) There will be no subsequent flushing, instead, the affected public shall be informed, by the Contractor, that the water will, for a stated and limited period, contain a higher than usual Chlorite content.
   d) For a further period, the Contractor shall, as agreed with the Engineer, add Chlorite by approved means (eg injection) to the otherwise normal supply.

3.3.6 Tolerances

3.3.6.1 General

No deviation will be permitted from the minimum cover specified or as shown on the drawings.
3.3.6.2 Control points

For the purpose of this specification valves set on the centre line of the pipeline and designated changes in gradient shall be regarded as control points and shall be located with a permissible deviation of ±100 mm on the centre line. The same deviation will be permissible laterally except where the Contractor is required to lay the pipeline at a designated distance from a boundary, kerb line, or fence line, in which case the permissible deviation shall be ±30 mm.

Unless otherwise directed and subject to a permissible deviation (measured along the centre line) of ±5 m, scour valves shall be located at the lowest points in pipelines and air valves at the highest points.

3.3.6.3 Alignment (plan and level)

Unless otherwise directed, the permissible deviation in alignment between control points from a straight line joining the control points, when measured on the top centre of the pipeline, shall be +100 mm or +20 % of the nominal diameter, whichever is the larger, and the permissible deviation per pipe length shall be ±30 mm.

The permissible deviation from the designated level at any point on the invert of the pipeline shall be ±50 mm or ±10 % of the nominal diameter of the pipe, which ever is the larger.

3.3.6.4 Valve chambers, manholes, etc.

Valve chambers, manholes, and the like shall be constructed centrally on the control points and, with the exception of tolerances that affect access to bolts, nuts, etc., with a permissible deviation of ±50 mm on all clearance dimensions. The clearance dimension between the outside of each nut and bolt-head and the inside face of the wall of a structure or any other fitting shall generally be 150 mm.

3.3.7 Testing and Acceptance

3.3.7.1 General

As the work proceeds, pipelines shall be tested in convenient lengths by means of test equipment supplied by the Contractor.

Each test shall be carried out in the presence of the Engineer or his representative. The Contractor shall be responsible for carrying out all tests and for all expenses incurred in this connection. When carrying out the hydraulic test, the Contractor shall ensure that all valves, tees, and bends are properly secured and shored to prevent movement of pipes and fittings and, should any such movement occur, the Contractor shall, at his own expense, reposition and, if necessary, repair the pipes and fittings and the securing means.

The section of the pipeline that is to be tested shall be gradually filled with water while avoiding pressure surges due to too rapid filling.

Until each section of the pipeline has been subjected to the hydraulic test and has complied with the requirement for leakage rates specified, the pipeline will not be accepted. The hydraulic test shall be repeated until the Engineer is satisfied that the section under test complies with the said requirement.

3.3.7.2 Standard hydraulic pipe test

Unless otherwise directed, hydraulic testing shall be commenced only after permanent anchor blocks have attained their specified strength, ie after 7 d, or any other time as approved by the Engineer.

After the pipe trench has been partially backfilled and before the trench is filled in at the pipe joints and the fittings, the pipeline shall be tested in sections between isolating valves and/or end caps, blank flanges, or other isolating devices, at the pressure appropriate to the type and, when relevant, class of pipe in the pipeline under test. Where mixed types or classes of pipe occur, and where the pipeline traverses a wide range of altitudes, the Engineer may require that temporary valves or blank flanges be inserted and that the pipeline be tested in reduced lengths and, in addition, at the point of maximum pressure.
Unless otherwise directed or specified in the Technical Specification, the test pressure for field testing shall be 1.25 times the maximum permissible working pressure (nominal pressure) specified or 1.5 times the actual working pressure at the point of testing, whatever is the greater.

The test pressure applied over any section of pipeline under test, taking any differences in elevation along the pipeline into account, shall be such that the pressure at any point along the section is not less than the design pressure or more than 1.5 times the design maximum working pressure at these points.

Where applicable, eg in the case of concrete, AC, or mortar lined pipes, each section shall be filled with water 24 h before the test pressure is applied to ensure saturation of the pipeline.

Care shall be taken to ensure that all air is expelled from the line to be tested after it has been filled and before the test commences.

The specified test pressure shall be maintained for a period of at least 3 h by means of a suitable pump, during which period all pipes, specials, joints, and fittings shall be carefully inspected for leaks. All visible leaks shall be made good and any pipe, special, or fitting found to be defective shall be removed and replaced at the expense of the Contractor and shall, after installation, be tested at the expense of the Contractor again.

In the case of pipes of nominal diameter under 400 mm, and if approved by the Engineer, the test period may be reduced proportionally to the diameter of the pipe, provided that in no case shall the test period be less than 1 h.

The test pressure shall be maintained for a further period of 1 h after the completion of the test period given above, during which time the volume of water required to be pumped into the pipeline for maintaining the pressure shall be measured.

Specific Criteria for allowable leakage during testing are given in part 2: Particular Technical Specifications.

3.3.7.3 Meter testing

Except where a meter is supplied by the Employer, the Contractor shall ensure that each meter has been tested by the manufacturer to twice the working pressure specified in the Technical Specification, and, if so requested by the Engineer, shall submit to him a certificate stating that each meter has successfully withstood the test pressure.

The Engineer may order that some or all meters to be tested on Site after installation to verify that the meter has not been damaged during installation and to determine the accuracy of the readings. Such tests shall be carried out by the Contractor under the direction of the Engineer using approved testing equipment and methods.

3.3.8 Measurement and Payment


3.4 SEWERS AND STORMWATER DRAINAGE

3.4.1 Scope

This specification covers the general construction requirements for sewerage and stormwater drainage systems including connecting sewers, manholes, and the like, but excluding sewer pressure mains, pump stations, treatment works, and ancillary works.

3.4.2 Interpretations

3.4.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) General
b) 2.1 Site Clearance
c) 2.2 Earthworks, as applicable.
d) 3.1 Pipe Trenches
e) 3.2 Pipe Bedding
f) 2.3 Concrete
g) 4.1 Brickwork

3.4.2.2 Application

This specification contains clauses that are generally applicable to sewer and stormwater drainage construction. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification (Part 2, Volume 2, Tender Documents).

3.4.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Expansion pipe joint - A pipe joint that allows relative longitudinal movement between adjacent pipes without the occurrence of fracture or leakage.

Flexible pipe joint - A pipe joint that allows relative angular (radial) and longitudinal movements between adjacent pipes without the occurrence of fracture or leakage.

Geofabric blanket - A blanket so woven from synthetic fibres that it is capable of acting as a filter that retains some or all of the solid particles carried by a fluid but, with varying degrees of restriction, allows the passage of the fluid.

Invert slab - The slab, normally of concrete, that forms the bottom of the culvert.

Prefabricated culvert units - Portal or rectangular culvert units that have been prefabricated from reinforced concrete.

Rigid pipe joint - A pipe joint that allows no relative movement between adjacent pipes without the occurrence of fracture or leakage.

3.4.2.4 Abbreviations

For the purpose of this specification the following abbreviations shall apply:

AC  Asbestos cement
CI  Cast iron
CID, DN Constant inside diameter
COD Constant outside diameter
PVC Polyvinyl chloride
uPVC Unplasticized polyvinyl chloride
CP Machine made concrete pipe
RCP Reinforced concrete pipe

3.4.3 Material

3.4.3.1 Pipes, fittings, and pipe joints

Vitrified clay pipes and fittings shall comply with the relevant requirements of the Particular Specification, shall have suitable flexible joints, and shall have a crushing strength of at least 45 kN per metre of bearing surface.

Reinforced concrete pipes and fittings shall comply with the relevant requirements of the Particular Technical Specification, shall have suitable rubber ring or other approved flexible joints, and shall have a cover to reinforcement on the inside face of at least 15 mm.

AC sewer pipes and fittings shall comply with the relevant requirements of the Particular Specification, shall have suitable rubber ring or other approved flexible joints. AC specials and fittings shall have a crushing strength that is equal to or better than that of the pipes to which they are coupled.
Other pipes, such as glass-reinforced polyester pipes, pitch-impregnated fibre pipes, and uPVC pipes, as applicable, also shall comply with the appropriate standards and requirements and shall have suitable approved flexible joints.

3.4.3.2 Alternative materials

Should the Contractor proposes to use pipes and fittings of material other than those referred to above, he shall submit for approval detailed specifications including full details of the type of joints and specials he proposes to use with such pipes and fittings. The Contractor shall not use such pipes or fittings until he has obtained written approval for their use from the Engineer.

3.4.3.3 Bedding

The requirements for bedding of specification 3.2-Pipe Bedding shall apply.

3.4.3.4 Culvert units and pipes

Prefabricated culvert units and pipes shall comply with the requirements as laid down in the Particular Technical Specifications and shall be either precast concrete pipes, AC pipes, or portal and rectangular precast concrete culvert units, as applicable.

3.4.3.5 Concrete

Concrete, cast-in-situ or precast concrete, shall comply with the relevant requirements of specification 2.3.

3.4.3.6 Manholes, catchpits, and accessories

Bricks and mortar shall comply with the relevant requirements of specification 4.1.

Prefabricated manhole sections may be of spun concrete, asbestos cement, glass-reinforced polyester, PVC, or such other material as are approved by the Engineer. Covers and frames for manholes and grid inlets shall be supplied in matching sets, each set bearing a serial number to enable them to be identified.

Step irons shall comply with the applicable requirements of BS 1247 or equal approved and shall be of suitable length for the wall of the manhole into which they are to be built.

3.4.3.7 Geofabric blanket

The synthetic fibres of a geofabric blanket shall consist of at least 85 % by mass of polyester, polyethylene, or polypropylene, or a combination of these polymers, and shall contain such additives as are necessary to render the geofabric blankets resistant to the effects of ultra-violet radiation and heat.

The Engineer's approval of the make and grade of the geofabric shall be obtained by the Contractor before he orders any geofabric or uses it on the Works.

For normal application, and if not otherwise directed by the Engineer or specified in the Particular Specification, geofabric blankets shall be of the non-woven, needle-punched type with a specific weight of approximately 270 g/m2.

3.4.4 Plant and Equipment

The plant and rigging equipment used by the Contractor for the handling and placing of pipes shall be of the type recommended by the pipe manufacturer and subject to the approval by the Engineer and shall be such that no pipe is overstressed during any operation covered by the specification.

The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment and laying of the pipeline.

The Contractor shall provide all the equipment, materials, tools, and fittings required for the performance of the tests given in clause 3.4.7 below, and shall provide suitable equipment for the location of faults up to the date of issue of the final certificate.
3.4.5 Construction and Workmanship

3.4.5.1 Trench bottom

The trench bottom shall be prepared as specified in 3.1-Pipe Trenches. Trenches shall be kept sufficiently dry to allow proper and safe bedding, laying, and jointing of pipes and kept dry until the pipeline has passed the required tests and construction of the selected fill blanket over the pipes has been completed.

For the laying of culvert elements, the trench bottom shall be excavated to a depth of 75 mm in soil, or 200 mm in rock, or such other depth as may be shown on the drawings, below the level of the underside of the precast invert slab or to the level of the underside of the cast-in-situ invert slab, as applicable, and this space shall be filled with granular material, compacted, and shaped to enable the culvert units to be bedded properly.

Where, because soft, soggy, spongy, or otherwise unsuitable material is encountered, the bottom of the trench as excavated does not provide a suitable firm foundation for the culvert, the unsuitable material shall be excavated to a depth below the bottom of the culvert indicated by the Engineer and replaced with gravel or other approved granular material compacted to at least 90% of modified AASHTO maximum density. When so ordered, the Contractor shall construct a layer of concrete blinding, at least 75 mm thick, to provide a suitable working floor.

The width of excavation shall be equal to the total width of the culvert plus a minimum of 1.0 m for both single and multiple openings.

3.4.5.2 Bedding, laying, and backfilling

Each pipe and fitting shall be thoroughly cleaned out and carefully examined for damage immediately before laying. The onus of detecting damaged pipes and fittings before installation shall be on the Contractor. Should any damaged pipe or fitting be found in the sewer after it has been laid, the damaged item shall be removed and replaced at the Contractor's expense.

Pipes shall be laid on the specified bedding cradle true to designated line and level, and the bedding shall be placed and compacted in accordance with the applicable requirements of clause 3.2.5.1. Designated invert levels shall take precedence over design depths shown on drawings.

The completed sewer or stormwater drain shall have no bends or undulations except where directed. Should pipes be allowed to have any deviation from straightness, they shall be so laid that preference is given to level over line.

The method of laying and bedding shall be such that barrels of pipes bear evenly on the bedding for their full length, that no packing is used under the barrels, and that no socket or coupling bears on the bedding.

Where the slope of a pipe is greater than 1 in 10, anchor blocks shall be constructed according to the details provided.

Pipes shall be so cut as to obtain a clean and square end, and, where pipes and fittings of different material shall be jointed, shall be so only with special adaptors recommended by the pipe manufacturer(s).

All pipe openings shall be sealed by the Contractor to ensure that no water, stones, or other foreign matter enters the sewer during or after laying.

The sewer or stormwater drains shall be so jointed to the pipes built into the manholes that there is a flexible joint positioned as close as possible to the manhole.

Unless otherwise directed, construction of culverts shall, as far as is practicable, begin at the lower end.

Precast units shall be lifted and handled only by means of lifting devices approved by the manufacturer.

Lifting eyes shall be caulked with a suitable mortar after the units have been installed.

The Contractor shall exercise due care not to damage, overstress, or displace any culverts by the imposition of any loads such as may be caused by the movement of his own vehicles or compaction.
equipment. Where superimposed moving loads in excess of those prescribed in the applicable road
traffic ordinance are, during the construction of the Works, likely to pass over completed culverts, the
Contractor shall provide sufficient additional cover over the culverts to ensure that the design stresses
on the culverts are not exceeded.

Any units that become deformed or cracked, or that are not constructed to the required lines, levels, and
grades, or that become displaced in the course of the work, shall be removed and replaced by the
Contractor at his own expense.

Joints of butt-ended pipes shall be externally wrapped with either 2 layers of 0.5 mm thick plastics
dampcourse or one layer of geofabric blanket. The wrapping shall be at least 200 mm wide and be
centrally placed over each joint.

Ogee type pipes need not be wrapped but shall be laid with the spigot ends pointing downstream.

Spigot and socket pipes with rubber ring joints shall, unless another method is directed or approved by
the Engineer, be jointed in accordance with the manufacturer’s instructions.

Backfilling of pipes and pipe culverts shall comply with the applicable requirements of specification 3.1.

Material for backfilling of portal or rectangular culverts shall comply with clause 3.1.3 and shall be
obtained by the Contractor from approved borrow pits, if necessary.

Backfilling alongside the walls and over the top of culverts shall be watered, mixed, placed, and
compacted in layers not exceeding 150 mm after compaction, to a density at least equal to that required
for the material in the adjoining layers of fill, subgrade, and subbase, as applicable, or to at least 90 % of
modified AASHTO maximum density in the case of excavation made in natural ground.

Backfilling shall be carried out simultaneously and equally on both sides of the structure to avoid
unequal lateral forces.

3.4.5.3 Manholes, inspection chambers, catchpits etc.

Manholes, inspection chambers, catchpits, inlets, outlet structures etc., shall be constructed of cast-in-
situ concrete, precast concrete, brickwork, or AC, as shown on the drawings or as directed, and shall be
in accordance with the relevant Particular Technical Specifications.

3.4.5.4 Concrete casing to pipes

In special cases, and where ordered by the Engineer, pipes shall be encased in concrete of the
specified grade, generally of at least 15 MPa. The lower part of the encasement shall be constructed in
the manner specified for Class A bedding (see 3.2). Once the sewer or stormwater drain has been
tested and approved, the pipes shall be surrounded with concrete to the specified depth and expansion
joints shall be cut or constructed in the upper part to coincide with those in the lower part. Use shall be
made of poker vibrators to ensure proper filling with concrete of all spaces under and around the pipe,
and displacement or flotation, or both, shall be prevented. All temporary supports provided for the pipes
shall be removed as concreting progresses. No earthfilling over the concrete shall be commenced until
at least 5 d after the concrete has been placed or until the concrete has attained a strength of at least 10
MPa.

3.4.5.5 Raising or lowering of existing manholes

Where an existing manhole is required to be raised or lowered, the work shall be so carried out that the
finished manhole complies with the applicable requirements of 3.4.5.3 above. Where practicable, the
same cover shall be used, which shall, on completion of a manhole be flush with the surface of the
finished road, shoulder, or sidewalk, as the case may be.

3.4.5.6 Connecting pipes

Connecting sewers or stormwater drains shall be laid from junctions provided in the main lines to the
positions and depths as shown on the drawings or as directed.

The Contractor shall record all relevant data (eg street name, number of plot, location measurements
and distances in relation to boundary peg(s), size of connection, depths of invert at connecting point and
end of connection etc.) for the preparation of "as-built" drawings, and shall make these records available to the Engineer.

3.4.5.7 Action to be taken during and after testing

The Contractor shall make good any defects that may be found while the pipeline is under test and after that the tests shall be repeated at his expense until the pipeline is found to comply with the specification.

After the sewer or stormwater drain has passed the tests all access lids shall be properly sealed with bitumen or by any other approved method that will ensure that they are watertight.

3.4.6 Tolerances

3.4.6.1 General

Tolerances will be determined on the basis of permissible deviations from designated location, alignment, grades, and levels. The Contractor shall construct each of the various parts of within the limits set out below.

3.4.6.2 Manhole and catchpit locations

The permissible deviation of the location of manholes and catchpits (other than kerbside catchpits) in plan of the designated position shall be half the pipe length longitudinally and ñ 200 mm laterally, except where locations are dimensioned from fixtures such as fences, kerbs, and the like, in which event the permissible deviation in each direction will be ñ 50 mm.

Such manholes or chambers shall be constructed at the meeting points of intersecting pipelines subject only to such deviations as can be tolerated by the junction channels or specials.

3.4.6.3 Invert levels

The permissible deviation from the designated level of the invert at each manhole shall be ñ 50 mm but, should the fall between any two successive manholes be less than 90 % of that specified, the said permissible deviation shall be reduced to a value such that the fall is at least 90 % of that specified.

The permissible deviation of the level of the invert of a culvert from the designated level shall be ñ 25 mm.

3.4.6.4 Alignment and grade

Subject to the permitted manufacturing tolerances applicable to the pipes being laid, the line of the pipe invert shall at no point between successive manholes deviate from a straight line by more than 5 % of the nominal diameter of the pipe, or be lower than at any other place closer to the lower manhole.

The permissible deviation of the alignment and grade of each culvert shall be ñ 25 mm from the designated line and level, when measured over any 6 m length, and all such deviations shall be gradual.

3.4.6.5 Manholes and chamber structures

The dimensions of walls and roofs of manholes and chambers shall conform to the dimensions specified, subject to the allowable tolerances laid down for concrete structures (see 2.3)

3.4.6.6 Kerbside catchpits, kerb inlets, or grid inlets

The permissible deviations of the longitudinal location shall be half a kerb length or 0.5 m, whichever is the greater and the permissible deviations of the lateral location from the designated distance from the centre line of the road shall be ñ 25 mm, except that any open grid or grid frame shall be truly parallel to and within 5 mm of the face of the kerb.

3.4.7 Testing and Acceptance

3.4.7.1 General

Stormwater drains and culverts will not be tested for leakage of water. Tests described below apply to sewers only.
All acceptance tests shall be carried out in the presence of the Engineer and at such times and in such manner as the Engineer may direct.

No pipe joint or fitting shall be covered until the tests applicable have been completed and the Engineer has authorized such covering.

The sewer or any section of it shall be inspected by the Contractor who, if he deems it ready to be tested, shall advise the Engineer of his intention to subject the sewer or the said section of it to the appropriate tests.

The sewer shall be tested in sections between manholes or chambers, as applicable, the section being tested being isolated from other sections by means of suitable plugs or stoppers that have been braced adequately.

Notwithstanding any authorization by the Engineer as described above, the Engineer may, after backfilling and compaction have been completed, order that the sewer be retested to check that it has not been disturbed or damaged during backfilling.

The Engineer may order one of the following to be carried out on the sewer or any section of it:

a) an air test on pipes, other than concrete pipes, of all sizes; or in the case of pipes, other than concrete pipes, of diameter up to 600 mm, an air test followed by a water test
b) a water test in the case of pipes of diameter up to 750 mm
c) a visual internal inspection in the case of pipes of diameter greater than 750 mm.

The Contractor shall provide all labour and apparatus (including expansible plugs and flexible bag stoppers) that may be required for carrying out the tests.

All test results shall be recorded in the manner directed, whether or not the pipeline or section of pipeline has passed the test.

3.4.7.2 Tests and acceptance/rejection criteria

a) Air test. An approved air testing machine shall be used to raise the gauge pressure in the section of the pipeline under test first to 3.75 kPa. After a 2 min stabilization period the pressure shall be reduced to 2.5 kPa. The machine shall be switched off and the time taken for the pressure to drop from 2.5 to 1.25 kPa shall be measured. The time taken shall be at least 2 min for ND 100, 3 min for ND 150, 4 min for ND 200, 4.5 min for ND 250, 6 min for ND 300, 8 min for ND 400, 10 min for ND 500, 12 min for ND 600, and 14 min for ND 700. Times applicable for other diameters may be interpolated.

b) Water test. The section of the pipeline under test and the manhole at the upper end of the said section shall be filled with water to such depth that every portion of the pipeline is subjected to a pressure of not less than 12 kPa and not more than 60 kPa. During the test there shall be no discernible leakage of water. An appropriate period, which shall be at least 12 min, shall be allowed for initial absorption, and the loss of water over the next 30 min shall be noted. The amount lost, in litres, per 100 m of pipeline per hour, shall not exceed the following values: 6 for ND 100, 9 for ND 150, 12 for ND 200, 15 for ND 250, 18 for ND 300, 23 for ND 400, 29 for ND 500, 36 for ND 600, and 44 for ND 700. Amounts applicable for other diameters may be interpolated.

c) Tests on existing pipes shall be carried out in accordance with the requirements laid down in the Particular Specification.

Should any section of the pipeline fail to pass the water test, a re-test will be permitted and, in such case, acceptance or rejection of the section will be determined on the result of the re-test.

3.4.7.3 Rejection

In the case of AC, vitrified clay, and fibre pipes, failure under the air test will be deemed to be cause for rejection. After such rejection the Contractor may apply a water test to locate the source of failure, rectify the pipeline, and re-apply the air test. In the case of concrete, failure under the water test will be deemed to be cause for rejection.
3.4.7.4 Testing of connecting sewers

Each connecting sewer shall be tested between its upper end and the junction at the main sewer. The upper end of the connection shall be kept securely closed with expanding plugs during the test. Where practicable the Contractor may test the main and connections simultaneously if he so wishes. On completion of the test, the upper end of the connection shall be permanently sealed by means of a plug stopper suitable for the type of pipe.

3.4.8 Measurement and Payment

3.4.8.1 General

Although measurement and payment for excavation and backfilling are covered in section 3.1 and the provision of bedding material in section 3.2 of this specification, the relevant items for sewers will be scheduled as shown below.

The operation of constructing the bedding cradle and selected fill blanket around and over the top of the pipeline will be regarded as part of the pipe-laying operation.

3.5 PIPE JACKING

3.5.1 Scope

This provisional specification covers the insertion, by jacking, of pipelines under roads and the like without disturbing the surface or interfering with the normal flow of traffic.

3.5.2 Interpretation

3.5.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.2 Earthworks
c) 3.1 Pipe Trenches
d) 3.2 Bedding

3.5.2.2 Application

This specification contains clauses that are generally applicable to pipe jacking. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification (Part 2, Volume 2, Tender Documents)

3.5.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Jacking - The action of pushing a pipeline into position.

Jacking frame - A frame on which the jacks are mounted and through which the jacking forces are transmitted.

Jacking structure - An assembly comprising the jacking frame, and the permanent pipes being jacked.

Lead pipe - A pipe that may be specially prepared at one end and that is intended to be the first pipe to be used in the jacking process.

Reception pit - An excavated pit or shaft that is located at the end of a jacked section of a pipeline.

Thrust pit - An excavated pit or shaft at the commencement point of a jacked section of a pipeline, in which the jacking structure and other equipment are installed and from which the jacking operations are carried out.
3.5.3 Materials

Unless otherwise directed, pipes for jacking shall be reinforced concrete pipes and shall be capable of withstanding, without damage, the maximum lateral and longitudinal forces to be transmitted during jacking and service.

3.5.4 Plant and Equipment

The Contractor shall provide and use suitable equipment for handling pipes and placing them in position for jacking, for jacking the pipes, for the lubrication of the outer surface of the pipeline, and for excavation within the pipe.

Each set of jacks shall be fitted with a suitably calibrated pressure gauge in good working order and such that the actual jacking force can be read at any time during the jacking operation. To transfer the load from the jacks to the pipes, suitable thrust plates shall be provided for placing against the ends of the pipes.

The Contractor shall provide adequate lighting for the execution of the Works.

3.5.5 Construction and Workmanship

3.5.5.1 General

If required, the Engineer will obtain prior permission from any third party who controls the land or any structure on the land, or both, under the surface of which the pipeline is to be jacked.

Jacking and excavation shall be supervised and undertaken only by persons fully conversant with this work.

The Contractor shall furnish detailed design calculations, specifications, and working drawings to show his methods of installation and method of providing temporary support for the road or other service or structure and any modifications to structures required before pipe jacking commences.

The Contractor shall not commence any work shown on the said drawings or specified in the said specifications until the Engineer has signified in writing that the Contractor may proceed.

Any permission to proceed shall not indicate acceptance by the Employer or the Engineer of any responsibility for safety or adequacy of jacking structures and methods of working and shall not limit the obligations and liabilities of the Contractor in regard to such safety or adequacy.

3.5.5.2 Safety control requirements

The pipeline shall be jacked through under the road or other service or structure, as applicable, without disrupting traffic and without disturbing the alignment or levels of the road surface or other service or structure, as applicable, to an extent that may impair their safety.

Before commencing work in the vicinity of any structure, the Contractor shall make a detailed examination of the structure, record its condition, and submit a copy of such record to the Engineer.

The Contractor shall take measurements before and after the construction period and shall record any change in line or level, or both, of any road or other service or structure being traversed. A copy of such record shall be made available to the Engineer.

3.5.5.3 Sleeve pipes

Pipes intended as sleeve pipes shall be laid with the inside walls smooth and free from projections and sharp edges.

3.5.5.4 Excavation

Generally, the requirements of the specification 2.2 shall apply.
The Contractor shall be responsible for excavation of the thrust and reception pits, which shall be of dimensions at least equal to the minimum dimensions needed for the Contractor's equipment and for safe and efficient working. The approximate dimensions of the pits that the Contractor intends to excavate shall be agreed upon with the Engineer before work commences. The excavated material shall be stockpiled for later backfilling.

The Contractor shall ensure that, at all times, each pit is provided with barriers and is a safe place within which to work.

During the jacking operation, excavation shall be such that overbreak is kept to a minimum. No material shall be removed in advance of the leading edge where the leading edge is in unstable or loose material. If the material at the leading edge starts to slip or run, excavation shall be stopped immediately and the Contractor shall take such action as is necessary to stabilize the material before excavation is resumed.

If necessary, the Contractor shall make provision for suitable de-watering of the material in the vicinity of the leading edge of the pipe.

Should any cavity occur around the outside of a pipe during the jacking process, such cavity shall be filled immediately by grouting or similar means.

Any subsidence occurring above the jacked pipe and arising from any cause related to jacking operations shall be made good to the satisfaction of the Engineer and at the Contractor's expense.

The Contractor shall ensure that the head of each excavation is drained at all times. Under no circumstances will jetting be permitted.

3.5.5.5 Jacking procedure

The pipes to be jacked shall be advanced by means of one or more hydraulic jacks of adequate capacity that bear(s) against a suitable thrust plate so that the thrust of the jack(s) is distributed adequately over the end face of the pipe.

The rear end of each jack shall bear against a suitably designed structure such that the force is transferred to the surrounding material and evenly distributed over an area sufficient to ensure that the bearing capacity of the soil is not exceeded and that no structure in the vicinity of the thrust pit is disturbed.

The Contractor may, with the written permission of the Engineer, inject or otherwise apply a suitable lubricant to the cutting edge of the lead pipe.

Thrust and reception pits should, whenever practicable, coincide with locations of manholes, junction chambers, and the like, as shown on the drawings or as directed, to avoid duplication of work. When jacking has been completed and jacking equipment dismantled and removed, the thrust and reception pits shall be backfilled to the extent necessary.

The Contractor shall, on completion of the work and before the final payment is made, supply to the Engineer transparencies showing details of the completed structure. Each such transparency shall be certified by the Contractor to be an accurate reflection of the details of the work as constructed.

3.5.6 Tolerances

The position of any point of the finished pipeline shall be within 100 mm horizontally and 50 mm vertically of the designed position. Adjustment to line and level, or both, shall be gradual and the pipe manufacturer's stated maximum permissible draw or angular deflection shall not be exceeded at any point.

Misalignment between pipe units shall not exceed 10 mm.
The Contractor shall check line and level at least once during the installation of each pipe length, and he shall take such corrective action as is necessary. A copy of the results of all checks and a statement of any corrective measures taken shall be available for inspection on the Site, and a copy shall be given to the Engineer as soon as the jacking has been completed.

Should the difference between the actual and the specified position or alignment of the finished pipeline exceed the values permissible to an extent that additional costs are incurred in (re)locating, installing, supporting, or maintaining any pipe or service that has been designed to be laid through the finished pipeline, the Contractor bear such additional costs provided that the details of the work to be done to relocate etc. and the order for the work to be done (by the Contractor or by others) have been given by the Engineer within 30 working days after the completion of the actual jacking operation.

3.5.7 Testing and Acceptance

No tests are required on the completed pipeline jacked.

3.5.8 Measurement and Payment

3.5.8.1 Principles

All items for the pipe jacking are provisional, as jacking is to be regarded as an alternative method to the "cut and cover" method specified elsewhere.

4 BUILDING CONSTRUCTION WORKS

4.1 BRICKWORK

4.1.1 Scope

This specification covers the general construction requirements for brickwork in general building construction.

4.1.2 Interpretations

4.1.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks
d) 2.3 Concrete

4.1.2.2 Application

This specification contains clauses that are generally applicable to brickwork construction, plaster work, and associated work. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification (Part 2, Volume 2, Tender Documents)

4.1.3 Materials

4.1.3.1 Bricks

Bricks shall be obtained from an approved manufacturer and shall be either general purpose bricks (for buildings) or special burnt clay bricks or engineering bricks (for manholes etc.) that comply with the relevant applicable standards as approved by the Engineer.

The Contractor shall submit to the Engineer samples of the bricks that he intends using in the construction of the different sections of the Works. The samples of the bricks that are approved will be retained by the Engineer.

Bricks shall be free from defects affecting strength and durability. The amount and extent of manufacture cracks or cracks and chips due to handling shall not be to such a degree as to give an
unsightly appearance to exposed brick surfaces and all face brick to be used on the Work shall match with the samples approved by the Engineer.

All bricks shall be machine made if possible, of good quality brick earth and thoroughly burnt, and shall be of deep cherry red or copper colour. The bricks when dried shall emit a clear ringing sound when struck together and shall not break when thrown on the ground or against other bricks from a height of 1 m. The bricks shall not absorb water more than one sixth of their weight after one hour of soaking by immersion in water. The bricks shall be wholly clean and free from flaws, cracks and underburnt lumps of any kind. They shall be uniform in size and regular in shape and have square, straight and sharp edges and even surfaces.

4.1.3.2 Hollow concrete blocks

The hollow concrete blocks for masonry works shall be machine made and thoroughly compacted in the moulds by external form vibrators or vibrating tables.

The hollow concrete blocks shall be made of 1 part of cement, to 6 parts of well graded fine and coarse aggregates mechanically mixed into a very dense and dry consistency with very low water cement ratio.

The hollow concrete blocks shall comply with relevant applicable standards (eg DIN 18153, IS 2185-1967 IS 2572-1963 or similar) and shall have following physical properties.

a) Compressive Strength 70 kg/cm²
b) Drying Shrinkage 0.04%
c) Moisture Movement 0.03%
d) Water absorption 240 kg/m³
e) Moisture content 40%

4.1.3.3 Cement for mortar

Cement for masonry mortar and grout shall be ordinary portland cement in accordance with the requirements of Section 2.3. All cement for mortar for exposed face work shall be of a uniform colour as approved by the Engineer.

4.1.3.4 Lime for Mortar

Lime shall be freshly burnt quicklime or hydrated lime conforming with the relevant applicable standards (eg DIN 1060 or similar).

4.1.3.5 Sand and water for mortar

Sand and water used shall be in accordance with the requirements of section 2.3 and sand for exposed face work shall be of a uniform color as approved by the Engineer. Sand shall be clean pit sand and shall be free from clay and other impurities and, if so directed, shall be properly screened and washed.

4.1.4 Plant and Equipment

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting plant and scaffolding where required.

Mixers used for mixing mortar and grout shall be in accordance with the requirements described under 2.3.4.

4.1.5 Construction and Workmanship

4.1.5.1 Mortar

Unless otherwise directed by the Engineer the mix proportions for mortars for masonry and plaster works by volume shall be as follows:

a) Cement mortars
CM 1:5 Cement: 1 part, Sand: 5 part
CM 1:4 Cement: 1 part, Sand: 4 part
CM 1:3  Cement: 1 part, Sand: 3 part  
CM 1:2  Cement: 1 part, Sand: 2 part  
CM 1:1  Cement: 1 part, Sand: 1 part  

b) Cement-lime-sand mortars  
CL 1:2:9  Cement: 1 part, Lime: 2 part, Sand: 9 part  
CL 1:1:8  Cement: 1 part, Lime: 1 part, Sand: 8 part  

c) Waterproof mortars for DPC and plaster works  
WCM 1:4:  Cement 1, Sand 4, Waterproof compound 0.03  
WCM 1:2:  Cement 1, Sand 2, Waterproof compound 0.03  

d) Coloured plaster  
DCM 1:2:  Cement 1, Sand 2, Pigment 0.01  
DCM 1:1:  Cement 1, Sand 1, Pigment 0.01  
DCM 1:1:4:  Cement 1, Lime 1, Sand 4, Pigment 0.01  
DCM 1:1:2:  Cement 1, Lime 1, Sand 2, Pigment 0.01  

4.1.5.2 Workability of mortar  
The mortar shall be of a readily workable consistency with only enough water to obtain a plastic condition suitable for troweling.  

4.1.5.3 Workability of grout  
Grout shall be of pourable consistency with a slump of 120 mm when tested in accordance with the standard slump test for mortar and grout.  

4.1.5.4 Cement mortar mixing and using period  
All cementitious materials and aggregate shall be mixed for a minimum of 2 min in a mechanical batch mixer. Only so much water shall be added as compatible with convenience in using the mortar. If mortar begins to stiffen from evaporation or absorption of a part of the mixing water, the mortar shall be remixed by adding water and remixed. All mortar and grout shall be used within 2.5 h of the initial mixing and no mortar or grout shall be used after it has begun to set.  

4.1.5.5 Hand mixing of mortar  
Hand mixing shall be carried out on clean, water tight platforms with approved methods.  

4.1.5.6 Brick laying  
Bricks shall be carefully handled at all stages in delivery, stockpiling, transportation on site and construction to prevent breakage or surface damage. Bricks shall be carefully unloaded by hand and shall not be dumped or thrown. Special care shall be taken with stacking and storage of bricks on the site.  
Bricks shall be thoroughly soaked in water before use and shall be set in a full bed of mortar and grouted in every course. Solid brick masonry shall be in English or other approved bond. The courses shall be laid level and with parallel, neat and regular joints.  
Brick masonry shall be carried up evenly and uniformly, no one portion being raised more than 1 m above another at any one time. Vertical joints shall be filled with cement mortar as the bricks are laid. Unfinished brick masonry shall be stepped back in course and thoroughly cleaned before new work is added. Any holes shall be filled with bricks identical with those already incorporated in the work. The conditions governing the laying of brick masonry in unfavorable weather shall be as specified for concrete in Section 2.3. Exposed faces of brick masonry shall be kept moist for 10 d after laying.  
All brickwork shall be placed only after the foundation surfaces have been prepared to the satisfaction of the Engineer.  
Bricks shall be well soaked in water for a minimum of 3 h immediately before being laid or as required so that the rate of absorption when laid does not exceed acceptable limits approved by the Engineer. The
method of wetting shall be such that each brick be nearly saturated but the surface appears dry when laid.

Bricks shall be laid in running bond with head joints in each course centered over the bricks in the course below and shall be plumb, level & true to line with full head and bed joints. The ends of brick shall be buttered with sufficient mortar to fill the head joints. The top of the joint mortar may be sloped toward the center of the wall to minimize the amount of mortar forced into the grout core space when the brick are shoved into. Mortar protruding from bed joints into the core space shall be removed before pouring the grout, and no mortar shall be placed or allowed to remain in the core space.

Joints in brickwork shall be uniform and generally 10 mm thick for horizontal and 6 mm wide for vertical joints. Joints shall be tooled to produce a dense V-shaped joint or as otherwise ordered by the Engineer or shown on the drawings. Defect joints shall be cut out and repointed with mortar as directed by the Engineer.

The color and texture of all exposed mortar joints shall be subject to the approval of the Engineer and shall be kept uniform throughout the particular contract by strict adherence to the approved mixes and samples.

Extreme care shall be taken to prevent any concrete, grout, or mortar from staining the face of masonry. If any grout or mortar does contact the face it shall be immediately removed and the surface cleaned with clean water. Masonry work shall be protected against staining, tops of walls shall be covered with waterproof coverings as required, and when work is interrupted.

All walls shall, to the extent possible and as practicable, be built up at the same time. In no case shall any walls be advanced more than 1.5 m above another. If it is necessary to stop off a horizontal run of masonry, the end shall be shaped in pyramid form or as otherwise approved by the Engineer.

Where mortar on joints has partially or totally set, the exposed surface shall be cleaned and thoroughly wetted so as to obtain the best possible bond with the new work. All loose masonry and mortar shall be removed prior to the commencement of the work.

Brickwork shall be taken up truly plumb and each set of four bricklayers shall be provided with a plumb bob and straight edge.

Bricks on the ‘fair face’ shall be the best available, care being taken that they are not chipped or stained as work proceeds. Bricks shall be laid so as to give a perfectly flat face as tested with a straight edge, and no chipping or rubbing back will be permitted to remedy bad laying.

In the event of fair faced brickwork not being finished with struck joints whilst the mortar is still damp, pointing may be carried out with the approval of the Engineer. In this case all joints shall be raked out to a depth of 20 mm, cleaned free from all loose material and any putlogs filled in. The area to be pointed shall then be thoroughly soaked before pointing takes place, the mortar used being to the satisfaction of the Engineer.

Care shall be taken to keep all brickwork free from mud splashing, mortar, bitumen droppings, etc., and it shall be well cleaned down before being handed over.

If, after the completion of brickwork construction, any of it is found to be out of alignment or level or otherwise not conforming with the permissible deviations specified or otherwise defective, it shall be removed and replaced or repaired by the Contractor, at his own expense, and to the satisfaction of the Engineer.

4.1.5.7 Hollow block laying

Hollow concrete block masonry and any composite masonry shall comply with the requirements of the brick masonry as stated above.

4.1.5.8 Partition walls

Top and ends of full height partition walls shall be securely fastened to beams, slabs, and walls, as applicable, with pre-fixed metal fasteners or holdfasts spaced not greater than 75cm apart unless otherwise indicated. Clearance between top and ends of partition wall and beams, slabs, and walls shall be caulked as indicated or as directed by the Engineer to form a closed continuous joint.
4.1.5.9 **Brick manholes**

Brick walls for manholes or chambers shall be constructed in an approved bond comprising header and stretcher courses with the fair face on the inside. No false headers shall be built in and only whole bricks shall be used except where closures are required to form bond.

Joints shall be flushed up solid at every course throughout the whole width of each course, which shall be laid on a solid bed of mortar of thickness not exceeding 10 mm, and, if plaster is required, the joints shall be raked out to form a key as the work proceeds for the extent of the area to be plastered.

The walls of a manhole, if so required in terms of the drawings or Particular Specification shall be plastered internally and steel-trowelled to a smooth and true surface free of sharp edges and corners. The thickness of plaster shall not be less than 10 mm and not more than 15 mm. All salient angles and arrises shall be slightly rounded, and all internal angles shall be finished true, square, and smooth.

The sockets of channels in manholes shall be filled in with 1:1 stiff cement mortar and the space between the channels finished off with the same mortar. Where two spigot ends abut, they shall have a layer of 1:1 cement mortar under the joint, and the space between the ends shall be filled with 1:1 cement mortar worked in and neatly finished off.

Where a pipe enters a manhole, it shall be thoroughly caulked into the wall and a 400 mm thick brick surround shall be built integral with the rest of the wall in order to ensure a watertight joint between the pipe and the manhole.

Concrete for benching in manholes shall be prescribed mix 20 with 13 mm chips. Semicircular channels and fittings, suitable for the type of pipe laid, shall be placed in position simultaneously with the concrete benching and embedded in it true to grade, level, and line.

All benching and sloping surfaces in the manhole floor shall be rendered in 20 mm thick 1:3 cement mortar and finished smooth and true with a steel trowel and rounded at corners and edges.

Step irons in manhole walls shall be in accordance with the relevant applicable standards (eg BS 1247 or similar) and shall be accurately built into the straight of the wall at 300 mm centres and staggered regularly right and left in truly vertical rows spaced at 200 mm centres horizontally.

4.1.5.10 **Brick pavement**

The brickwork in paving shall be laid in 1:4 cement mortar and be made with machine made bricks, and shall be laid to the specified slopes, levels, dimensions, pattern, and bonds as shown in the drawing or as directed by the Engineer.

The widths of mortar joints shall not exceed 12 mm and be fully packed with mortar. The brick pavement shall be laid over a layer of mortar of 12 mm thickness, and shall not be disturbed at least for 7 d after it has been laid and shall be kept wet for at least 10 days.

4.1.5.11 **Brick soling**

Dry brick soling in foundations and under flooring shall be laid flat over a compacted surface as required, and be made of machine made bricks as specified above. The dry brick soling shall be laid over a cushion of sand of 25 mm thickness unless otherwise shown on the drawings or directed by the Engineer. All joints shall be completely filled with fine sand.

4.1.5.12 **Plaster**

The surface to be plastered shall be brushed clean. Mortar joints of brick masonry or hollow concrete walls to be plastered shall be raked to a depth of approximately 12mm, and the surface brushed down with a stiff brush and thoroughly wetted. The surface shall be free of all dust, loose materials, grease, etc.

Before starting plaster work, the contractor shall prepare a sample panel of plastering of a size at least 1 m² for the approval of the Engineer. The sample shall be prepared in an area designated by the Engineer. The Contractor shall obtain approval before starting work and preserve the approved sample intact until all plastering is completed.
Plaster shall be applied in two coats. The thickness of the first coat shall be just sufficient to fill all unevenness of the surface and shall be applied with even, firm pressure to insure good bond, cross scratched and shall be moist cured. After the first coat has properly cured, and allowed to dry thoroughly, the surface shall be dampened before applying the finish coat. The finish coat shall be steel trowel finished to a smooth, even, burnished surface, completely free from defects or trowel marks. The thickness of plaster in total shall not be less than 12 mm. Wall plastering shall be started from top and work down to the floor. Ceiling plastering shall be completed before starting the wall plastering. To ensure uniform thickness and vertical plaster face, plumb guider strips may be applied as required.

If required to achieve the smooth, burnished finish, the surface shall be finished with lime putty of just sufficient thickness to fill in uneven surface or defects due to coarse sand in the plaster mix. Lime mortar finish shall be applied immediately after the finish has set sufficiently firm.

In order to obtain additional strength at external angled corners, the corners shall be dusted with cement during the steel trowel finishing of the finish coat.

Care shall be taken to insure that finished plaster surfaces shall be plumb, square, straight, and true to line. All arises and corners shall be straight, clean, and sharp.

### 4.1.5.13 Curing of plaster works

Moist curing shall be accomplished by keeping the plaster uniformly damp by suitable means. Moist curing shall start during application and continue for not less than 7 d.

### 4.1.5.14 Approval by the Engineer of plaster work

All plaster work shall be subject to approval of the Engineer, and work failing to meet the requirements of the specifications or not being to the satisfaction of the Engineer shall be removed and reapplied at the Contractor's expense.

### 4.1.6 Tolerances

The dimensions of brickwork walls and structures such as manholes shall conform to the tolerances laid down for concrete structures (see specification 2.3), as applicable, or as directed by the Engineer. The German code DIN 18202 "Dimension Tolerances in Building Construction" may also be used as a guide, at the discretion of the Engineer.

### 4.1.7 Measurement and Payment

#### 4.1.7.1 Principles

Brickwork and plasterwork will be measured as the net area, for the different types and thickness applicable. No deductions will be made for openings of area up to 0.5 m2.

### 4.2 STRUCTURAL STEEL AND METALWORK

#### 4.2.1 Scope

This specification covers structural steelwork for buildings and other structures, except cranes and bridges. It does, however, include sundry items such as ladders, stairs, handrails, open grid flooring, metal doors and windows, etc., that are usually fabricated from commercial quality steel, as well as corrosion protection.

#### 4.2.2 Interpretations

#### 4.2.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

- **a)** 1 General
- **b)** 2.3 Concrete
- **c)** 4.1 Brickwork
4.2.2.2 Application

This specification contains clauses that are generally applicable to structural steelwork construction, metal work, corrosion protection, and associated work. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification (Part 2, Volume 2, Tender Documents).

4.2.2.3 Definitions

For the purpose of this specification, the following definitions shall apply:

Coat. A single layer of a corrosion-protection material.

Coating system. The method and degree of surface preparation, the type of coating, the method of application of the coats and the requirements of the completed system.

Grade (of a bolt). A strength designation consisting of two numbers (separated by a dot), the first number being approximately one-hundredth of the minimum specified tensile strength in MPa and the second one-tenth of the ratio (expressed as a percentage) between the stress at permanent set of 0.2 % (yield stress) and the minimum tensile strength. (For example, Grade 10.9 indicates a nominal tensile strength of 1000 MPa and a nominal set stress (0.2 %) of 900 MPa). The letter S, when added to the grade designation, eg Grade 8.8S, denotes a metric high-strength structural bolt with a heavy series hexagon head.

Normal temperature. A temperature that exceeds 15º C but does not exceed 32º C.

4.2.2.4 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>DFT</td>
<td>Dry film thickness</td>
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<tr>
<td>HD-bolts</td>
<td>Holding-down bolts</td>
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<tr>
<td>HDG</td>
<td>Hot-dip galvanizing</td>
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4.2.3 Materials

4.2.3.1 Structural steel

Steel generally and section profiles used in structural steelwork and in the fabrication of sundry items shall be in accordance with the requirements of the relevant applicable standards (eg BS 4, BS 4548, IS 808).

Regardless of the standards used, the yield stress shall not exceed 450 MPA, the ratio of the tensile strength to the guaranteed yield strength shall be at least 1.2:1, and the elongation shall be at least 15 %.

All steel used in the manufacture of cold-formed sections for use as structural members in buildings shall have a minimum yield strength of at least 200 MPa.

4.2.3.2 Welding consumables

Welding electrodes shall apply with and shall be stored and handled in accordance with the requirements set out in the relevant applicable standards (eg BS 639, IS 814).

Welding consumables shall be such that they produce weld metal that has a minimum yield stress and minimum tensile strength at least equal to those of the parent metals.

4.2.3.3 Bolts, nuts and washers

Bolts and nuts shall comply with the relevant applicable standards (eg BS 709, BS 4604, IS 1367, IS 4000) and may be either ordinary black bolts, fitted bolts, or high-strength friction-grip bolts, as applicable. Nuts shall be of at least the strength grade appropriate to the grade of bolt or other threaded element with which they are used.
4.2.3.4 Coating materials

All coating materials and constituents shall be delivered in the manufacturer's original sealed containers which bear the manufacturer's labels. Each label shall display all the information necessary to ensure correct storage and traceability, and instructions for the application of the contents of the containers. Any container showing traces of leakage shall, before use, be rejected together with its contents.

The Engineer may require that the contents of any container be subjected to sample testing.

All coating materials held in storage prior to use shall be kept in an approved store which shall be dry and enclosed. Care shall be taken to avoid the accumulation of old stock.

All Site stores used for the storage of coating material shall be provided with adequate fire extinguishers placed in a prominent and accessible position outside the entrances. "No smoking" signs shall be placed inside and outside such stores. No naked flames shall be permitted inside such stores.

Stores for coating materials shall not, at any time, be used for the accommodation of personnel.

4.2.4 Plant and Equipment

Plant and equipment used in handling, fabrication and erection of steelwork shall comply with the requirements of the relevant applicable standards and safety regulation (eg BS 5531). Handling and lifting plant shall have enough capacity to ensure that steelwork is placed in its final position without distortion or undue stressing of members.

The use of cranes, lifting devices, safety belts, harnesses, nets and barricades shall, in particular, comply with the recommendations given in BS 5531.

Plant and equipment for applying the specified coating system shall be suitable for obtaining the specified result. If, however, consistent and satisfactory results are not achieved with the plant and equipment used by the Contractor, the Engineer may order the Contractor to obtain and use such plant and equipment as may be necessary to achieve the required results.

4.2.5 Construction and Workmanship

4.2.5.1 Shop detail drawings

On the basis of the Engineer's design drawings, the Contractor shall, immediately on receipt of such drawings satisfy himself that the drawings contain all the information required for the preparation of his own shop details and supporting calculations. These shop detail drawings and supporting calculations shall be submitted in duplicate to the Engineer for approval at least 1 week before commencement of fabrication. The Contractor's drawings shall be complete in every respect (including welding details and shop splices). One copy of each drawing will be retained by the Engineer and, within 1 week of the date of receipt by the Engineer, the other copy will be returned to the Contractor with the Engineer's comments or written approval, as the case may be.

Such approval given by the Engineer relates to structural adequacy and does not absolve the Contractor from his responsibility for dimensional accuracy.

Steel sections shall be provided as specified on the drawings except that substitutions will be permitted with the Engineer's prior approval.

4.2.5.2 Fabrication

All structural steel shall, before and after fabrication, be within the tolerances specified below, and, unless required to be formed to a particular shape, be flat, straight and free from twist. Any necessary straightening or forming shall be carried out by methods that neither weaken nor deface the material.

Cutting may be done by sawing, shearing, cropping or machine flame-cutting. Manual flame-cutting is permissible only when authorized.

Holes for fasteners shall be drilled, except that holes for HD-bolts may be flame-cut if specifically approved, and that holes for bolts other than fitting bolts, may be punched, if approved, and if the material to be punched is not thicker than the diameter of the hole.
Any punching through material thicker than 12 mm shall be done only with the prior approval.

The diameter of the holes for bolts other than fitted bolts and friction-grip fasteners shall not exceed the diameter of the bolt by more than 2 mm in the case of fasteners of diameter up to 24 mm and 3 mm for larger diameters. For friction-grip fasteners, the holes shall generally be not more than 2 mm larger than the bolts, and for holes for fitted bolts, the allowable tolerance shall be ± 0.15 mm.

Slotted holes shall be formed by drilling, punching a pair of holes and flame-cutting between the holes, or slot punching in the case of material of thickness not exceeding 12 mm. All burrs shall be removed from holes before assembly.

Where a sealed hollow member is holed for a fastener or pin, provision shall be made to prevent ingress of moisture to the interior of the member.

For joints in compression, the abutting surfaces of a joint dependent on contact for the transmission of load shall so butt that the areas necessary to transmit the load are in full contact. A bearing face that is to be grouted direct to a foundation need not be machined but such a face shall be true and parallel to the upper face of the foundation.

Where required, the ends of hollow sections may be flattened, or otherwise formed, for welded or bolted connections provided that the method employed does not damage or deface the material, and the change of shape shall be gradual.

The interior of any hollow member, whether a structural hollow section or a fabricated member, shall be so sealed as to prevent the ingress of moisture.

4.2.5.3 Assembly

Before delivery to the construction Site, each piece of steelwork shall be distinctly marked, in accordance with the marking diagram, and shall bear such other marks as will facilitate assembly and erection.

The component parts shall be so assembled that the whole and all parts of the finished structure are within the tolerances specified, that no member is bent, twisted or otherwise damaged, and that specified cambers are obtained.

All matching holes for fasteners or pins shall so register with each other that the fasteners can be inserted freely. Drifting to align holes shall be so done that the metal is not distorted and the holes are not enlarged. Holes that cannot be aligned without enlargement shall be cause for rejection unless enlargement by reaming is specifically approved.

Welding shall be carried out in accordance with the recommendations of the relevant applicable standards, in particular AWS D1.1 or BS 5135.

For bolting, other than friction-grip bolting, the parts to be jointed shall be firmly drawn together and bolts shall be tensioned by hand to the limit of the torque that can be applied by the use of a standard podger spanner. High tensile bolts for major tension type or moment type connections and where fatigue is a consideration, shall be tightened to a tension of 75 % of the proof load stress of the bolt. Except in the case of fitted bolts, washers need not be used where surfaces are flat and flanges untapered, and holes have normal clearances. On tapered flanges, tapered washers shall be used to give bolts and nuts a satisfactory bearing.

The length of each bolt shall be such that after the bolt has been tightened, at least one thread projects through the nut and at least one full thread remains clear between the nut and the unthreaded shank.

Fitted bolts shall be long enough to ensure that no threaded portion is within the thickness of the connected parts required to develop the bearing load on the bolt, and shall be provided with a washer or washers, under the nut, of thickness such as to ensure that at least one full thread remains clear between the nut and the unthreaded shank. All the bolts in each group shall be re-tightened after the last bolt has been fitted.

For friction-grip fastening, the turn-of-the-nut tightening method shall be used, unless otherwise directed by the Engineer, or otherwise recommended by the manufacturer. Once friction-grip bolts of Grade
10.9S and galvanized bolts of Grade 8.8S have been tensioned, they shall not be reused, but other bolts may be re-used solely at the discretion of the Engineer.

4.2.5.4 Setting-out

Before the Contractor commences erection of steelwork on Site, he shall check that the setting-out and the levels of HD bolts and of concrete foundations, beam faces, column, etc., are in accordance with the drawings and he shall report any discrepancies immediately to the Engineer.

4.2.5.5 Erection

Before commencing erection of steelwork on Site, the Contractor shall submit to the Engineer, for his general scrutiny and information, full details of the erection procedure and methods of erection.

While it is incumbent on the Engineer to ensure that the structure or elements thereof can be erected without loss of stability or without overstress, the Contractor is responsible for the maintenance of safety standards during erection.

All pockets that are to receive HD-bolts, fittings or steelwork shall be cleaned out immediately before erection is commenced. Each part of a structure shall be aligned as soon as possible after it has been erected... Members shall not be permanently connected until enough of the structure has been aligned, levelled, plumbed and temporarily connected to ensure that they will not be displaced during the erection or alignment of the remainder of the structure.

Drift pins, jacking equipment and the like shall not be used to bring improperly fabricated members into place. A moderate degree of reaming and cutting, however, may be employed to correct minor misfits only if, in the opinion of the Engineer, this will not be detrimental to the strength or appearance of the steelwork.

4.2.5.6 Grouting of supports

Grouting shall be done in accordance with the requirements of clause 2.3.5.5.12.

The Contractor shall ensure that all grouting has been completed before any imposed load is applied, and that no bedding or grouting is carried out by others until enough of the structure has been aligned, levelled and plumbed and adequately braced.

Steel wedges or packings or other levelling devices of adequate strength and rigidity shall be used to support the steelwork. Immediately before being grouted, the space and all pockets under the steel shall be cleared of all debris and free of water.

Before steel sections are embedded in concrete, the complete corrosion protection system shall be applied to each member down to at least 100 mm below the level of the concrete.

4.2.5.7 Sundry items

a) Handrails. Handrails shall be of the type and shall be purpose made in the style and shapes shown on the drawings or specified in the Particular Specification. The Contractor shall ensure, by making in-situ measurements before manufacture is started, that the handrails suit the situation in which they are to be installed. Handrails are to be supplied complete with all the necessary fixing bolts, nuts, etc.

b) Ladders. Ladders shall be manufactured in accordance with the details and general arrangements shown on the drawings or specified in the Particular Specification. Ladders shall be supplied complete with all the necessary fixing bolts, nuts, washers for fixing, etc.

c) Open grid flooring. Open grid steel covers and floor panels shall be manufactured by an approved firm specializing in such work. They shall be pressure locked or welded (or both). They shall be so designed that the deflection of any bar under design load condition does not exceed 1/200th of the clear span, or 10 mm, whichever is the lesser. Flooring shall be made in panels of sizes that conform to the dimensions given on the drawings, and shall be supplied prefabricated with cut-outs as required. Unless authorized by the Engineer to do so, the Contractor shall not cut or weld open grid floor panels on Site.
d) **Floorplate floors.** Floorplate shall be as shown on the drawings and shall have an approved raised pattern. Lifting key holes shall be provided as shown.

e) **Metal Doors, Windows, Ventilators, Glazed Shutters etc.** Glazed units shall be made from galvanized steel folded sheets sections or approved equivalent free from rolling defects. All steel doors, windows and glazing shall conform to IS 4351 or equal approved with electro galvanized finish conforming IS 1570 unless otherwise directed. The doors, window and ventilation frame section are made of folded plate as per manufacturer's specification to conform with the drawings. The Contractor is required to submit shop drawings for approval by the Engineer.

f) **Window grills, fences, railing.** Mild steel grill, fences and railing of approved pattern and manufacture, finished with one coat or red lead primer followed by one coat of aluminum paint, all complete, shall be as shown on the drawings or as directed and shall comply with the requirements of IS 800 or equal approved. Welded joints shall be neatly made, filed smooth and left clean. The Engineer is to be informed when the welded work is ready for inspection and any such work must be left unprimed until the Engineer gives his approval. The Contractor shall furnish at his own expense all necessary tools and all materials which he may require for the safe erection of the work, and remove the same when the work is completed. The Contractor shall be solely responsible for any damage done to the structure during erection and any member which has been bent or otherwise distorted either before or after erection shall be straightened or replaced in an approved mean at his own expense. The grill work shall be finished with one coat of red lead oxide paint and fixed in the opening.

g) **Collapsible gates, rolling shutters.** These shall be double or single collapsible gates depending upon the size of the opening. The collapsible gates shall consist of vertical channels 20 x 5 mm and top and bottom rails of T-iron 40 x 6 mm with 38 mm dia. steel pulleys or ball bearings in every 4th double channels, unless otherwise specified. Where a collapsible gate is provided with the opening and is fixed along the outer surface the T-iron at the top may be replaced by flat iron 40 x 10 mm. The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles.

Unless otherwise ordered, the rolling shutters shall conform to IS 6248 and be suitable for fixing in the position ordered ie outside, inside, on or below lintel or between jambs. Shutters up to 12 m2 in area shall be manually operated or push up type while bigger sizes shall be of reduction gear type mechanically operated by chain or handles.

Laths shall be of 18 gauge best quality mild steel 75 mm wide strips interlocking, rolling centres, machine rolled and straightened with an effective bridge depth of 16 mm. Side guides and bottom rails shall be built up mild steel rolled sections. The spring assembly shall be supported on strong mild steel or malleable cast iron brackets shaped to fit the lintel. The rolling springs shall be from tested unbreakable high tensile steel wire or strip of adequate strength to balance the shutter in all positions. The shutter shall be complete with door suspension shafts, locking arrangement, pulling hooks, handles and other accessories.

**4.2.5.8 Execution of corrosion protection**

**Safety and general workmanship**

The Contractor shall, at all times, enforce adequate safety measures in terms of the legislation applicable to the work Site.

All work shall be carried out by competent workmen under the supervision of an experienced supervisor.

No cleaning or coating shall take place when Site conditions are likely to affect these operations adversely.

Equipment nameplates and identification plates shall be protected against damage or overcoating.

Any areas not required to be coated shall be masked in such a way that these surfaces are protected during all coating operations.

**Dressing and repair during fabrication**

All surfaces of welds shall be free from slag, slag inclusions, cracks and holes. Weld profiles shall have a smooth contour, free from irregular projections, undercut and sharp edges. Areas adjacent to welds shall be free from weld spatter and such spatter shall have been removed by grinding or scraping.
All burrs and sharp edges caused as a result of activities such as guillotining, flame cutting, drilling or hole punching shall be removed by chamfering or ground to a smooth radius of at least 1 mm.

**Preparation for coating**

Prior to any other form of preparation, all obvious harmful deposits on the surface of steelwork, such as oil, grease, chemical deposit, clay, bitumen, or mud, shall be removed by a method described below.

a) Abrasive blast cleaning (sand blasting) shall be carried out in accordance with the methods described in the relevant applicable standards (e.g., BS 4232, SIS 05 59 00). Where sprayed metal coatings are to be applied to steelwork, angular grit shall be used.

Dry abrasive blast cleaning shall be carried out on a dry surface. When air is used, it shall be oil-free, clean and dry. Final blasting shall not be carried out if the steel temperature is less than 3 °C above dew point.

All blast-cleaned surfaces that are to be coated shall be so within 8 h of blasting unless otherwise agreed to by the Engineer.

In addition to or as an alternative to dry blast cleaning, it may be necessary to apply wet blast cleaning in order to remove soluble salts from the surface of steel that have been exposed to aggressive environments. Such wet blast cleaning is subject to the approval by the Engineer.

b) Cleaning by hand or with power tools. This is mainly done by wire brushing in accordance with the relevant applicable standards (e.g., DIN 55928).

c) Degreasing. Liquid-solvent cleaning, solvent-vapour cleaning and alkali and emulsion cleaning may be carried out at the discretion of the Engineer and in accordance with the relevant applicable standards (e.g., DIN 55928).

**Latent material defects**

Before the application of the first coat of a protective system, unacceptable defects such as cracks or laminations, that become evident after preparation of the steelwork, shall be ground out, repaired or the material rejected, as decided by the Engineer.

**Cleaning of surfaces about to be coated**

No coating shall be applied on a prepared surface that is contaminated with oil, grease, perspiration, rust or chemical deposits until such surface has been adequately cleaned. Uncoated steel shall not be touched with bare hands. Where contamination has occurred, it shall be removed with an approved solution or cleaning solvent. Degreasing shall be followed by rinsing with water to remove residues.

Where any coat has oxidized or become excessively hard, it shall be abraded to a matt finish and cleaned prior to the application of further coats.

Unless otherwise approved, coats shall only be applied on moisture-free surfaces.

**Coating system**

The coating system shall be as specified in the Particular Specification and shall be applied at the location specified.

**Application of paint coatings**

The method of coating application shall comply with the manufacturer's recommendation and data sheets. Multicomponent materials shall be applied with due care, the specified application techniques being used.

All coatings shall be substantially free from tears, runs, curtaining, foreign inclusions and material surface defects and shall, in addition, be free from misses.

Maximum and minimum intercoat intervals shall comply with the paint manufacturer's recommendations, taking cognizance of ambient conditions.

The colour of each coat shall be different from that of the previous coat.

Surfaces that will be inaccessible for coating after fabrication or erection shall receive the full specified coating system prior to final fabrication or erection.
All coating components, particularly two-component or multicomponent materials, shall be thoroughly mixed until a homogeneous mixture is achieved. The mixture shall be frequently agitated during application to keep the solids in suspension. The preparation time and pot life of these materials shall be closely adhered to.

**Application of metal coatings (HDG, metal spraying)**
All HDG shall comply with the requirements of the relevant applicable standards (eg BS 729, DIN 55928).

If a galvanized surface is to be coated to provide a duplex system of coating, the galvanized surface shall first be cleaned and prepared in accordance with the coating manufacturer's recommendations.

No drilling, cutting, welding or machining shall be carried out after metal coating. Unavoidable damage shall be repaired in accordance with clause 4.2.5.8.9 below.

**Repair of damaged coatings**
Damaged areas shall be cleaned down to a metal condition or to an undamaged coated surface.

Spot repairs shall re-instate each of the previous coats, or shall be made using an approved patching material. The patch shall extent at least 25 mm over adjacent surfaces which shall have been prepared by feathering with suitable abrasive paper. The repair of metal coatings shall be to a procedure approved by the Engineer.

### 4.2.6 Tolerances

#### 4.2.6.1 General

The permissible deviations (PD) on the dimensions of components (such as gusset plates, cross bracing, etc.) and on the location of bolt holes in components and elements of a structure shall be ± 2 mm. All calculated PDs shall be rounded up to the next whole millimetre.

#### 4.2.6.2 Tolerances on dimensions, accuracy of erection, etc.

The tolerances on all dimensions (other than of rolled sections), accuracy of erection, location of HD-bolts, location of column bases, levels, etc., shall be as given below:

- **a)** Width of flange ± 4 mm
- **b)** Depth of beams ± 3 mm
- **c)** Off-centre of web 6 mm
- **d)** Tilt or warpage of flange b/200 mm
- **e)** Length of a member + 1, -2 mm
- **f)** Out of plumb < 50 or H/500 mm
- **g)** Straightness of members < 25 or L/500 mm
- **h)** Location of HD-bolts ± 3 mm
- **i)** Level and position of column bases ± 3 mm
- **k)** Other levels ± 2 mm

#### 4.2.6.3 Dry film thickness

At least 90 % of all coating thickness measured shall comply with the minimum requirements of the Particular Specification. Up to 10 % of all readings may be below the specified thickness, but may be not less than 70 % of the specified thickness. Where DFTs are less than those specified, remedial action shall be taken to built up the thickness to that specified. DFT in excess of the prescribed maxima shall not necessarily constitute a reason for rejection if the paint film is demonstrated to be sound in all respects.

The method used to measure DFT and the significance of the readings for each particular job shall be as agreed upon by all parties prior to commencement of work.
4.2.7 Testing and Acceptance

4.2.7.1 Testing of steelwork

If requested by the Engineer, test certificates or cast analysis certificates (or both), pertaining to the steel to be used shall be supplied to the Engineer by the Contractor.

The Engineer shall have access at all reasonable times to all places where the work is being carried out and shall be provided with all the necessary facilities for inspection during all stages of construction.

Welds shall be examined visually to check that there are no uneven leg lengths, no cracking or unacceptable undercutting or porosity and that full fusion has been achieved while welding is in progress. Dimensional checks shall be carried out in accordance with the requirements of the relevant applicable standards (eg BS 5135).

Only where so required by the Engineer shall welders be tested or destructive or non-destructive tests being carried out.

4.2.7.2 Testing of coatings

Testing of coatings by the Contractor and inspections by the Engineer shall be carried out in accordance with the requirements laid down in the relevant applicable standards (eg ISO 3233) and as directed by the Engineer.

4.2.8 Measurement and Payment

4.2.8.1 Principles

Work involving steel, platework, and sundry items will be measured by mass of steel. Such mass will be calculated from a steel density of 7850 kg/m³.

Corrosion-protection coatings will be measured in the same units as the steelwork that is to be protected. Tonnage will be measured as the gross tonnage of unpainted steel.

4.3 PLUMBING AND HOUSE DRAINAGE WORKS

4.3.1 Scope

This specification covers the general requirements for plumbing and sanitary installation required in general building construction.

4.3.2 Interpretations

4.3.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 3.3 Pressure Pipelines
c) 3.4 Sewers

4.3.2.2 Application

This specification contains clauses that are generally applicable to plumbing, sanitary installations, house water supply and drainage work, and associated work. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification (Part 2, Volume 2, Tender Documents).

4.3.3 Materials

All pipes, fittings, and sanitary ware shall be of selected quality approved by the Engineer. It shall be suitable for the intended purpose and appropriately matched to each other. All pipes, fittings, and sanitary ware shall be supplied complete with all necessary fixing, coupling and jointing material.
Pipes for water supply shall be of galvanized seamless steel, cast or spun iron, ductile cast iron, PVC, etc., and shall be jointed by fitting, screwing, or welding, as applicable.

Pipes for drainage may be cast iron, ductile cast iron, vitrified clay (glazed earthenware), PVC/PE, AC, concrete, etc.

All fittings shall be supplied according to the pipes required, whether or not specifically called for in the drawings.

All sanitary equipment, lavatories, cisterns, urinals, toilets, water fountains, floor drains, gullies, petrol, and oil traps, etc., shall conform to the relevant applicable standards as shown below.

BS 437 and BS 1130 for cast iron drain pipes and fittings
BS 1211 for spun iron pipes and fittings
BS 2760 for pitch fiber pipes and fittings
BS 1387, IS 1293 for galvanized pipes
BS 1740, IS 1879, IS 554, IS 2633 for galvanized pipe fittings
IS 4980, IS 8008, IS 7634 for HDPE pipes and fittings
IS 1276 for covers and frames
IS 774, IS 2556 for white ceramic sanitary ware

4.3.4 Plant and Equipment

The apparatus used for the line, level, and positional control of pipelaying and installation work shall be accurate, sturdy, and in good operational condition. The Contractor may use any acceptable device for such control.

In addition to the pumps, gauges, storage tank, tools, pipes, fittings, specials, and bracing necessary for the tests required, the Contractor shall provide all plugs for the temporary stopping off of pipelines for the purposes of testing.

4.3.5 Construction and Workmanship

4.3.5.1 Sanitary fixtures

All fixtures specified or shown on the drawings shall be furnished and set by the Contractor in a neat and workmanlike manner, making connections with all supply, waste, soil and vent pipes, as specified or as directed. General requirements for fixtures shall be the following:

A sample of each type of fixture shall be subject to the approval by the Engineer. The samples shall be completely fitted and set up at the building or in some other convenient approved place.

The approved fixture samples shall not be removed and shall be protected at all times during the construction period for comparison purposes. All fixtures of poorer quality than the one of the samples will be cause for rejection.

All ceramic fixtures shall, unless otherwise shown on the drawings or directed, be of white vitreous china thoroughly fused, producing a white material which, when fractured, shall show a homogeneous mass with close grain and free from pores. All surfaces coming in contact with walls, floors, or surfaces of other fixtures shall be reasonably flat.

Enameled cast iron shall be of an approved quality and thickness. Porcelain enamel coat shall be applied so that the enamel will be smooth, of even thickness, white and free from craze, discoloration and chips. Exterior exposed surfaces not required to be enameled shall be treated with one coat of filler at the factories. The Contractor shall be responsible for any revisions of connections required to adapt the roughing sleeves and openings to the particular fixture he proposes to use.

All fixtures shall bear the manufacturer’s guarantee label or trade mark for identification purposes. All fixtures requiring hot and cold water shall have the cold water tap on the right hand side of the fixture and the hot water on the left hand side of the fixture.

All fixtures shall be of the same manufacture, unless otherwise directed by the Engineer.
The location of each fixture and the fixing method of ceramic fixtures shall be as shown on the drawings or as directed by the Engineer.

After fixtures have been mounted, the Contractor shall before leaving the job, thoroughly clean all fixtures furnished and mounted under this contract, remove all plates, stickers, rust stains and other foreign matters or discolorations on fixtures, leaving every part in perfect condition and ready for use.

4.3.5.2 Piping

The Contractor shall submit to the Engineer a piping diagramme for approval. This diagram shall show the symbols of the sanitary fixtures connected with both, the potable water supply and the drainage system. Valves, diameter of pipes, materials, etc., shall be indicated in the diagramme. The limit of the work to be executed inside the building shall begin and end 1 m beyond the outer line of the structure, unless otherwise directed.

All supply lines shall be designed for a nominal pressure of 1 MPa (10 bar), unless otherwise directed.

Before covering the pipes work pressure test shall be carried out to the satisfaction of the Engineer.

The waste water shall be drained through septic tank, soakaway drains or pits, or drainage system, as applicable, by use of vitrified clay pipes or PVC/PE pipes as directed or shown on the drawings.

Great care shall be taken in setting out and determining the general levels and falls of drain pipes, so that a fall giving a self-cleaning velocity shall be obtained.

4.3.5.3 Fixing

W.C. commodes shall be fixed to the floor with C.P. brass screws or by means or 75 mm long 6.5 mm dia counter sunk bolts and nuts embedded in the concrete floor or as per the instruction of the Engineer. The base of the pedestal of the commodes shall squarely rest on the finished floor. Any gap between the finished floor and the pedestal shall be filled with white mastic mixed with pigment to match the shade of floor or as directed by the Engineer.

The W.C. Pan (Indian or Orissa) shall be laid in floor slope towards the pan in a workmanlike manner, care being taken not to damage the W.C. pan, etc. in the process of fixing. If damaged in any way, it shall be replaced at no cost of the Employer. The pans, etc. shall be fixed on a proper base of cement concrete 1:2:4 mixer (1 cement: 2 coarse sand: 4 stone ballast of 20 mm nominal size) taking care that the cushion is uniform and even without having any hollows between the concrete base and W.C. pans, etc. Joint between the W.C. pan and finished floor shall be neatly done and no hair cracks shall be visible. Joint between the outlet of the W.C. pan and ceramic ‘P’ or ‘S’ trap shall be made with neat cement, yarn, linseed oil, white lead and waterproofing compound and made leakproof. The outlet of the ceramic traps shall be centrally placed in the rubber gasket of the socket of the HDPE pipe and shall have no leakage.

Flush valves shall be installed exposed as shown on the drawing, in accordance with the manufacturer's instruction or as directed by the Engineer. The C.P. long flush bend pipe shall be fixed to the water closet with the help of rubber adopter and shall show no signs of leakage.

Washbasins shall be supported on bracket (s) as per the manufacturer's instruction and/or on vitreous china pedestals or as directed by the Engineer. There shall not be any gap between top edge of the basin and finished face of wall.

Urinals shall be fixed to the wall by means of C.P. brass screws as per the manufacturers instruction and/or directed by the Engineer. There shall not be any gap between the back edge of the urinal and finished face of the wall.

4.3.6 Tests and Acceptance

All water services shall be subjected to a hydraulic test pressure 1.5 times the working pressure maintained for a period of two hours.

All soil waste and vent pipes shall be subjected to an air test as described in clause 3.4.7.

All drainage pipework shall be subjected to a hydraulic test pressure of 150 mm head at the highest fitting, maintained for a period of four hours.
The Contractor shall include for providing all necessary appliances and labour at these tests.

All water service pipework shall be flushed through upon completion of installation, to ensure cleanliness.
All drainage pipework shall be rodded through upon completion of installation to ensure cleanliness.

4.3.7 Measurement and Payment

4.3.7.1 Principles

The transport to site, handling, laying and jointing of pipes and fittings, including inspection, cutting, turning, welding, supply and installation of metallic tape etc., will be measured throughout the overall length without deduction of valves etc. and will be paid for by the linear meter of work performed depending on the pipe types, diameters, and location the pipe is to be installed.

The installation of stop valves, air valves, washouts, hydrants etc. will be paid by the number installed.

Testing and disinfection of mains will be paid for the linear meter of work performed depending on the pipe diameter.

An extra item will be paid for connections to be made to existing pipelines, depending on the diameter of the existing pipe.

4.4 FINISHES

4.4.1 Scope

This specification covers the general construction requirements for finishes, such as flooring, painting, roofing, water proofing, etc., required in general building construction (eg administration buildings at treatment plants, well houses, etc.).

4.4.2 Interpretations

4.4.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.2 Earthworks
c) 3.1 Concrete
d) 4.1 Brickwork

4.4.2.2 Application

This specification contains clauses that are generally applicable to finishes on walls, floors, and roofs of buildings and associated work. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification (Part 2, Volume 2, Tender Documents).

4.4.3 Materials

Ceramic tiles shall be 100 x 100 x 6 mm size unless otherwise shown or specified on the drawings or directed by the Engineer. They shall either be ceramic vitreous tiles, with colours as selected by the Engineer, or approved glazed tiles conforming with IS 777.

Lime, cement, sand, and water used for tiling work shall be in accordance with the requirements of section 4.1.

Granular material (eg marble chips) for in-situ flooring, screeds, and skirting shall be as approved by the Engineer.

The Contractor shall submit samples of tiles for selection and approval by the Engineer, and all tiles used shall conform to the approved samples with regard to size, quality, texture and colour.
The materials for painting and colour washing of internal and external walls and similar surfaces shall conform to the requirements of the relevant applicable standards (eg IS 5410).

Waterproofing materials, such as waterproofing bituminous felt and other bituminous materials shall be in accordance with the relevant applicable standards (eg IS 1322, IS 1580).

Waterproofing additives to mortar, plaster, and concrete shall be in accordance with the requirements laid down in the relevant applicable standards (eg IS 2645) and shall be added at the rate of 2% by weight of cement or in accordance with the manufacturer's recommendations and shall be subject to the approval of the Engineer.

Pigments and other necessary additives to produce coloured plasters and mortars shall conform to the relevant applicable standards (eg IS 57) and shall be applied at the rate of 1 % by weight of cement or to produce a colour and texture indicated on the drawings or as directed by the Engineer. The sample of such colour plaster shall be subjected to approval of the Engineer before applying in the work.

Caulking compounds shall be of approved manufacture such as to provide a continuous waterproof barrier installed with exposed caulking smoothly recessed from the finished steel or brick surface.

4.4.4 Plant and Equipment

Plant and equipment shall be suitable for applying the specified flooring and coating systems and for obtaining the specified results. If, however, consistent and satisfactory results are not achieved with the equipment used by the Contractor, the Engineer may order the Contractor to obtain and use such plant and equipment as may be necessary to achieve the required results.

4.4.5 Construction and Workmanship

4.4.5.1 Tiles

Wall surfaces shall be brushed clean, wetted, and fitted with on approximately 12 mm thick level and plumb scratch coat of cement mortar 1:3 applied in accordance with section 4.1. The scratch coat shall be moist cured for at least 24 h before the application of a floating coat. Before applying this floating coat, the scratch coat shall be thoroughly wetted. The floating coat, a plastic mix of neat cement of approximately 3 mm thickness shall be applied even, and with screeds to true plane. The floating coat shall be applied over areas no larger than can be covered with tiles while the mortar is still plastic (half set). Glazed tiles shall be soaked, completely immersed in clean water, at least 30 min. and drained.

Tiles shall be installed by applying a skin coat of a plastic mix of neat cement to backs of tiles and firmly pressing them into the floating coat to true plane and position. White cement shall be used for the skin coat where white joints are required.

Tiles shall be installed by dusting a thin layer of dry cement over the setting bed worked lightly with trowel or brush until damp, and tiles shall than be set with straight uniform joints 1 mm or less in width, accurately aligned in both directions and tamped solidly to the bed.

During the process of setting tiles, continuous horizontal and vertical cuts every 40 to 60 cm shall be made through the floating coat while plastic, using the point of a trowel turned edge wise. Care shall be taken to prevent cutting into the scratch coat.

Where full size tiles cannot be laid, they shall be cut (sawn) to the required size and the edges rubbed smooth to ensure a true and straight joint.

Joints in tile work shall be accurately aligned with horizontal joints level and vertical joints plumb. The joints shall be maintained uniformly wide by aligning spacer lugs on tile edges if tiles are so manufactured or by use of wetted strings.

The layout of tile work shall be so that no tile less than half size occurs. Where tiles must be cut at edges or penetrations, the cut edges shall be carefully fitted and neatly ground. No chipped, cracked or broken tile shall be used and all defective work shall be replaced and repaired to the satisfaction of the Engineer and at the Contractor's expense.

After tiles have been set firm and joint strings removed, tiles shall be dampened and joints grouted full with a plastic mix of neat cement by trowel, brush or finger application. Unless otherwise directed, grout
shall be made with white cement. During grouting all excess grout shall be cleaned off the tile surface with damp cloth sponges.

Where the setting bed is applied directly to a concrete slab, the slab surface shall be thoroughly wetted, with no free water left standing, and sprinkled with dry cement. The setting bed shall be 1:5 cement mortar and shall be placed to the required level, grade and slope and tamped firmly. Cement mortar at a rate of 4.4 kg per square meter shall then be spread. The floor tiles shall then be placed in position and tapped with a wooden mallet until the tiles are properly bedded in line and level.

Where the setting bed is applied over a waterproofing membrane, metal reinforcing wire mesh shall be installed lapped at least one full mesh at edges and supported so as to be located approximately mid-height of setting bed. At edges where wall tiles are foreseen, the mesh shall be turned up at least 80 mm.

All finishing tile work shall be adequately protected from damage during the progress of construction and any damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

4.4.5.2 Cast in-situ floors, screeds, skirting

Before placing of in-situ concrete flooring, the base shall be made rough and watered, and given a cement wash. A first concrete layer shall than be laid to the depth required. After laying, the concrete shall be compacted by hand or mechanical means leveled with wooden floats.

Within one hour of laying the bottom layer, the second and finishing layer shall be placed and the surface tamped lightly before finishing it of perfectly level with a straight edge float and trowel.

The finishing layer shall consist of cement-sand mixed at 1:1.

Cement skirting shall consist of 20 mm thick cement mortar mixed at 1:3. The cement skirting shall be applied to the wall surface to the line, levels and dimensions, and finished with a floating coat of neat cement.

Curing and protection of cast in situ floor shall be in accordance with the requirements of sections 2.3 and 4.1.

4.4.5.3 Waterproof Cement paint

The contents of each fresh container of the paint shall be loosened by rolling or shaking the container before opening for the first time. To one volume of water in a clean container, an equal volume of cement paint shall be added and stirred well to achieve a uniform consistency. No further dilution will be permitted.

The cement paint powder shall be kept secured from the exposure to atmosphere by properly tying up the polythene liner in the container and the lid firmly closed.

The cement paint shall be used within two hours of mixing and shall be kept stirring during use.

For application, the base surface shall be cleaned by use of a stiff brush to remove loose dust and dirt. The base surface shall be thoroughly wetted and water allowed to run off.

The first coat shall be well brushed in a manner to give a good bond of the paint with the surface. The second and subsequent coats shall be brushed or sprayed as approved. The cement paint shall be applied at the following rate:

<table>
<thead>
<tr>
<th>Type</th>
<th>Rate per m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) on brickwork</td>
<td>2 kg/m²</td>
</tr>
<tr>
<td>b) on in situ concrete</td>
<td>3.5 kg/m²</td>
</tr>
<tr>
<td>c) on concrete blocks</td>
<td>2 kg/m²</td>
</tr>
<tr>
<td>d) on cement sand rendering</td>
<td>3.2 kg/m²</td>
</tr>
</tbody>
</table>

The curing of the waterproof cement paint shall be carried out by application of fine water spray at an interval of 6 to 8 h after the application of the paint for duration of at least 7 d.

The finished surface shall be protected from any damages, staining, etc., by approved means.
4.4.5.4 Oil bound distemper

All plaster surfaces shall be thoroughly cleaned and shall receive 3 or more coats. The first coat shall be a prime coat. The second and third coats shall be of oil bound distemper of approved colour, shade, and quality, and shall be mixed with petrifying liquid in accordance with the manufacturer's recommendations.

After these operations, if the work is not to the satisfaction of the Engineer, one or more coats shall be applied without extra cost until a smooth and even surface is achieved and approved by the Engineer.

4.4.5.5 Distempering

Distemper shall be dry distemper as approved by the Engineer. The distemper shall be mixed with clean water as recommended by the manufacturer and shall be stirred until the mixture attains an even consistency.

The surface shall be cleaned, cracks and holes repaired, all irregularities and inequalities sand papered smooth and wiped clean to present a fine smooth surface which shall be completely dry before distempering is started.

The mixture shall be applied evenly with a brush in long parallel strokes evenly so as not to leave any visible brush marks.

The surface of this first application shall be allowed to dry and harden. Then the second coat shall be allowed to be applied on the first coat. If a uniform surface is not achieved, a third coat shall be applied.

4.4.5.6 Plastic emulsion paint

The surface shall be prepared as specified for oil paints. First, a priming coat of primer as specified by the manufacturer shall be applied.

The second and third coats of plastic emulsion paint of approved shade and manufacture shall be applied to achieve an even surface. If the finish is not to the satisfaction of the Engineer, more coats shall be applied to achieve a smooth and even surface.

4.4.5.7 Ready-mixed enamel paint

Surfaces to be painted shall be dry, free from dust and dirt and rubbed smooth by means of sand paper or pumice stone to the satisfaction of the Engineer.

The paint shall be ready-mixed synthetic enamel or oil paint of approved make and manufacture. The primary coat shall be applied evenly with a brush. After the primary coat is applied and perfectly dried, all holes, cracks etc. shall be filled with putty and the surfaces sand papered. A second coat of paint of approved shade and manufacture shall then be evenly applied and allowed to dry. The third coat shall be carefully applied as and when required, to achieve a smooth and even surface.

4.4.5.8 French Polish

The work shall be first cleaned and sandpapered thoroughly. It then will be painted with a "filler", composed of methylated spirit, and sandpapered.

A thin coat of French Polish shall then be applied and sand papered. Subsequent coats of French Polish shall be applied till the proper finishing is achieved to the satisfaction of the Engineer.

4.4.5.9 Roofing

A water proofing coating on bare reinforced concrete roofs shall be bitumen based and shall be applied in two layers of primer and one layer of finishing coat in accordance with the manufacturer's instructions and recommendations.

Such coating shall be applied by brushing, spraying, or roller application and shall be placed on concrete which has been cured and has reached an age of not less than 3 months.
If not otherwise shown on the drawings or directed by the Engineer, the prime coats shall be applied at a rate of approximately 0.85 l/m² and the final coat at a rate of about 1.2 l/m².

Care shall be taken in connection with drains, gutters, etc. to achieve proper flashing and lapping with the bitumen membrane.

### 4.4.6 Tolerances

The tolerances for flooring work shall be as described in 2.3 and for paintwork as described in 4.2, as applicable, unless otherwise agreed between the Contractor and the Engineer prior to the commencement of the work.

### 4.4.7 Measurement and Payment

#### 4.4.7.1 Principles

Finishing work will be measured as the net areas covered and no deductions made for openings of area up to 1.5 m².

Separate items will be scheduled for each type of finish, and for different location of application, if such location will substantially effect the pricing.

Doors, windows, glazed partition walls will be paid for by area measured across the whole surface, without deducting unpainted fillings such as glazing, plastic coated boards, etc.

### 4.5 CARPENTRY AND JOINERY WORKS

#### 4.5.1 Scope

This specification covers the general construction requirements for timber work, carpentry and joinery, required in general building construction (e.g. administration buildings at treatment plants).

#### 4.5.2 Interpretations

##### 4.5.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

- a) 1 General
- b) 2.3 Concrete
- c) 4.1 Brickwork

##### 4.5.2.2 Application

This specification contains clauses that are generally applicable to timber works, carpentry and joinery for buildings and associated work. Interpretations, additions, and variations of this specification are set out in the Particular Technical Specification (Part 2, Volume 2, Tender Documents).

#### 4.5.3 Materials

Timber for general purposes shall be approved hardwood, with quality attributes as for the normal class according to DIN 4704, or similar and planed on all sides. The timbers shall be impregnated with an odorless wood preservative.

Unless specified elsewhere or otherwise directed, the frames, architraves, etc., of doors and windows, etc., shall be of well-seasoned wood free of knots, fissures, and decay. Local wood of equivalent quality shall be used whenever possible.

Door shutters shall be of chipboard or blockboard of approved quality having both sides faced with either commercial ply 5 mm thick or other approved veneering. Samples of such shutters shall be submitted for approval.
The fittings and fixtures like hinges, hooks, anchors, locks, handles, key plates, keys, doorstops, etc., shall be of best quality and manufacture. The Contractor shall submit samples of such fittings and fixtures well in advance for approval. Except for hinges which shall be of heavy pattern of steel or brass as appropriate, all other fixtures shall be of anodized light metal, aluminium, or stainless steel, as appropriate, and as directed.

Timber and other wood material shall be straight, sound, bright, of mature growth, well seasoned and conditioned to suit the particular purpose, for which it is to be used. The material shall be cleanly sawn, square edged, and free from injurious shakes, splits, warps, wanes and knots, soft spots and rot, incipient decay and all other defects.

For the structural components which will be concealed after installation, e.g., in the case of built-in cupboards, wardrobes or wall linings, either the type of wood specified for the unconcealed structural components (spruce, fir, pine or a wood of at least equal quality) or an equally suitable material may be used at the Contractor's own choice, unless otherwise specified.

The timber shall be in a suitable condition so that the components made of it will neither crack, warp nor twist.

The moisture content of timber assemblies when leaving the manufacturer's works shall be as follows (referred to the overdry weight):

a) 8 to 12% for interior finish components
b) 10 to 15% for structural parts in permanent connection with the outside air.

Proof of this moisture content shall be furnished to the Engineer.

Plywood and wood chip boards, all surfaces to the veneered or seal coated shall be adequately closed.

Wooden fiber boards, veneers, coating slabs and coating foils of plastics shall be suitable for their intended applications.

Adhesives (glues) must not cause any discoloration or other damage.

Sealing compounds shall be resistant to atmospheric influences, shall not harden and shall not be aggressive.

Coating materials shall form a good bond with the base. Their surface shall be brushable and insensitive to wiping contact.

All fittings such as hinges, hooks, anchors, locks, handles key plates, keys, etc., shall be submitted to the Engineer in good time for approval.

All coating materials shall form a good bond with the base. Their surface shall be readily brushable and insensitive to wiping contact.

All polish (polishing varnish) shall be fast to light and unsuitable condition so that it provides a surface which is elastic to the greatest possible extent and resistant to scratches, water, acid and heat.

Wood preservatives shall be of an officially approved type. Where subsequent painting of the timber is required, the wood preservative shall be compatible with the paint. In interior applications, the wood preservative shall be odorless.

Treated lumber shall be accompanied by a certificate from a recognized lumber treating company, certifying the amount of treatment and the percentage of moisture after drying.

### 4.5.4 Plant and Equipment

Plant, equipment, and tools for the execution of timber work, carpentry and joinery shall be sufficient in number and capacity, in good working order, and in accordance with the requirements of the applicable safety regulations.
4.5.5 Construction and Workmanship

If not otherwise shown on the drawings, or directed by the Engineer, DIN 18334 shall be binding for the execution of the works as well as the other DIN Standards as follow:

DIN 1052 Timber Structures
DIN 68365 Timber for Carpenters’ Work, Quality Specifications
DIN 4074 Timber for Wood Building Components
DIN 68800 Timber Protection in Building Construction
DIN 17440 Stainless Steels; Quality Specifications
DIN 18202 Dimensional Tolerances in Building Construction,

Timber as specified shall be jointed and erected in accordance with DIN 1052 and the drawings, including the required wind bracing. Posts shall be fixed to the concrete slab by means of bearing plates, straps and angles according to the structural calculations. Only non-rusting steel according to DIN 17440, Material No. 1.4571 shall be used for fixing components.

The Contractor shall supply to the Engineer shop drawings in accordance with the architectural design and Contractor’s statical analysis, which are subject to approval before any execution starts.

All structural components shall not warp or crack under any circumstances including stresses due to temperature and humidity that will have to be expected.

All timber connections and miters shall be accurately fitted. The surface exposed to view shall be trimmed, eg by planing and grinding. There shall be no plane cutting marks.

Solid timbers shall be joined in such a way that in the event of variations of air humidity, the wood is free to swell and shrink without affecting the joint.

Framing timbers shall not be butted.

Dovetailing may be used subject to the Engineer’s consent.

All edge surfaces of plywood, wood-chipboards and composite slabs exposed to view shall be veneered or provided with banding (insets or strips). On sealed, veneered and coated surfaces joints and irregularities of the base shall not show even after final drying.

All grained veneers shall be protected against tearing. All timbers ultimately in contact with outside air or permanently with particularly humid air or connected to masonry or concrete shall be treated on all sides with suitable wood preservative before being inserted. The manufacturer’s instructions have to be observed.

4.5.6 Test and Acceptance

A selection of samples for visual inspection and dimensional checks on material and fittings may be made by the Engineer. Supplier’s material and test certificates pertaining to the material to be used shall be supplied to the Engineer by the Contractor.

The Engineer shall have access at all reasonable times to all places where the work is being carried out and shall be provided with all the necessary facilities for inspection during all stages of manufacture or construction.

4.5.7 Measurement and Payment

4.5.7.1 Principles

Generally, the works shall be measured in-situ.

The method of measurement shall be based on the following:

Payment for windows and doors shall either be made by area in m2 or by number for each type and size.
If items scheduled call for measurement by area, architraves linings, sills etc. shall not be measured separately but shall be considered as being included in the area of the opening closed by the window, door, shuttering or any other specified closure.

Wall panels or linings will be paid for by area in m². The unit rate shall include all substructure, fasteners, doweling etc.

Built-in cupboards, cabinets and wardrobes will be paid for separately according to types and dimensions, by m² of covered rear wall area.

Surface treatment will be paid separately at the area treated.

All costs for hardware and iron ironmongery shall be included in the unit rate of the relevant bill item.
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PART II: PARTICULAR TECHNICAL SPECIFICATIONS

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1.1 DRAWINGS

The drawings related to the major works of the project are given in Volume III of the Bidding Documents.

During the course of the contract, the Engineer may issue supplementary drawings in respect of the structures, installation and finishing to be constructed in addition to the drawings included in the Bidding Document. It shall be the contractor's own responsibility to prepare from this information such working drawings as he may require for the proper setting out and construction of such structures, work shall not commence on an individual structure or parts until the relevant working documents have been approved by the Engineer.

Within 15 days of the date of written acceptance of the Bid, the contractor shall submit to the Engineer a schedule of working drawings listing the anticipated dates upon which they will be submitted for approval by the Engineer. The submission dates shall be spaced at reasonable intervals to enable the Engineer to give the information due consideration.

All dimensions shall be in metric units and each drawing shall be properly lettered and numbered to indicate the contractor's name, or sub-contractor, the title of the drawing, scale, and date of issue. Only A4 or multiple size sheets preferably A2 size, shall be used.

The Contractor shall make any changes or modifications to the Working Drawings that the Engineer considers desirable and the work executed accordingly without additional cost to the Employer. The Contractor shall supply two copies of all such approved Working Drawings to the Engineer. The cost of preparing and providing all Working Drawings shall be included in the Contract Rates.

No examination by the Engineer of any document submitted by the Contractor or of the Contractor's Working Drawings, nor the approval expressed by the Engineer in regard thereto, either with or without modification, shall absolve the Contractor from the obligation liability imposed upon him by any provisions of the Contract. Notwithstanding the Engineer's approval of the Working Drawings shall relieve the Contractor from responsibility for any dimensional or other errors.

Such Working Drawings as have been selected by the Engineer shall be correctly modified for inclusion in the final record drawings taking into consideration, inter alia, such variations to the Works as may have been ordered and executed. Such Drawings shall show the arrangement of all items of equipment installed under the Contract and shall be submitted to the Engineer for approval. After approval and before issue of the Certificate of Completion for the whole of the Works, the Contractor shall provide one reproducible and two photocopies of all Working Drawings as modified for record purposes.

Each set of prints of such Drawings shall be substantially bound with durable covers and a title page and index page. The title page shall be as per the approval of the Engineer's Representative.

1.1.1 Discrepancies in Drawings and BOQ

a) All work shall be carried out according to the approved drawings and instructions of the Engineer. The Contractor shall bring to the immediate notice of the Engineer any discrepancies and contradictions in the drawings and Bill of Quantities and the Engineer will make necessary revisions to correct the discrepancies and contradictions.

b) The Contractor shall review the drawings and Bill of Quantities well in advance of the execution of the work to ensure all discrepancies, contradictions and any other questions or issues are resolved prior to commencing the work. No claim will be accepted for any loss due to discrepancies and contradictions in the drawings and Bill of Quantities.

1.1.2 Layouts and Schedules Provisional

The locations, levels and dimensions as shown on the Drawings or given in the design data or structure schedules are subject to amendment. Details of any such amendment or confirmation of the original design will be given by the Engineer or the Engineer's Representative during the course of construction.
1.1.3 Survey and Datum for Levels

Prior to the start of the Works the Contractor will receive from the Employer a list of Project Benchmarks and their values and reference points on the site.

Thereafter, the Contractor shall establish all setting out necessary for the performance of the work, to the approval of the Engineer including levels of the original ground surface at the Site and final surveys of the completed Works for the final measurement. Levels shall close within 2.4 mm times the square root of the length of the circuit in km.

Ground levels shall be taken jointly by the Contractor and the Engineer's Representative both prior to commencing and after completion of earthworks.

Where cross sections are ordered these shall be at 10 m intervals or at such other spacing as may be ordered by the Engineer's Representative on Site. The location of the first cross section shall be approved by the Engineer's Representative and each cross section shall extend a minimum distance of 10 m beyond the limits of the new works.

From the centerline and grades established, the Contractor shall furnish and place all additional stakes, templates and bench marks necessary for marking and maintaining points, lines and sections for layout of the Works.

The Contractor's methods of recording survey data shall be subject to approval and field books and tabulated data shall be well maintained and made available for inspection and checking by the Engineer's Representative when ordered.

Instruments and equipment for surveys shall be subject to rigorous inspection by both the Contractor and the Engineer's Representative and any item found to be defective, in the opinion of the Engineer, shall be promptly replaced, repaired or adjusted as directed. All surveying shall be done under the direct supervision of a qualified surveyor or engineer who, as an employee of the Contractor shall be subject to the approval of the Engineer at all times during the progress of the work in accordance with Clause 16 of the Conditions of Contract.

1.2 PROGRAMME

In amplification of the requirements in Clause 14 of the Conditions of Contract, the particulars supplied by the Contractor with the programme shall include the following details: -

i) The statement giving the numbers and categories of supervisory and technical staff and skilled and unskilled labor to be employed on the Works;

ii) The list and type details of major Constructional Plant (including vehicles) which the contractor proposes to employ on the Works stating whether they are to be acquired from inside or outside Nepal, including programmed dates for order and delivery.

iii) Details of the Contractor's methods of working for all operations including construction of different installations.

iv) The statement and outline layouts giving the proposals for location or locations and sizes of construction camps, accommodation, offices, workshops and stores at the Site.

v) Details of the programme for the Works from the date of receipt of the Engineer's order to commence the Works, including a complete resource allocation showing the number of units and allotted times for each unit of Constructional Plant, materials and labor allocated for each part of the Works.

The Contractor shall notify the Engineer from time to time of any revisions to the approved programme, which he considers necessary if the Works are to be completed within the time, stipulated in the Bid.

1.2.1 Notice of Operations

The Contractor shall give full and complete written notice of all important operations including setting out to the Engineer sufficiently in advance to enable the Engineer to make such arrangements as the Engineer may consider necessary for inspection and for any other purpose. The Contractor shall not start any import operation without the written approval of the Engineer.
1.2.2 Water Supply

Not less than fourteen days before commencing any portion of the Works, the Contractor, if ordered, shall submit to the Engineer for his approval complete drawings of all Temporary Works the contractor may require for the construction of that part of the Works.

Notwithstanding approval by the Engineer of any design for the Temporary Works the contractor shall be entirely responsible for their efficiency, security and maintenance and for all obligations and risks in regard to such Temporary Works which are specified or implied in the Contract.

Except where specific items are provided in the Bill of Quantities, the cost of all Temporary Works of every description, including dewatering, temporary diversions of canals, drains, roads, telephone lines and all services shall be included in the Contract Rates.

The Contractor shall make his own arrangements for the supply of water, including potable water, for the purposes of the Contract. The quality of the water shall be to the approval of the Engineer and suitable for the purpose for which it is intended.

Wastewater shall be disposed of clear of the Site to the satisfaction of the Engineer so as to cause no damage or nuisance to the Environment and the surrounding areas.

1.2.3 Latrines

The Contractor shall provide throughout the period of construction of the Works and shall maintain and clean suitable and sufficient latrines for use by his employees; he shall ensure that his employees do not foul the Site but make proper use of the latrines.

1.2.4 Contractor’s Camps, Workshop, Stores, Offices etc.

The Contractor shall construct, guard and look after the camp or camps for his workmen together with workshops, stores, offices etc. The sites of the camp and other buildings shall be approved by the Engineer and the standard of accommodation, ablution and canteen facilities and amenities shall be to the satisfaction of the Engineer. The camp and other buildings shall be kept in a seemly and hygienic state until the conclusion of the Contract. On Completion of the Contract, all buildings in the camp should be demolished and the sites left clean and tidy with all materials and debris removed from the site.

1.2.5 Medical Arrangements

The contractor shall make arrangements for treatment on the site of casualties and sick persons in first-aid units or in such other wards as may be necessary in accordance with the appropriate regulations.

Notwithstanding the minimum requirements prescribed above, the Contractor shall be responsible for the adequacy of all the arrangements made as per the provisions of the Contract.

1.2.6 Contractor’s Power Supply

The contractor shall make his own arrangements for the supply of electric power for the purposes of the Contract.

1.2.7 Supply of Fuel Oils

The Contractor shall be responsible for arranging and ensuring that adequate supplies of high speed diesel oil, motor spirit, kerosene, lubricants and other petroleum products are available at all times to meet his requirements for the purposes of or in connection with the Contract; the Contractor’s particular attention is drawn to this requirement as from time to time shortages and interruptions in the supply of fuel oils, etc. occur in the region.

1.2.8 Supply of Cooking Fuel and Firewood

The Contractor shall be responsible for and supply adequate quantity of cooking fuel as liquid petroleum gas, kerosene and firewood required for the cooking of food for his employers, staff and any other purpose as provided in the Contract. The Contractor shall prevent cutting of trees, bushes by his
employees and for the purpose of the Contract. Any unauthorized cutting of trees or deforestation by the Contractor or his employees shall be subject to the jurisdiction of the related authority.

1.2.9 Clauses Not Applicable

Any Clause in the Specification, which relates to work or materials not required by the Bill of Quantity or subsequently ordered in accordance with Clause 51 of the Conditions of Contract shall be deemed not to apply.

1.2.10 Provisional Items

All provisional items in the Schedule shall be carried out at the discretion of the Engineer, and may or may not form part of the Contract. In case the Contractor carries out the provisional items the rates shall be settled as for extra items as stated in the Conditions of Contract.

1.3 Assistance to Engineer

1.3.1 Meetings and Reports

Approved representative of the Contractor shall attend formal meetings at the office of the Engineer on site or in the Clients office or in the Project Area, when called upon, for the purposes of Contract Administration.

The contractor shall submit in duplicate to the Engineer each month a report in a manner approved by the Engineer on his progress in the performance of the contract. Such reports shall include information regarding delivery, manufacture, and installation etc.

1.3.2 Photographic Records

1. Still Photographs

The Contractor shall supply negative and unmounted positive prints of photographs, postcard size, of such proportions of the works, in progress and completed, as may be directed by the Engineer and specified herein. The photographs shall be of two categories:

a) Progress photographs
b) Record photographs

The photograph shall be indexed with date and short description of the object of the photograph. The photographs as ordered by the Engineer shall be supplied in one negative and two prints, having signatures of the Contractor and the Engineer of the Consultant on the back of the photograph for the purpose of attestation.

The contractor shall provide such type of photographs to the consultant covering all the daily site activities being done during construction works. The contractor shall provide set of photographs as mentioned above along with the albums one in a week.

2. Digital Photographic Record

The contractor shall supply a high resolution Digital Camera with 8 GB memory card with capacity for the consultant’s engineer for the keeping records of different construction activities as the site engineer's requirements. The Digital Camera shall be accompanied with complete set of cables, Battery (2 set) and battery charger of good quality.

3. Video Record

The contractor shall supply a set of Handy Cam of Sony Brand for the use of consultant engineer's use for the keeping vediographic records of necessary (specially completed and new type of works) construction works for future technology transfer purposes. The contractor shall supply necessary cables, battery (2 sets) and a set of battery charger along with the camera.

1.3.3 General Assistance

The Contractor shall supply such assistance and plant as may be required in performing operations in connection with the execution, examination, inspection and measurement of the Works including the installation and surveying of bench marks and survey stations and marks wherever and whenever the
Engineer shall deem necessary. The Contractor shall also supply such labor, either continuously or from
time to time, as may be required by the Engineer for the operation and maintenance of the laboratory, as
messengers in connection with the Works and as watchman over the Engineer's office at site.

1.3.4 **Scaffolding, etc. for Inspection**

The Contractor shall provide safe access when requested by means of scaffolding, slings, etc. for the
Engineer to inspect at close quarters those portions of the Works not safely accessible by other means.

1.4 **FACILITIES FOR THE ENGINEER'S REPRESENTATIVE**

1.4.1 **General**

The Contractor shall provide and maintain the well equipped (with Drinking Water, Electricity,
Telecommunication, TV Cable) site office, laboratory, vehicle, furnishings and equipment for use of the
Engineer as described herein. Unless the Engineer agrees otherwise all facilities provided for his use
shall be new. The full details of the facilities, which the Contractor proposes to provide for the Engineer,
shall be submitted, for the Engineer's approval, within 7 days of the Letter of Acceptance.

The Contractor shall not complete any arrangements, nor place orders for the purchase of any items,
nor start work on the installation of the Engineer's facilities until he has received the approval of the
Engineer.

During the construction period the Contractor shall provide such temporary facilities as may be required by
the Engineer in the execution of his duties under the Contract. Alternatively the Engineer may make his
own arrangements for temporary facilities in which case the Contractor shall reimburse the Engineer for
the costs so incurred.

On completion of the Works in accordance with the Conditions of Contract the Engineer will instruct the
Contractor to remove those facilities not required during the Defects Liability Period. At the end of the
Defects Liability Period the Contractor shall remove the remaining facilities from site in accordance with the
Condition of Contract. All buildings, fittings, and furnishings provided for the use of the Engineer except
rented vehicle and laboratory equipment and those items provided by the Contractor for the proper
maintenance of the facilities or rented accommodation, shall become the property of the Contractor at the
end of the Contract.

1.5 **INSURANCE**

The Contractor shall provide, in the joint names of the Employer and the Contractor, insurance coverage
from the Start Date to the end of the Defects Liability Period, in the amounts and deductibles stated in the
Contract Data for the following events that are due to the Contractor's risks:

(a) loss of or damage to the Works and Materials;
(b) loss of or damage to Equipment;
(c) loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection
   with the Contract; and personal injury or death caused by the Contractor's act or omissions for:
   (i) anyone authorized to be on site
   (ii) third parties who are not authorized to be on site.

Policies and certificates for insurance are to be delivered by the Contractor to the Engineer for his approval
before the Start Date. All such insurance shall provide for compensation to be payable in the types and
proportions of currencies required to rectify the loss or damage incurred.

If the Contractor does not provide any of the policies and certificates required, the Employer may affect the
insurance that the Contractor should have provided and recover the premiums the Employer has paid from
payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be
a debt due.

Alterations to the terms of insurance shall not be made without the approval of the Engineer.

Both parties shall comply with all conditions of the insurance policies.
1.6 **QUALITY ASSURANCE PLAN**

The Contractor shall submit the Quality Assurance Plan (QAP) of the Works for the approval of the Engineer.

The Quality Assurance Plan should clearly set out working procedures, equipment, materials, workmanship, tests requirements, testing frequency the Contractor will adopt in carrying out the works so that the material and works are in compliance to the requirements of contract and as per the Technical Specifications. Only after receiving approval from the Engineer the Contractor shall proceed with the work.

The cost of this item will be borne by contractor himself.

2. **SITE WORK**

2.1 **SITE CLEARANCE**

2.1.1 Site Inspection by the Contractor

The bidder is recommended to carefully examine the site and to ascertain for himself the nature there of and the type of materials to be excavated.

2.1.2 Investigation of Site by the Contractor

The bidder may make any sub-surface exploration he desires prior to the Contract Agreement. Limited sub-soil investigations have been made by the Engineer. However, the Engineer makes no guarantee of the accuracy of the information. Its corrections shall not affect the provisions of the Contract.

2.1.3 Clearance of Site

The Contractor shall clear the parts of the Site subsequently to be occupied by the Works and shall maintain them clear of vegetation.

The Contractor shall not clear the Site of any structure without prior written permission of the Engineer.

Prior to the general clearance of Site the Contractor shall clear the Site to the extent required by the Engineer's Representative for checking the Works and setting out of the Works.

The Contractor shall fill and make good with appropriate materials those cavities and losses of soil which result from clearing the parts of the Site not subsequently to be occupied by the Works.

2.1.4 Disposal of Vegetation and Plants

The Contract shall dispose of the vegetation and plants obtained from the site clearance under Sub-Clause 2.1.3 above as approved by the Engineer. The disposal shall not be made in any instance to the river or lake or any other place which may cause pollution to the air, soil and water.

2.2 **SITE PROTECTION**

The Contractor shall enclose the entire work area allocated for construction and material storage with fencing suitable to prevent any unauthorized entrance to the site. The type of fence and location shall be approved by the Engineer.

The Contractor, at his own expense, shall supply and install a signboard conspicuously located at an approved site for public information regarding the project. The signboard shall be approximately 1200 x 2000 mm in size and contain the following information: the name of the Project, the names of the Employer, the Contractor and the Design and Supervising Consultant and the names of any specialized consultant or other information as directed by the Engineer.

The Contractor shall clear the building area and 6 metres beyond the foundations of all obstructions, loose stones and materials, rubbish and brush before starting construction. The Contractor shall dress the ground surrounding the building/s to a distance of 6 metres from the foundations cutting raised areas and filling holes and hollows up to maximum 300 mm. The Contractor, at the completion of the project, shall leave the Works clean and free of all blemishes and shall remove all rubbish and debris whether
construction waste or otherwise and dispose of as directed by the Engineer. No extra charges will be assessed for the removal of debris and dressing unless otherwise specified.

No tree or other plants, except brush, shall be cut without the explicit approval of the Client. The removal of any tree or plant shall be considered an extra item and paid for as such providing the tree or plant be not less than 900 mm in circumference measured 300 mm from the ground.

2.3 **TEMPORARY PROTECTION**

The Contractor will make all necessary provisions to effectively protect trenches, walls, newly laid concrete and other works from any damage due to inclement weather or accidents. All provisions to protect the work will be at the Contractor's own expense.

2.4 **MATERIAL SPECIFICATION**

2.4.1 **General**

2.4.1.1 **Quality**

All materials and equipment shall be the best quality available and shall conform to the requirements of above Specifications or, in case of ambiguity, Engineer's decision will be final. All material and equipment supplied and used in the Works shall be new, unless otherwise specified or permitted in writing by the Engineer and shall be fabricated, handled and used to the best standards and practices currently prevailing. Workmanship shall conform to the best practices currently prevailing and only those craftsmen capable of working with best practice methods shall be engaged in this Project.

2.4.1.2 **Sources**

The use of any kind or class of material from more than one source is prohibited, except by written permission of the Engineer. Such permission, if granted, will set forth the conditions under which the change may be made. The sources or kinds of materials shall not be changed at any time without written permission of the Engineer. If the product from any source proves unacceptable at any time, the Contractor shall make such arrangements as may be necessary to assure acceptable material, either by alterations in plant operations or by a change of source. Claims for increased costs, which maybe occasioned by such alterations or changes, will not be given consideration unless the source of the unacceptable material was designated in the Contract as a source of material. When any manufactured product, either new or used, is furnished by the Employer, the location at which such material will be delivered to the Contractor will be designated in the Contract. In such cases the Contractor shall transport the materials from the designated delivery point to point of use, and cost for such transportation will be considered included in the Contract unit price for placing the materials in the finished work.

2.4.1.3 **Brand Names**

Certain articles or materials to be incorporated in the work may be designated under a brand name or the name of a manufacturer or from a particular catalogue. The use of an alternative article or material that is of equal quality and of the required characteristics for the purpose intended will be permitted subject to the following requirements.

a. Contractor has to proof that materials/products are not being manufactured any more or any other valid reason.

b. The burden of proof as to the quality and suitability of alternatives shall be on the Contractor and he shall furnish all information necessary as required by the Engineer to verify. The Engineer shall be the sole judge as to the quality and suitability of all alternative articles or materials and his decision shall be final.

c. whenever the Specifications permit the substitution of a similar or equivalent material or article, no tests or action relating to the approval of such substitute material will be made until the Contractor submits in writing a request for substitution and submits all relevant information needed to verify the quality and suitability of the material or article proposed. Such request shall be made in ample time to permit approval without delaying the work.
3. **Material and Equipment Samples and Testing - General**

The Contractor shall keep records of all tests conducted in connection with compliance with the specification and shall supply copies of the results of such tests to the Engineer when required.

The quality of concrete and its constituent materials will be monitored by tests carried out in the Engineer's laboratory on samples provided by the Contractor or taken by the Engineer, all as detailed in Clause 3.5 hereof. In particular, the Engineer shall test for compliance of concrete under the terms of Clause 6.12 hereof and shall keep the register of test results so obtained for each class of concrete.

Samples required for tests in the Engineer's laboratory, or a nominated laboratory, shall be supplied and delivered by the Contractor in appropriate containers, suitably packed and labeled.

The Contractor shall examine all material and equipment and satisfy himself that the material and equipment conforms to the specified requirements before submitting to the Engineer for approval.

The Contractor shall submit samples of all material and equipment together with the manufacturers' specifications and test certificates to the Engineer's for his approval prior to commencement of the Works. At his discretion the Engineer's Representative may order independent tests to verify the quality of any particular item submitted for use in the Works by the Contractor, whether the manufacturer's test certificate has been submitted or not. Cost of such tests will be borne by the contractor.

The Contractor, at his own expense, shall provide all samples and facilities to the Engineer as may be required to collect, forward and test, either at the site or at any other testing facilities nominated by the Engineer, samples identified for verification. The Contractor shall not incorporate into the work the materials represented by the samples until the tests have been made and the materials are found to comply with the requirements of the Specifications, except that any materials that have a satisfactory record of compliance with the Specifications may, at the discretion of the Engineer, be used until the tests are completed. If the material fails to pass the tests, no further use thereof shall be made until the Contractor has taken steps approved by the Engineer to correct the deficiencies. Materials actually delivered to the site for incorporation in the work must conform to the standard of the approved samples and any deviation will be ground for re-testing at the Contractor's own expense.

3.1 **Testing Requirements**

The Contractor shall carry out all tests listed below or in any section of the Conditions of Contract and specification at his own cost in the laboratory specified by the Engineer:

i) **Concrete Testing** (the part and clause numbers refer to the tests or procedures as specified in BS 1881): -
   (a) Aggregate moisture tests for determination of water cement ratio
   (b) Slump tests
   (c) Compacting factor test
   (d) Making and curing test cubes
   (e) Compression testing of test cubes

ii) **Cement Testing** (the section numbers refer to the tests in BS 4550 Part 3): -
   (a) Compressive strength (mortar cubes)

iii) **Fine and Coarse Aggregate Testing** (the part and paragraph numbers refer to the tests as specified in BS 812): -
   (a) Silt, clay and dust fraction
   (b) Flakiness index
   (c) Elongation index
   (d) Water absorption
   (e) Particle size and grading
   (f) Silt content by field settling test
   (g) Aggregate crushing value
   (h) 10 per cent fines value
   (i) Soundness
   (j) Alkali-aggregate reactivity
   (k) Shrinkage
   (l) Soluble sulphates
iv) Water Testing
(a) Organic and inorganic matter in solution and suspension
(b) Sulphate content
(c) Alkali bicarbonate/carbonate

3.2 INSPECTION AND ACCEPTANCE OF MATERIALS AND EQUIPMENT

Final inspection and acceptance of materials will be made only at the site of the work. The Engineer reserves the right to sample, inspect and test materials throughout the duration of the work, and to reject any materials which are found to be unsatisfactory at the time of use. A preliminary inspection of materials may be made at the source for the convenience of the Contractor, but the presence of Engineer's or his representative at the source shall not relieve the Contractor of the responsibility of furnishing materials that comply with these Specifications. The Engineer and his representative shall have free entry at all times to those parts of any plant that concern the manufacture or production of the materials ordered.

3.3 DEFECTIVE MATERIALS AND EQUIPMENT

All materials and equipment that do not conform to the requirements of the Contract will be rejected whether in place or not. They shall be removed immediately from the site unless otherwise permitted by the Engineer. No rejected material shall be used in the work unless approved in writing by the Engineer. In the event the Contractor fails to comply promptly with any order by the Engineer to remove and replace the rejected material, the Engineer may remove the rejected materials by other means and deduct the cost thereof from any moneys due to the Contractor.

3.4 CONTRACTOR’S EQUIPMENT

All equipment including survey, measuring, testing and laboratory equipment; concrete mixers; concrete vibrators; mechanical compactors; measuring boxes; formwork and shuttering; props etc. shall be new or in ‘like new’ condition and maintained in ‘like new’ condition for the duration of the work under the scope of this Contract. Any equipment that has been damaged during the execution of work or declared unfit for service by the Engineer shall be replaced promptly with the same type of equipment in new or ‘like new’ condition.

3.5 STORAGE AND PROTECTION

All materials, equipment etc. shall be delivered in a manner as approved by the Engineer. The Contractor shall be responsible for the proper care and protection of all his materials, equipment etc. delivered at site. The contractor shall protect and be responsible for any damage to his work or material, from the date of the agreement until final certificate is made and shall make good without cost to the employer any damage or loss that may occur during this period. The Contractor shall handle all material as directed so that it may be inspected by the Engineer. All materials that may be affected by the weather shall be protected to keep them free from damage while they are being transported to the site. Should any material be found defective or in any way contrary to the contract, this material, no matter in what stage of completion, may be rejected by the Engineer and shall be removed from the premises at once.

3.6 MATERIAL STORAGE

The Contractor, at his own expense, shall provide safe, dry and proper storage facilities to protect material from damage, contamination and theft. Cement storage facilities at the site should be specially protected from any dampness and should accommodate minimum of 250 bags of cement. Reinforcing and structural steel must be protected from dampness and other corrosive elements. Sand and aggregate must be stored in the shed with brick paved floor, roof covering and side walls, so as to protect the material from rain and contamination by soil, leaves or any other foreign matter.

3.7 CONCRETE SAMPLING AND TESTING

The Contractor shall be responsible for providing samples of Concrete and its constituent materials either for testing by himself on behalf of the Engineer or for testing at the Engineer's or a nominated laboratory. For these purpose concrete test cubes which shall be made in accordance with BS 1881, Part 3, Clause 2, shall be deemed to be samples. All sampling of constituent materials shall be carried out in accordance with the provisions of the appropriate British Standard, and all sampling of fresh and
of hardened concrete shall be carried out in accordance with the provisions of BS 1881 unless such provision is at variance with the Specification.

The tests at the Engineer's or a nominated laboratory for which samples are required are those listed in Clause 3.03 (i), (ii), (iii), and (iv) above. Details of all such samples shall be recorded by the Contractor and passed to the Engineer. The frequency with which such samples are to be delivered to the laboratory shall be given by the Contractor in the form of a sampling plan. The Engineer will make available to the Contractor the results of each test carried out on the samples so provided.

The tests which the Contractor is required to undertake himself on behalf of the Engineer are those to be carried out on fresh concrete at the place of final deposit, or elsewhere on the Site as directed by the Engineer. These tests comprise slump tests to BS 1881, Part 2, Section 2. The contractor shall keep records of all such test results and supply copies of same to the Engineer. The frequency with which these tests are carried out shall be as directed by the Engineer in the form of a testing plan.

The Contractor shall also test aggregates for moisture content and so determine the water/cement ratio of the fresh concrete. Determinations of water/cement ratio shall be carried out as required by the Engineer and the results and calculations submitted to him.

From each such sample three concrete cubes shall be made; each cube shall be marked indelibly for identification when it is in the mould. After retention at the site of the structure for 24 hours the cubes shall be delivered to the Engineer's laboratory for removal from their moulds, curing and testing. Moulds will be returned to the Contractor for re-use. Sampling fresh concrete for such cubes shall be carried out by the Contractor in accordance with a sampling plan. The principles of this sampling plan shall be as follows:

The frequency of sampling for each class of concrete from each batching centre in each active day to be at the rate of:

(a) one sample from one batch of every 10 batches, or
(b) one sample per 10 cubic metres of concrete, or
(c) one sample

whichever involves the greatest number of samples. Where more than 20 cubic metres from one batching centre is placed in one location in one day, the rate of sampling may be decreased with the approval of the Engineer to one sample from one batch of every 20 batches or one sample per 20 cubic metres of concrete, whichever involves the greater number of samples. The actual rate of sampling may vary to the approval of the Engineer according to the random selection of batches to be sampled and shall be increased when ordered by the Engineer in appropriate circumstances. This will depend on size of batch for example from 10/7 cft drum type mixes to a batching plant of 30 m³ / Hour capacity. Therefore, minimum 5 Batch is O.K.

In addition to his other duties in connection with the sampling and testing of concrete the Contractor shall provide the instruments for, and record the temperatures of concrete, concrete materials and the atmosphere, as required by the Engineer, and copies of such records shall be supplied to the Engineer.

3.8 SAMPLES OF MATERIALS AND WORKS

The Contractor shall furnish for the approval of the Engineer any samples required by the Specifications or that may be requested by the Engineer, of any and all materials, equipment and works proposed for use in the project. All finished work shall conform to the approved samples and the requirements of the specification. The sample shall be maintained at the site for reference.

The Contractor shall provide for the approval of the Engineer samples of all construction materials and manufactured items required for the Permanent Works, if ordered. All samples rejected by the Engineer shall be removed from Site. All approved samples shall be stored on Site by the Contractor for the duration of the Contract, and any materials or manufactured items subsequently delivered to Site for incorporation in the Permanent Works shall be of a quality at least equal to the approved sample.

3.9 RESPONSIBILITY FOR SAMPLING AND TESTING

With regard to sampling, testing and the costs thereof, nothing in the foregoing shall be deemed to derogate from the responsibilities placed on the Contractor under the terms of Clause 33 of the Conditions of Contract.
3.10 **PROPRIETARY ARTICLES**

Where articles to be supplied from a particular manufacturer are specified, the Contractor may propose an alternative manufacturer if, at his own expense, he can prove to the Engineer's satisfaction that the articles to be supplied are of an equal or better quality. The Engineer's approval to an alternative manufacturer will not be unreasonably withheld.

3.11 **PACKAGING**

All materials, articles and items of fabricated and finished work of whatever description or kind for use in the Works shall be suitably packed for delivery to the satisfaction of the Inspecting Engineer. Each piece, package, bundle and crate shall be clearly marked before dispatch with its weight and description, together with the appropriate shipping mark.

3.12 **INSPECTION, SAMPLING AND TESTING COSTS**

Notwithstanding the provisions of Clause 34 of the Conditions of Contract all costs, except for the Inspecting Engineer's fees, incurred by the Contractor, in connection with inspection and sampling of materials and items shall be deemed to included and covered by the Contract Rates.

Notwithstanding the provisions for payment in respect of testing given in Clause 34 of the Conditions of Contract all costs in connection with conducting tests and delivery of samples to an approved laboratory shall be deemed to be included and covered by the Contract Rates for the following categories of tests:

i) Tests conducted at the premises of the Contractor, sub-contractor, manufacturer or supplier which are normally of customarily carried out at such premises for the items or materials being supplied for the Works;

ii) Tests which are normally or customarily conducted on the items or materials being supplied for the Works by the Contractor, sub-contractor, supplier or manufacturer but which have to be conducted at an approved laboratory because the necessary testing facilities are not available on the premises of the actual contractor, sub-contractor, supplier or manufacturer.

iii) Tests on locally obtained materials or items either on the Site or at an approved laboratory for the purposes of obtaining the approval of the Engineer to the classification, use and compliance with the Specifications of such items or materials.

iv) Routine quality control tests conducted by the Contractor to ensure compliance with the Specification.

v) Regular testing of concrete as specified in Chapter 8 of the Specification.

vi) Shop and Site acceptance tests, including trial assemblies, of mechanical equipment.

3.13 **INSPECTING ENGINEER**

The Engineer may appoint Inspecting Engineers to inspect and test materials and articles on his behalf prior to their dispatch to the Site. The Inspecting Engineer will examine, test and if necessary analyze all materials and articles to be used in the Works including all items of fabricated or finished work unless the Engineer shall direct otherwise. The Inspecting Engineer shall be granted free access at all reasonable times to the premises of the Contractor and/or any sub-contractor and shall be afforded every facility for making inspections, making tests, which it is normal or customary to undertake at the premises of the Contractor or sub-contractor and for taking samples for testing and analysis.

The Contractor and/or sub-contractor shall provide to the satisfaction of the Inspecting Engineer all appliances, apparatus and equipment required for the testing at his convenience of the materials and articles at their premises, and shall supply such samples and test pieces as may be necessary to enable tests and analyses to be made at the Inspecting Engineer's laboratory.

The Contractor and/or sub-contractors shall give adequate notice to the Engineer or the Inspecting Engineer as to when any materials, articles or fabricated work will be ready for inspection and shall take into account the possibility of delays in postal communications when giving such notice. Belated
requests by telephone or telex for an immediate inspection of particular items scheduled for shipment which cannot be met will be sufficient reason for waiving inspection thereof and the Contractor shall be held solely responsible for all consequences arising out of any delay resulting from his failure to give adequate notice.

3.14 NOTICE OF INSPECTION AND PROGRESS

The Engineer and the Inspecting Engineer shall be kept properly informed of the progress of any work being carried out on materials and articles being prepared or supplied by the Contractor or any sub-contractor for use in the Works to enable them to make such arrangements for inspection, testing and analysis as they may consider appropriate.

3.15 INSPECTION AGAINST APPROVED DRAWINGS

The inspection of all items of fabricated or finished work will be carried out only against drawings that have been approved by the Engineer and that bear his endorsement of approval.

Neither the Engineer nor the Inspecting Engineer will undertake the inspection of any item of fabricated or finished work until such time as the Contractor shall have forwarded to the Engineer the two paper prints and one unreduced transparency of the approved working or shop drawings covering the items to be inspected, together with two copies of the appropriate orders and sub-orders.

3.16 SAMPLES OF MATERIALS

In addition to any special provision made herein as to sampling and testing materials by particular methods, samples of materials and workmanship proposed to be employed in the execution of the Works may be called for at any time by the Engineer and these shall be furnished without delay by the Contractor at his own cost. Approved samples will be retained by the Engineer who will be at liberty to reject all materials and workmanship that are not equal in quality and character to such approved samples.

3.17 TESTS AT SITE

Notwithstanding the results of any examination or tests that may have been carried out on any materials and articles before dispatch to the Site, the Engineer’s Representative will be at liberty to carry out any further tests after delivery of such materials at the Site, and to reject any materials which fail to comply with the required quality or conditions.

3.18 PASSING CERTIFICATES

No materials, articles or items of fabricated or finished work to be supplied by the Contractor or by Sub-contractors which have been inspected and tested by the Engineer or the Inspecting Engineer shall be dispatched unless a passing certificate has been issued to the effect that the same are approved. Neither the Contractor nor Sub-contractors shall make use of any materials or articles ordered by them for the purpose of fabrication until such time as a passing certificate covering the said materials and articles shall have been issued by the Inspecting Institutions.

3.19 MATERIALS TO BE DELIVERED AT SITE IN ORIGINAL SHAPE

All materials shall be delivered on site intact in their original shape with manufacturers level, seal, packing etc. These materials are due for inspection by the Engineer and only after approval can be used in the respective works. All materials that has not approved shall be immediately removed from the site.

4. EARTHWORKS

4.1 EARTHWORKS EXCAVATION IN ANY MATERIALS

4.1.1 General

The Contractor shall make excavations in any material for the several parts of the Works and shall dispose of the excavated materials as shown on the Drawings, or ordered by the Engineer.
4.1.2 Scope

Earthwork in excavation in trenches, raft foundation, etc., in soil including dressing of sides, ramming of bottom, lift up to 2.0 meter stacking of excavated materials at least 4 meter clear from the building area and refilling with excavated soil in 150mm layers when required in plinth, under floors, sides of foundation, laying and depositing in layers by watering and ramming and then disposing of all surplus excavated soil as directed.

4.1.3 Workmanship

The foundation shall be dug to the dimensions and depth shown on the drawings except that the Engineer may direct the excavation to continue to a greater depth until, in his opinion, stratum of firm, stable soil is reached.

The excavation shall be carefully made to the levels, shapes and dimensions as shown or figured on the Drawings or as directed by the Engineer to receive the concrete work. Should any material be removed below the specified levels, the Contractor shall fill such excavation at his own expense with M10 concrete rammed in place up to the specified level. Filling with excavated material will not be allowed for this purpose.

If foundations are made broader or longer than directed, the extra length and breath, the Contractor, at his own cost, shall refill only after the foundations are built and the earth rammed hard.

The Contractor, at his own expense and without extra charge shall, make provision for all extra excavation in slope, pumping, dredging or bailing out water and these trenches shall be kept free from water while the foundation work is in progress.

The Contractor at his own cost shall remove such portions of boulders or rocks and the remains of the old dismantled structures as are required to make the bottom of the trench horizontal and level, Nothing extra shall be admissible separately in the Bill of Quantities. The Engineer shall inspect the excavations before any foundations are started and record the trench level. The filling in of side of trench excavations can be done in not more than 150mm layers. Each layer shall be watered and rammed hard before adding the next layer. Refilling shall be brought to the ground level without extra charge and shall form part of the item of excavation.

4.2 Notice to be Given Before Commencing Earthworks

The Contractor shall give to the Engineer at least seven days written notice of his intention to commence earthworks on any part of the Site. The earthworks shall not be commenced until the Contractor has received written approval from the Engineer.

4.3 Excavations to Dimensions

Excavation shall be to the dimensions and depths indicated on the Drawings or to such lesser or greater depths as the Engineer may deem necessary and so instruct the Contractor. Bottoms of all excavations for foundations shall be in sound soil. Bearing for all foundations, unless noted otherwise, shall be leveled.

4.4 Stripping and Replacement of Topsoil

Areas to be excavated or filled as well as borrow areas where material for filling is to be excavated, shall be stripped of topsoil containing organic or other unsuitable matter to a depth of at least 150 mm or to such greater depth as may be shown on the Drawings or as may be determined by the Engineer’s Representative, including grubbing up of roots. The topsoil shall be stockpiled and preserved in separate dumps or spoil banks for re-use as necessary.

4.5 Extent of Excavations

The extent of excavations shall be the minimum practicable in the opinion of the Engineer for the construction of the Permanent Works.

The construction of trenches for pipelines shall at any one time be limited to lengths previously approved by the engineer in writing. Except with the written approval of the Engineer, work on each approved
length shall be completed to the satisfaction of the Engineer before work on any new length is commenced.

4.6 **EXCAVATION OF UNSOUND MATERIAL**

If any unsound material occurs in the bed of foundations, the Contractor shall remove and dispose of it to the satisfaction of the Engineer. Unsound material shall include roots, organic matters, mud, gypsum, sand and deleterious substances. Unless otherwise specified or ordered by the Engineer, the Contractor shall fill the voids so formed with concrete Grade M10 for major structures and with compacted fill material for minor structures.

If the Contractor encounters any material, which in his opinion may be unsound, he shall immediately inform the Engineer who will instruct the Contractor in writing as to whether or not the said material shall be treated as unsound.

4.7 **SLIPS AND FALLS**

The Contractor shall exercise the greatest possible care and take all necessary precautions to prevent slips and falls of material from the sides of the excavation.

In the event of slips and falls occurring the Contractor shall make good all earthworks and associated works and execute any requisite modifications of the works to the satisfaction of the Engineer.

4.8 **OVER EXCAVATION**

Should the excavation be carried below required depths, it shall be filled to proper elevation only with concrete in accordance with Chapter - V. The additional costs under this requirements shall be at the Contractor’s expense. Other excavations carried below required depth shall be filled to the proper grade as specified herein for filling and back filling.

4.9 **TIMBERING OF FOUNDATION**

Whenever the risk of collapse exists such as in deep excavations or in loose, unstable soil, the sides of the trenches shall be protected by erecting timber shoring and structuring. Timbering shall be close or open depending on the nature of the soil and work. The arrangement of timbering, sizes and spacing of members shall be as directed by the Engineer. Nothing extra on this account shall be admissible which require special treatment for the purpose of excavation, and it shall be deemed to be included in the rate for excavation in soil. Ordinary pebbles or canker shall be taken under soil for which nothing extra shall be paid.

4.10 **SHORING OF EXCAVATION AND PROTECTION**

4.10.1 General

Excavations shall be shored and braced where necessary to prevent accident to persons, damage to structures, injurious caving or erosion. Remove shoring during back filling in a manner to prevent caving.

4.10.2 Implementation

Where necessary to do shoring, the Contractor shall be responsible for the design of shoring for proper excavation. Shoring shall be of sufficient strength to resist side pressure ensuring safety from slips, prevent damage to work and property and injury to persons. It shall be removed as directed after all the items for which it is required are completed. Near towns and all frequented places, foundation pits, well pits and similar excavation shall be securely fenced and marked with red lights at night in charge of watchmen to avoid accidents. Adequate protective measures shall be taken to see that the foundation excavation does not affect or damage adjoining structures. All measures required for the safety of the excavation, the people working in and near the foundation trenches, property and the people in the vicinity shall be the responsibility of the Contractor. The Contractor shall be entirely responsible for any injury to life and damage to property caused by his negligence or accidents due to his constructional operations.

No extra shall be paid in this connection unless otherwise specified.
4.11 PUMPING GROUND WATER AND RAIN WATER

4.11.1 General

Pumping and draining of ground water, surface water and rainwater shall be carried out as required during excavation and foundation work to keep the work free from standing water.

4.11.2 Implementation

Water pumping out from excavation for basement or any other water should be made as per site condition.

The Contractor shall not be paid extra for bailing out or pumping out of all water which may accumulate in the excavation during the progress of the work either from seepage, springs, rain or any other source and shall be removed after their purpose is served.

Pumping water from any foundation enclosure or trenches shall be generally in such a manner as to preclude the possibility of any damage to the foundation trenches, concrete or masonry or any adjacent structures. The excavation shall be kept free from water (i) during inspection and measurement, (ii) when concrete and / or masonry works are in progress and till they come above the natural water level and (iii) till the Engineer considers that the mortar is sufficiently set. If this work has not been implemented during construction works the reasonable amount of cost will be deducted from the claimed sum of contractor's bill.

4.12 FILL, BACKFILL FREE FROM ORGANIC MATTER

All organic matter, debris and refuse from earth obtained by site excavation shall be removed before using for fill and backfill. Use this material outside building only.

4.13 BORROW PITS

No borrow pits will be allowed to be opened on the site unless otherwise in writing by the Engineer.

4.14 LEVEL OF EXCAVATIONS (TRIMMING AND LEVELING)

4.14.1 General

No excavations or bottom of excavations shall be filled in or covered up until all measurements necessary have been made, inspected and approved by the Engineer.

4.14.2 Implementation

The bottom of all foundation should be trimmed and leveled in accordance with the Drawings. Bottom of the foundation shall be rammed and watered before concrete is deposited.

(i) Measurement to 2 Meters Depth

All excavations shall be measured correct to 10mm and be the product of the exact length and width of the lowest step of the footings according to the drawings or the Engineer's instructions and the depth measured vertically. Where the ground is not level, average depth shall be taken. Rate shall be inclusive of all the Works described above.

(ii) Measurement Greater than 2 Meters Depth

Separate payment will be made for extra lift from 2 -10 meters. Measurement shall be the exact length, breath and depth greater than 2.0 meters.

4.15 COMPACTION OF FILL, BACKFILL

4.15.1 General

All fill within the buildings shall be compacted to 95% modified proctor density and all fill and backfill outside the building to a density of 90% at optimum moisture content.
4.15.2 Implementation

Filling in plinth with imported materials in 150mm layers under floors including watering, ramming, consolidation and dressing, all complete.

Imported fill shall be approved by the Engineer prior to delivery at the site. The rate for imported fill shall include the cost for transport from a source up to 10 km from the project site. The sand shall be either pit sand or river sand as approved by the Engineer.

The work shall be done with earth/sand fill in 150mm layers, each layer being watered and rammed thoroughly. It shall include excavation of earth/sand, transportation, screening, if necessary, filling and the cost of labor, all complete.

4.15.3 Measurement

The measurement shall be taken for the consolidated thickness of earth/sand and paid in cubic meters. Pit or stack measurements shall not be taken for the purpose of payment. Quantity of earth fill under this item shall be arrived at by deducting the total quantity involved in foundation excavation from the total of earth filling required in trenches around foundations, over raft, under floors or any other filling.

4.16 Methods of Compaction of Fills

Fill shall be deposited in horizontal, uniform layers or such thickness as required by the nature of the soil or as directed, but not exceeding fifteen (15) centimeters uncompacted thickness. Compact each layer to uniform solid mass by rolling, tamping or other approved means. Compact each layer until no weaving or creeping takes place.

4.17 Moisture Content of Fill

The moisture content of the compacted fill shall be controlled to insure maximum density by either the addition of water or by harrowing and working the fill prior to compacting. No puddling will be permitted.

4.18 Record of Soil Strata

Records of the nature of the strata penetrated shall be kept and every facility and assistance shall be provided to the Engineer to obtain complete information concerning the type of material at each excavation.

4.19 Starting Level

The starting level for excavations shall be deemed to be ground level or the reduced level or bench marks provided.

4.20 Materials for Sub Drainage

The materials shall consist of one or a mixture of the followings natural gravel, crushed gravel, crushed quarry stone, and natural sand. The materials shall be graded with 30% to 80% passing the No. 8 sieve, 90% passing the 40 mm sieve and not more than 40% passing the No. 200 sieve by weight. The materials shall be free draining even when thoroughly compacted.

4.21 Drainage Layers

The drainage layer shall be continuous and shall be so placed that mingling with fill will be prevented. If required, planks or other suitable separators that can be withdrawn as the work progresses shall be kept between the drainage materials and the fill. The minimum thickness of the drainage layer shall be 30 cms unless otherwise shown on the Drawings.

4.22 Drainage Layer Around Pipes

Drainage layer surrounding drain pipes shall be placed in loose lifts not exceeding 15 cms and hand tampered to avoid damaging pipe.
4.23 **FILTER LAYERS AND WEEP HOLES**

The inlet and or all weep holes and drains shall be covered with filter materials to prevent migration of finer materials. Filter layers may be required between the drainage layer and fine-grained fill material as directed by the Engineer. Filter layer shall be a layer of successively finer granular materials, which can be placed behind coarser materials, the coarsest materials against the structure being gravels of size up to 75mm.

4.24 **DRAINAGE LAYER IN CONTACT WITH WATER PROOFED SURFACES**

In the event that a drainage layer is in contact with a waterproofed surface, a 10 cm layer of sand shall be placed between the surface and the drainage layer.

4.25 **SITE CLEARANCE**

4.25.1 **General**

Site clearance shall mean leveling and removal of all grass, shrubs, rubbish and any other plant, waste or foreign matter of any kind. The maximum depth of excavation or fill shall be 300mm.

The area extending 6 meters from the foundations around the building shall be dressed and leveled properly with an outward slope of 1 in 100. The surplus excavated material shall be disposed as directed. Removal of any trees or hedges shall be measured and paid separately.

4.25.2 **Measurement**

No extra payment

5. **CONCRETE WORKS**

5.1 **GENERAL**

5.1.1 **Standards and Codes of Practice**

All concrete work shall be carried out in accordance with British Standard Code of Practice 110 or IS 456 or equivalent NS unless otherwise specified herein.

5.1.2 **Costs of Testing and Sampling of Concrete and Concrete Materials**

The cost of all sampling, transport of samples and testing in connection with the concrete shall be in accordance with Clause 3.05 and where such costs are to be borne by the Contractor they shall be included in and covered by the Contract Rates for concrete.

5.1.3 **Failure to Meet Specified Requirements**

If the specified requirements have not been met, the Contractor shall take such remedial action as the Engineer or Engineer's Representative may order, and shall, before proceeding further with concreting, submit for their approval details of the action proposed to ensure that the concrete still to be placed in the works will comply with the specification.

5.2 **CEMENT FOR CONCRETE**

a) **Cement**

The cement used shall be ordinary Portland cement and shall conform in all respects with B.S.12 or IS 269. White or colored cement shall be of approved quality and chemical composition shall conform with IS 269.

b) **Packing**

The cement shall be packed in six-ply paper bags or as approved in plastic bags of approved quality and the net mass of each bag shall be not less than 50 kg. The permissible tolerance on the mass of cement supplied in bags shall be + 2.5% per bag with an overall tolerance of + 0.5% per 10 tones wagon load of bagged cement.
**c) Delivery of cement and storage**

The cement shall be delivered in the manufacturer's sealed and branded bags in quantities sufficient to insure that there is no suspension or interruption of the concrete work and stored separately in dry weatherproof, well-ventilated stores raised above ground level and shall at all times be carefully protected from moisture. The Cement shall be stored in such manner that each consignment may be easily inspected and identified and used in the order of its delivery.

**d) Records, certificates and Samples**

Prior to the delivery to the site, the contractor shall supply the manufacturer's test certificates shall be furnished to the Engineer, and as directed by the Engineer, the contractor shall furnish, free of cost, test certificates relating to the cement to be used on the work. Each certificates shall indicate that the sample has been tested by an approved firm and that it conforms in all respects with the relevant specification BS12 or IS 269-1967. Analysis of the cement shall be shown.

The Contractor shall forward a weekly report to the Engineer's Representative giving full particulars of the various consignments in store.

The Contractor shall maintain a record available for inspection by the Engineer's Representative of the locations of concrete made from each consignment.

The Contractor shall supply samples of cement for test and send them for testing by the inspecting Engineer when requested by the Engineer's Representative both from the Contractor's store on Site and from the place of manufacture.

### 5.3 AGGREGATES

**(a) Supply and Classification**

The Contractor shall make his own arrangements for procuring, crushing, grading and delivering aggregate for the works as required from sources to be approved by the Engineer's Representative.

Separate fine and coarse aggregates shall be used for the manufacture of concrete. The term 'fine aggregate' is used to designate aggregate mainly passing a 5.00 mm, BS 410 test sieve and containing only so much coarser materials as is permitted for the various grading zones given in Table 5.2. The term 'coarse aggregate' is used to designate well graded aggregate mainly retained on a 5.00 mm BS 410 test sieve and mainly passing a 37.50 mm, BS 410 test sieve and only containing much coarser or finer materials as is given in Table 5.1.

Coarse aggregate shall be supplied in the following primary sizes:

<table>
<thead>
<tr>
<th>Size designation</th>
<th>Nominal size range</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5 mm to 10 mm</td>
</tr>
<tr>
<td>20</td>
<td>5 mm to 20 mm</td>
</tr>
<tr>
<td>40</td>
<td>20 mm to 40 mm</td>
</tr>
</tbody>
</table>

Aggregates shall be graded to produce workable dense concrete.

**(b) Quality**

All aggregates to be used in concrete shall be clean, hard, dense, sound, chemically inert, of limited porosity and uncoated particles as free clayey or organic matter.

- Grading: in accordance with Tables 5.1 and 5.2 herein
- Mechanical Properties: when tested in accordance with BS 812, part 3, the 'Ten per cent Fines Value' shall be not less than 5 Kg.
- Silt, Clay and Dust Fraction: when determined in accordance with the decantation method given in BS 812, Part 1 the silt, clay and dust fraction by weight shall not exceed 1% for coarse aggregates, 3% for natural sand or crushed sand and 15% for crushed sand.
- Water Absorption: when tested in accordance with BS 812 Part 2 the water absorption after 24 hours shall not exceed 4%.
- Aggregate impact Value: when determined in accordance with BS 812 Part 3 shall not exceed 45%.
- Soundness: when tested in accordance with the sodium sulphate soundness test specified in ASTM C88 the aggregate shall have a percentage loss of less than 15.
- Alkali-aggregate Reactivity: when tested in accordance with ASTM C-289 aggregate exhibiting evidence of alkali aggregate reactivity will not be acceptable unless the Contractor can show that the proposed cement aggregate combination, when tested in accordance with ASTM C277 of other tests, will not produce deleterious alkali-aggregate reactivity, as to which the Engineer shall be the sole judge.
- Shrinkage: when determined in accordance with the BRE Digest 35 test the drying shrinkage shall not exceed 0.065%.
- Mica Content: shall not exceed 0.5% by weight or as otherwise approved by the Engineer.

(c) Testing
Testing of aggregates is to be in accordance with BS 812 or as specified herein.
For each source of aggregate and at least four weeks prior to the preparation of trial mixes samples of aggregates together with the results of the tests listed below shall be submitted to the Engineer's Representative for approval of the sources of aggregate and quality:
- Grading analysis to BS 812, Part 1.
- Mechanical properties. Ten per cent Fines Value Test to BS 812 Part 3.
- Silt, clay and dust fraction in both fine and coarse aggregates decantation method to BS 812, Part 1.
- Specific gravity and water absorption to BS 812 Part 2.
- Sodium sulphate soundness test to ASTM C227 and/or ASTM 289.
- Chloride content test to BS 812, Part 4.
- Mica content (method to be notified)
- Flakiness and elongation indices to BS 812, Part 1.
- Shrinkage test to BRE Digest 35 (2nd series).

Approval of a source of aggregate by the Engineer's Representative shall not be construed as constituting the approval of all materials to be taken from that source and the Contractor shall be responsible for the specified quality of all such materials used in the Works. The Contractor shall not obtain aggregates from sources which have not been approved by the Engineer or given in the Bill of Quantities. The maximum size of coarse aggregate in concrete for any part of the Works shall be the largest of the sizes given in Table 5.1 the use of which is practical from the standpoint of satisfactory workability and consolidation of the concrete. The Contractor shall obtain the approval of the Engineer's Representative to the maximum size of aggregate for each section of the Works.

(d) Storage
The contractor shall provide means of storing the aggregates at each point where the concrete is made such that (a) each nominal size of coarse aggregate and the fine aggregate shall be kept separated at all times (b) contamination of the aggregates by the ground or other foreign matter shall be effectively prevented at all times and (c) each heap of aggregate shall be capable of drain freely.

The contractor shall ensure that the graded coarse aggregates are tipped, stored and removed from the store in a manner that does not cause segregation.

Wet fine aggregate shall not be used until, in the opinion of the Engineer, it has drained to a constant and uniform moisture content, unless the Contractor measures the moisture content of the fine aggregate continuously and adjusts the amount of fine aggregate and the added water in each batch of concrete mixed to allow for the water contained in the fine aggregate. If necessary to meet the requirements of this clause, the Contractor shall protect the heaps of fine aggregate against inclement weather and floor to be made of brick and sloping outwards.

The contractor shall make available to the Engineer such samples of the aggregate as he requires. Such samples shall be collected at the point of discharge of the aggregate to the batching plant. If any such sample does not conform with the specification, the aggregate it represents shall be promptly removed from the site and the contractor shall carry out such modifications to the storage arrangements as may be necessary to secure compliance with the specification.

(e) Coarse Aggregates
Coarse aggregate shall consist of crushed rock. Friable and flaky pieces such as mica and shale shall not be present. Coarse aggregates shall be well graded within grading given in Table 5.1 and to the satisfaction of the Engineer's Representative.
TABLE 5.1: Grading of Coarse Aggregates

Percentage by Weight Passing Standard Sieves BS 410

<table>
<thead>
<tr>
<th>Standard</th>
<th>10mm to 5 mm</th>
<th>20mm to 5mm</th>
<th>40mm to 5mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>37.5</td>
<td>-</td>
<td>100</td>
<td>95-100</td>
</tr>
<tr>
<td>20.0</td>
<td>100</td>
<td>95-100</td>
<td>35-70</td>
</tr>
<tr>
<td>10.0</td>
<td>85-100</td>
<td>30-60</td>
<td>10-40</td>
</tr>
<tr>
<td>5.0</td>
<td>0-25</td>
<td>0-10</td>
<td>0-5</td>
</tr>
</tbody>
</table>

(f) Fine Aggregates

Fine aggregate shall consist of natural sand or a mixture of natural sand and crushed gravel or crushed rock. The Engineer's Representative will permit the addition of crushed gravel or crushed rock fine aggregate to the natural sand only where in his opinion it is impracticable to obtain the required fine aggregate grading otherwise than by such addition.

The grading of the fine aggregate shall lie within one of the grading zones as set out in Table 5.2 below and specified in BS 882

TABLE 5.2: Grading of Fine Aggregates

Percentage by Weight Passing Standard Sieves

<table>
<thead>
<tr>
<th>BS 410 Standard Zone Mesh</th>
<th>Grading Zone 1</th>
<th>Grading Zone 2</th>
<th>Grading Zone 3</th>
<th>Grading Zone 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00 mm</td>
<td>90-100</td>
<td>90-100</td>
<td>95-100</td>
<td>90-100</td>
</tr>
<tr>
<td>5.00 mm</td>
<td>60-95</td>
<td>75-100</td>
<td>85-100</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>30-70</td>
<td>55-90</td>
<td>75-100</td>
<td>90-100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>15-34</td>
<td>35-59</td>
<td>60-79</td>
<td>80-100</td>
</tr>
<tr>
<td>0.600 μm</td>
<td>5-20</td>
<td>8-30</td>
<td>12-40</td>
<td>15-50</td>
</tr>
<tr>
<td>0.300 μm</td>
<td>0-10</td>
<td>0-10</td>
<td>0-10</td>
<td>0-15</td>
</tr>
</tbody>
</table>

5.4 WATER FOR MAKING CONCRETE, ETC.

Water used in mixing concrete, mortar or grout shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials or other substances that may be deleterious to concrete or steel. The water shall be to the approval of the Engineer's Representative and in accordance with BS 3148, including Appendix B thereof.

The Contractor shall, at least four weeks prior to the making of the trial mixes, sample the water he proposes to use and carry out test and deliver the test certificate the Engineer's Representative.

5.5 CHEMICALS IN CONCRETE

The total sulphate content, whether as gypsum or more soluble salts, of the concrete ingredients when measured as sulphur trioxide shall not exceed 4% of the weight of cement in the concrete.

The chloride of the concrete ingredients when measured as chloride ion shall not exceed 0.2% of the weight of cement in the concrete.

If instructed by the Engineer's Representative the Contractor shall obtain samples from the concrete for testing, all in accordance with BS 1881, Part 6. The cost of sampling and transport shall be covered by the Contract Rates for concrete.

5.6 ADDITIVES

5.6.1 General

Concrete shall be made from cement, aggregates and water as specified. No other ingredient shall be mixed with the concrete or mortar without the Engineer's approval.
If the use of retarding or workability agents is approved by the Engineer their use shall be subject to the following conditions:

- there shall be no reduction in characteristic strength at 28 days compared with additive free concrete of the same grade and class
- there shall be no reduction of minimum cement content specified and
- the use of the admixture shall be strictly in accordance with the manufacturer's instructions in respect of the conditions at the Site. Admixtures shall be introduced to the concrete by approved dispenser.

The contractor may use a retarder to facilitate the preparation of construction joints subject to the approval of the Engineer of the composition of the retarder and its method of application.

5.7 ADMIXTURE

Admixture shall mean material added to the concrete materials during mixing for the purpose of altering the properties of the concrete mix.

If the contractor wishes to use admixtures, otherwise than as expressly ordered by the Engineer, he shall first obtain the Engineer's written permission. The methods of use and the quantities of admixture used shall be subject to the Engineer's approval, which or otherwise shall in no way limit the contractor's obligations under the Contract to produce concrete with the specified strength and workability

**Technical Specification of Silica Cement Admixture**

Product Name: Silica Cement Admixture
Materials: Natural Volcano Ash
Chief ingredient: SiO2 above 85%
Characteristic of the Material: Amorphous (shapeless)
Particle size: 0.4 um
Specific surface area by Blaine: 60,000 cm2/gram
Colour: White
Ratio: 5% amount of Cement

5.8 PRE-CONSTRUCTION ANTI-TERMITE CHEMICAL TREATMENT (NOT APPLICABLE)

5.9 STEEL REINFORCEMENT

5.9.1 Scope

Supplying and fixing deformed high strength steel reinforcement in reinforced cement concrete (RCC) work including supply, storage, cutting, bending, binding with wire, placing in position including the cost of binding wire, all complete as per design and the instructions of the Engineer.

Supplying and fixing mild steel reinforcement grade 1 conforming to IS 432-1966 in reinforced cement concrete (RCC) work including supply, storage, cutting, bending, binding with wire, placing in position including the cost of binding wire, all complete as per design and the instructions of the Engineer.

5.9.2 General

Reinforcement shall be free from pitting due to corrosion, loose rust, mill scale, paint, oil, grease, adhering earth, ice or other materials that may impair the bond between the concrete and the reinforcement or that may in the opinion of the Project Engineer cause corrosion of the reinforcement or cement grout.

5.9.3 Bar Reinforcement

Bar reinforcement described as “Mild Steel” shall be plain round hot rolled steel bars. Bar reinforcement described as “Deformed Steel” shall be hot rolled deformed bars and cold twisted. With respect to manufacture, quality, physical properties and related requirements, reinforcement bar of the foregoing descriptions shall comply with appropriate parts of IS & BS Standards for Mild Steel and Deformed Steel respectively.
5.9.4 Quality

Steel for the reinforcement of concrete shall be hot-rolled bars or cold twisted bars complying with latest revising BS 4449, 1139 - 1966 or IS 432 and IS 1786 for mild steel, tor-steel and TMT respectively.

5.9.5 Testing and Test Certificates

Reinforcing steel ordered from the mills shall be examined at the mills by the Inspecting Engineer and, wherever possible, and unless otherwise approved shall be tested in his presence in accordance with BS 4449. Two copies of all works tests certificates relating thereto shall be forwarded to the Inspecting Engineer.

In the case of steel not tested in the presence of the Inspecting Engineer, whether ordered from the mills or from stockholders, copies of works test certificates shall be supplied as prescribed herein and the Engineer or the Inspecting Engineer reserves the right to carry out such further tests as he may consider necessary.

Copies of the Inspecting Engineer's test certificates or works test certificates in respect of each consignment of steel reinforcement delivered to site shall be supplied to the Engineer's Representative prior to delivery of reinforcement to the Site. Every consignment and its related test certificates shall carry reference markings such that they are uniquely identified.

The Contractor shall supply samples of reinforcement from the stocks on Site when required by the Engineer's Representative and shall forward the samples to the Inspecting Engineer for testing as directed at the cost of Contractor.

5.9.6 Storage and shape of supply

Reinforcement shall be stored clear of the ground and supported to prevent distortion.

At the time of incorporation in the Works, reinforcement shall be clean and free from defects, oil or grease, loose mill scale and loose rust, or any other substance, which may adversely affect the steel, concrete or reduce bond.

Bars, which have become bent, shall not be straightened or re bent for incorporation in the Works. All bars should be supplied in straight form from the manufacturing plant. Bars in coils or folded shall not be used in the permanent works unless otherwise specifically approved by the Engineer.

5.9.7 Dimensions of Reinforcement Bars

The diameter of reinforcement bars described on the Working Drawings or elsewhere shall be the minimum and the rolling margin and other tolerances shall be above this size. The length of a reinforcement bar shall be not less than the length on the drawing or elsewhere specified and shall not be more than 50 mm in excess of that length. The Contractor shall prepare a bar-bending schedule based on the design and submit for approval to the Engineer prior to executing the work. The cost for preparing the bar-bending schedule is deemed to be included in the rate for steel reinforcement and no extra shall be paid for this work.

5.10 Classes and Grades of Concrete

The concrete used in the Works shall be of the grades or classes shown on the Drawings or indicated in the Bill of Quantities or ordered by the Engineer.

The characteristics of the mixes of concrete to be used in the works shall be as given in Table 5.3 unless otherwise approved by the Engineer.

5.11 Maximum Sizes of Aggregate to be Used

Unless shown on the Drawings or given in the Bill of Quantities the maximum size of coarse aggregate in concrete for any part of the Works shall be the largest of the sizes given in Table 5.3 the use of which is practical from the standpoint of satisfactory workability and consolidation of the concrete.
5.12 MIXES OF CONCRETE

The concrete strengths shown in the Bill of Quantities are the strengths required for the various items of work. These strengths shall be strictly adhered to. Quantity of water shall be adjusted to compensate for the moisture content in aggregates.

The Contractor, at his own expense, shall prepare a mix design prior to starting any concrete work. Only those materials approved by the Engineer for use in the work shall be used to produce a mix design. The Contractor shall provide at his own cost sufficient quantity of approved materials to the Engineer to prepare 15 test cubes and for independent testing of the approved mix. The compressive strength results shall meet the requirement indicated in sub-clause 2.4. In case the strength requirement is not met, the source of materials shall be changed until the requirement is met without changing the proportions. If the source of materials is changed further laboratory tests shall be carried out.

During casting, test cube samples shall be made in sufficient number to test at 3, 7, and 28 days. At least cubes are required for each day of testing. In no case shall the 28 days cube strength be less than that mentioned in the Bill of Quantities. At least nine cubes shall be taken for each element of structure, e.g., footing, column and beam. Additional cube tests to be carried out shall be at the discretion of the Engineer's Representative.

5.13 COMPRESSIVE STRENGTH COMPLIANCE

The compressive strength of the concrete shall be based on the compression testing of 150 mm concrete cubes, made and tested in accordance with Chapter 3 of this Specification.

The compressive strength of the concrete is specified by the characteristic compressive strength; Table 5.3 lists the values for each grade of concrete.

The characteristic compressive strength of the concrete is the value of the cube compressive strength, when tested at an age of 28 days, below which not more than 5% of results shall fall.

The concrete in the Works shall be considered to comply with the commotion as to which the Engineer's Representative shall be the judge; but lifts shall not normally exceed 1.5m for members more than 1.5m in height.

Where steps, splayes and kickers occur these shall be cast in one continuous sequence with the slab/beam and additional care shall be taken during vibration and finishing to ensure that thorough compaction is achieved.

All concrete shall be compacted to produce a dense homogeneous mass.

Any concrete, which has reached a temporary set or has become so stiff that proper placing without tempering cannot be assured, shall not be used.

Concrete having required characteristic strengths greater than 10 N/Sq. mm shall be compacted by mechanical vibrator. Vibration shall not be applied by way of the reinforcement and every care shall be taken to avoid contact with the reinforcement. The Contractor shall provide sufficient vibrators, in serviceable condition, so that standby vibrators are always available in the event of breakdowns. The number and type of vibrators used on concrete placement shall be to the approval of the Engineer's Representative.

Where immersion type vibrators are used, they shall have a minimum frequency of vibration of 7000 revolutions per minute when immersed in the concrete. Form vibrators shall be securely fastened to the forms and shall operate at speeds of at least 8000 revolutions per minute when vibrating concrete. Concrete shall not be subjected to vibration between it taking its initial set and 24 hours after compaction. Vibrators shall not be used to move concrete along the forms. Over vibration causing segregation, surface laitance and leakage through formwork shall be avoided.

Concrete having required characteristic strengths not greater than 10 N/sq.mm may be compacted by hand but shall be deposited in layers not exceeding 300 mm in thickness and shall be well worked with special tools and rods until it has settled closely in place and is free from air bubbles.

Except where otherwise directed concrete shall not be placed unless the Engineer's Representative or his representative is present and has previously examined and approved the positioning, fixing and
condition of the reinforcement and of any other items to be embedded, and the cleanliness alignment and suitability of the containing surfaces. At least 24 hours notice shall be given in writing to the Engineer's Representative of the placing of concrete and request for approval to concrete.

**Strength Requirements:**
Where ordinary Portland cement conforming to IS: 269 - latest revision or Portland cement- Furnace Slag cement conforming to IS: 455 - (latest revision) is used, the compressive strength requirements for various grades of concrete shall be as shown in Table - IV and shall apply to both controlled concrete and ordinary concrete.

The acceptance of strength of concrete shall be as per clause 5.4 “Sample size and Acceptance Criteria” of IS: 456 - latest revision subject to the stipulations and/or modifications stated elsewhere in this specification.

The Contractor, at his own cost, shall dismantle and replace as per specification all work found unsuitable. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good free of charge by the Contractor to the satisfaction of the Engineer.

Compressive strengths for different grades of concrete are specified in Table - IV and shall always refer to the cube strength. Other requirements of concrete strength as may be desired by the Engineer shall be in accordance with IS: 456 (latest revision).

**Strength Requirement of Concrete**

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Compressive strength of 15 cm. cube at 28 days after mixing in accordance with IS: 456 - latest revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 15</td>
<td>Preliminary tests N/mm² 20</td>
</tr>
<tr>
<td>M 20</td>
<td>Work test N/mm² 26</td>
</tr>
<tr>
<td>M 25</td>
<td>32</td>
</tr>
</tbody>
</table>

With permission of the Engineer, for any of these above mentioned grades of concrete shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment for the additional cement will be made.

5.14 **WORKABILITY**

The workability of the concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer, alternatively, the compacting factor test in accordance with IS: 1199 - (latest revisions), shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around on the type and nature of structure shall be based on experience and tests within the preferred limits of consistency as specified in Table below for various types of structures.

**Limits of Consistency**

<table>
<thead>
<tr>
<th>Degree of Workability</th>
<th>Slump in mm</th>
<th>Use for which Concrete is Suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Min. 20</td>
<td>Mass concrete foundations without vibrations, simple reinforced section with vibration.</td>
</tr>
<tr>
<td></td>
<td>Max. 40</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Min. 50</td>
<td>Normal reinforced beams, columns, slabs without heavily reinforced section with vibration.</td>
</tr>
<tr>
<td></td>
<td>Max. 100</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Min. 100</td>
<td>Section with congested reinforcement not normally suitable for vibration.</td>
</tr>
<tr>
<td></td>
<td>Max. 150</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The slump to be obtained for work in progress shall be as per the instruction of the Engineer.

5.15 **LOAD TEST**

Load test of structural members may be required by the Engineer when the strength of job control cubes falls below the required strength and is not acceptable as per “Acceptable Criteria” of IS: 456 - (latest revision). If the load testing is decided by the Engineer, the member under consideration shall be subjected to a superimposed load equal to one and quarter (1.1/4) times the specified superimposed load used for design and this load shall be maintained for a period of 24 hours before removal. The detailed procedure of the test is to be decided by the Engineer.
If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made free of cost. If on the other hand, the failure becomes evident, the Engineer under special circumstances (with the approval of the designer), can retain the portion of the structure under test, provided suitable modification for strengthening and/or dispersion of design load is feasible. Cost of such modification of dispersion of load shall be borne by the Contractor.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable it shall be dismantled and replaced by a fresh structure as per specification. The cost of dismantling and the cost of concrete, formwork and reinforcement involved in the dismantled portion shall not be paid to the Contractor.

If in the course of dismantling, any damage is done to the embedded items and or other adjacent structures the same shall be made good free of charge by the Contractor to the satisfaction of Engineer.

5.16 WORKMANSHIP

General: All workmanship shall be according to the latest and best possible standards.

5.16.1 Mixing of Concrete

The proportion of fine and coarse aggregate, cement and water shall be as determined by the preliminary tests or according to fixed proportions in case of ordinary concrete and shall always be approved by the Engineer. The quantities of fine and coarse aggregates shall be determined by weight. The water shall be measured accurately after giving proper allowance for surface water present in the aggregates for which the Contractor shall make regular checks. Due allowance shall be made for bulking in case of volume batching in accordance with IS 2386 (Part III) - (latest revision).

Concrete shall be always mixed in a mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant structures. Unless otherwise approved by the Engineer, the water shall not be poured into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is uniformity in color and consistency, but in no case shall mixing be done for less than two minutes and at least forty revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. The mixer shall not be loaded above its rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredient for the next batch is fed into the drum. No partly set, re-mixed or excessively wet concrete shall be used and it shall be immediately removed from site.

Each time the work is stopped, the mixer shall be thoroughly cleaned and when the next mixing commences, the first mix shall have 10% additional cement at no extra cost to allow for loss in the drum.

When hand mixing is permitted by the Engineer for concrete in unimportant structures, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in color and consistency. In case of hand mixing, 10% extra cement shall be added to each batch with no extra cost.

5.16.2 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of final deposit as rapidly as practicable by approved means before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. If segregation does occur during transport, the concrete shall be re-mixed. During very hot or cold weather, the Engineer may specify deep containers in which the concrete shall be transported to reduce water loss of by evaporation and loss of heat. Conveying equipment for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipment shall be kept free from set concrete.
5.16.3 Placing Concrete

Prior to placing any concrete the Contractor shall obtain approval in writing from the Engineer for the formwork and reinforcement. Concrete shall be placed in its final position without segregation. The forms shall be well wetted and all shavings, dirt, water and foreign matter that may have collected at the bottom shall be removed before concrete is placed. The interval between adding the water to the dry materials in the mixer and the completion of the final placing inclusive of compaction of the concrete shall be not more than initial setting time of the cement, normally 30 minutes for ordinary Portland cement. The concrete shall be well placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner that may cause segregation. Any drop above 180 cm shall have to be approved by the Engineer. Once the concrete is placed in its final position, it shall not be disturbed. After the concrete has been placed, it shall be spread and thoroughly compacted by approved mechanical vibration to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the concrete form and shape. Vibration shall not be used to spread the concrete. Vibration must be operated by experienced personnel and over vibration shall not be permitted. Hand tamping in some cases may be allowed subject to the approval of the Engineer.

Concrete shall not be placed in open areas during a period of rainfall. If there has been any sign of separation of cement and sand by washing, the concrete shall be entirely removed immediately. Suitable precautions shall be permitted on freshly laid concrete to prevent any rainwater damage. Slabs, beams and similar members shall be poured in one operation normally. Bleeding of under layer, if any shall be effectively removed. Moulding, throating, drip coarse, etc. shall be poured as shown on the drawing or as directed by the Engineer. Holes shall be provided and bolts sleeve, anchors fastenings or other fixtures shall be embedded in concrete as shown on the approved drawings or as directed by the Engineer. Any deviation from the drawing shall be set right by the Contractor at his own expense as instructed by the Engineer.

Concrete shall be rebated at the joint to such shape and size as may be required by the Engineer or as shown on the drawing. All vertical construction joints shall be made with step boards that are rigidly fixed and slotted to allow for the passage of the reinforcing steel. If desired by the Engineer keys and/or dowel bars shall be provided at the construction joints. In the case of water retaining structures water stops of approved material shall be provided if so specified in the drawings or desired by the Engineer. Construction joints shall be provided in positions as described, the joints shall be in accordance with the followings:

In a column, the joints shall be formed about 75mm below the lowest soffit of the beams forming into it.

Concrete in a beam shall be placed throughout without a joint, but if the provision of a joint is unavoidable, the joint shall be vertical at the point of balanced moment along the span. A joint in a suspended floor slab shall be vertical at the face of balanced moment and at right angles to the principal reinforcement. The locations of construction joints shall be planned by the contractor well in advance of pouring and will have to be approved by the Engineer.

Before fresh concrete is placed the cement skin of the partially hardened concrete shall be thoroughly removed and surface made rough by hacking, sand blasting, water jetting, air jetting or any other method as directed by the Engineer. The rough surface shall be thoroughly wetted for about two hours and shall be dried and coated with 1:1 freshly mixed cement sand slurry before placing the new concrete. The new concrete shall be worked against the prepared surface before the slurry sets. Special care must always be taken to see that the first layer of concrete placed after a construction joint is cold.

Joints during pour shall be treated with 1:1 freshly made cement sand and bonding agent. Slurry only after removing all loose materials. Bonding agent type and make has to be approved by the Engineer.

5.16.5 Protection and Curing of Concrete

Newly placed concrete shall be protected by approved means from rain, sun and wind. As soon as the concrete has hardened sufficiently for the surface to be marked, it shall be covered either with sand, hessian, canvas or similar materials and kept continuously wet for at least fourteen days after final setting. This period may be extended at the discretion of the Engineer.
5.16.6 Control Tests on Concrete

The Contractor shall cast nine test cubes for each type of work for each 8-hour period or less of concreting. If the value of concrete poured is less than 20 cubic meters on any day per mixing plant, the Engineer may exempt or reduce the number of test Cubes. The samples of concrete shall be tested in an approved laboratory in presence of the Engineer and the test results shall be submitted in triplicate to the Engineer. The Contractor shall carry out the sampling and testing according to the provisions of this specification at his own cost. No payment shall be made for the concrete cast in test cubes.

To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor free of charge every two hours or as directed by the Engineer. The amount of mixing water shall not be changed without prior approval of the Engineer. Slump of the concrete for each test cube shall be recorded for reference. The Engineer if so desires may order special tests to be carried out on cement, sand or coarse aggregates, water, reinforcing steel, or traverse tests in accordance with ISI recommendations. If the materials tested is found to be suitable for the intended use, the cost of these special tests shall be borne by the Employer. If the material is found not suitable for the intended use the cost of these special tests shall be borne by the Contractor. Further, during the progress of the work if the Engineer has any doubt about the quality of any material in use he may instruct suspension of its use until the material is found acceptable by approved testing methods. Any consequent loss arising out of the suspension shall be borne by the Contractor.

5.16.7 Exposed Surface

The Contractor shall patch, immediately after stripping formwork, with 1:1 mortar mix and rub smooth with carborundum stone surfaces having honeycomb or cavities in areas where strength is not critical. The Contractor shall also remove fins and projections and rub smooth the concrete surface all to the satisfaction of the Engineer. In sections critical to the stability of the structure, the Engineer shall determine the extent of the defects and may either direct the work to be replaced or direct it to be repaired by pressure grouting. In the case where the Engineer determines that pressure grouting is sufficient to rectify the work, the Contractor shall engage a professional company approved by the Engineer to undertake the work all at the Contractor’s own cost.

5.17 BENDING SCHEDULES

The Contractor shall ascertain for himself from the information given on the Drawings and in the Specification the precise requirements of steel reinforcement to be obtained for the Permanent Works. From the information provided the Contractor shall prepare Working Reinforcement Drawings and Bending Schedules and shall submit these to the Engineer for his approval at least one month prior to commencement of fixing the reinforcement. In preparing the Working Reinforcement Drawings the Contractor shall keep laps to the minimum number and length required. No additional payment will be made for laps, which in the opinion of the Engineer are unnecessary for construction of the Works.

5.18 CUTTING, BENDING AND FIXING REINFORCEMENT

Reinforcement shall be cut from straight bars and cold bent, using a bending machine approved by the Engineer. Cutting, bending and marking shall be in accordance with BS 4466 unless otherwise specified, or ordered by the Engineer.

The Contractor shall place and fix reinforcement accurately in the positions shown on the approved reinforcement detail drawings, and shall ensure that it remains in position during the placing of concrete.

Reinforcement projecting from previously cast concrete must not be bent without the prior approval of the Engineer.

All reinforcement shall be supplied in the full lengths indicated on the Drawings. No splicing of bars, other than in locations shown on the Drawings, will be permitted without the approval of the Engineer.

All reinforcement left exposed for future work shall be protected against exposure and corrosion to the approval of the Engineer.

5.19 COVER TO REINFORCEMENT

The cover to reinforcement shall be at least 50 mm unless shown otherwise on the Drawings. Cover shall be maintained by the use of concrete blocks or approved spacers. Concrete spacer blocks shall be
made from cement, sand and small aggregate to match the mix proportions of the surrounding concrete as far as is practicable to ensure comparable strength, durability and appearance.

The cost of spacer blocks and steel chairs shall be included in the contract Rates for concrete.

5.20 MECHANICAL SPICERS IN REINFORCEMENT

Mechanical compression and tension splicer shall not be used without the prior approval of the Engineer. Where such splicers are approved they shall be fitted strictly in accordance with the manufacturer’s recommendations.

5.21 CONCRETING IN ADVERSE CONDITIONS

The Contractor shall not place concrete in the Works:

- during heavy rains or dust storms;
- when the (shade) air temperature exceeds 38°C;
- when the air temperature is less than 2°C;
- if the temperature of the concrete is less than 4°C or more than 30°C without taking the necessary measures to ensure acceptable concrete temperatures all to the approval of the Engineer’s Representative;
- when the (shade) air temperature exceeds 30°C, without taking precautions to the approval of the Engineer’s Representative to ensure that the maximum internal temperature of the concrete does not exceed 38°C during the initial set; and
- When the temperature of the formwork or reinforcement exceeds 30°C

5.22 ANCHOR BOLTS, ANCHORS, OPENINGS, SLEEVES, INSETS AND OTHER BUILT-IN FIXTURES

The Contractor shall leave all openings, grooves, chases etc. in concrete work as shown on the drawings or as specified by the Engineer. He shall build into the concrete work all the materials noted below and shall embed and secure the same as and when required. The materials to be supplied by the Contractor shall be of best quality available of approved manufacture and shall be approved by the Engineer.

Materials to be embedded:

- Inserts, hangers, anchors, opening frames, manholes, covers, floor clips, sleeves and conduits.
- Anchor bolts and plates for machinery, equipment and for structural steel work.
- Dowels bars, etc. for concrete work falling under scope of future works.
- Lugs or plugs for door and window frames occurring in concrete work,
- Flashing and jointing in concrete work.
- Any other built-in-fixtures as may be required.

Correct location, exact alignment, etc. of all these shall be entirely the responsibility of the Contractor.

5.23 CURING AND PROTECTION

The Contractor shall for not less than 7 days protect the concrete from the harmful effects of frost, wind, sun, high and low temperatures, rapid temperature changes, premature loading, deflection, impact, running water and aggressive groundwater. Protruding steel shall be kept cool.

All exposed concrete surfaces be kept continuously moist for not less than 7 days after casting, by watering, by covering with hessian or sacking which shall be kept fully saturated at all times or by other methods approved by the Engineer’s Representative.

Curing membranes approved by the Engineer shall be applied in conformity with the manufacturer’s instructions. They shall be applied to unshuttered surfaces as soon as the moisture film has disappeared from the concrete, but while the surface is still damp and shall incorporate an approved reflecting agent. Surfaces with applied curing membrane shall be shaded from the sun.

5.24 BUILT IN ITEMS

Where pipes, sleeves, water stops or other items are built into concrete, they shall be rigidly secured in position to prevent movement and shall be free from external coatings which might adversely affect the
bond. The Contractor shall take precautions as approved or directed by the Engineer’s Representative to prevent the formation of air pockets, voids or other defects whilst the concrete is being placed around built-in items.

5.25 **CONCRETE RECORDS**

The Contractor shall furnish daily to the Engineer’s Representative a record, in a form to be approved by the Engineer’s Representative, showing the quantities of cement, the number and volume of mixings of each grade of concrete used in each section of the Works and in Temporary Works and details of sampling and testing.

5.26 **SURFACE FINISHES**

The types of finishes required on the various concrete surfaces shall be as specified below unless indicated otherwise in the Specification or on the Drawings.

Where a surface is partly below and partly above the final ground level, the finish for the exposed surface shall extend for 0.5 m below the final ground level.

All permanently exposed arises shall be formed with a 20 mm x 20 mm chamfer unless otherwise shown on the Drawings.

A concrete surface, which in the opinion of the Engineer’s Representative, fails to achieve the required standard shall render that section of concrete, the member of which it is a part, or in extreme cases the whole structure, liable to be rejected by the Engineer’s Representative. No remedial Work to defective concrete surfaces shall be started before the defective section has been inspected by the Engineer’s Representative. If remedial work is permitted as an alternative to reconstruction, the Contractor shall submit his proposals in respect of the repair to the Engineer’s Representative for his approval.

Finishes for surfaces formed by shuttering shall be:

**Back**

Finish for surfaces against which backfill or further concrete will be placed. It shall be formed using sawn boards, sheet metal or any other suitable material, which will prevent the loss of any constituents when the concrete is vibrated. Surfaces shall be free from voids, honeycombing or other large blemishes. This surface will, in general require no treatment after the removal of formwork other than curing and the repair of defective concrete if approved.

**Face**

Finish for surfaces prominently exposed to view and where accurate alignment and density and soundness of surface are of importance to prevent the destructive effects. The finish shall be obtained by the use of forms having a hard, smooth surface. The resulting concrete surfaces shall be smooth with true, clean arises. Only very minor surface blemishes shall be permitted and there shall be no staining or discolouring from the release agent.

Joints between panels shall be arranged as far as possible to coincide with architectural features or changes in direction of the surface and shall be vertical and horizontal unless otherwise directed. Joints between slab soffit panels shall be parallel to the supports. If the Engineer’s Representative considers it necessary, the surface shall be sack-rubbed to fill small pits and air holes. Sack-rubbing shall be done as soon as the forms have been removed but after any approval of repairs have been carried out. The sack rubbing shall be carried out in an approved manner. After surface treatment has been carried out the specified curing shall continue.

Finishes for unshuttered concrete surfaces shall be:

**Screed**

This finish shall be used unless otherwise specified for the surfaces of roadways, footpaths, foundations, base slabs and structural units to be covered by backfill, subsequent stages of construction, bonded concrete toppings or mortar beds. It shall be obtained by levelling and screeding the concrete to produce an even, uniform plan or lightly ribbed surface without laitance, and surplus concrete shall be struck off by a straight edge immediately after completion. Screeded finish is the first stage of subsequent grades of finish.
Before carrying out this finish on roads and footpaths the Contractor shall obtain the approval of the Engineer's Representative as to the direction of the ridges on the surface and the method of screeding.

**Trowelling**

This is a hard smooth finish for surfaces of concrete pavings, tops of walls, coping and unformed surfaces or architectural features including precast units, for surfaces of beds and slabs to receive thin flexible sheet and the pavings bedded in adhesive and seatings for metal items.

Finishing shall initially be screeded and floated. Floating may be performed by use of hand or power driven equipment. Floating shall be started as soon as the screeded surface has hardened sufficiently and shall be the minimum necessary to produce a uniform surface free from screed marks. Floating shall continue until a small amount of mortar without excess water is brought to the surface so as to permit effective trowelling. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess fine material from being worked to the surface. The surface shall be trowelled under firm pressure such as will flatten the sandy mixture of the surface and produce a dense uniform surface free from blemishes and trowel marks.

Finishing of concrete surfaces shall be performed only by skilled workmen and in the presence of the Engineer's Representative.

No extra payment shall be made for finishing to unshuttered concrete surfaces.

### 5.27 FORMWORK

#### 5.27.1 Scope

Supply, erection and removal of all types of formwork (centering and shuttering) for concrete work including the erection of all supporting structures such as props, struts etc.; placing, leveling and aligning forms, applying form oil; sealing to prevent leakage of grout; and removal of forms all complete.

#### 5.27.2 General

The terms formwork and shuttering shall be interpreted as meaning one and the same thing. Formwork shall include all temporary or permanent forms required to obtain the profiles and finishes as specified and shown on the Drawings.

Falsework shall be interpreted as meaning all temporary or permanent work required to support the formwork such that it shall remain rigid during the placing and setting of the concrete and such that dimensional deviations in the finished concrete structure do not exceed the specified limits.

All formwork shall be designed and detailed by the Contractor. All designs and details shall be submitted to the Engineer for approval 15 days for ordinary and 30 days for major structures prior to the commencement of the construction.

The Engineer's approval of the formwork shall not relieve the Contractor of his responsibilities under the Contract for any damage or injury that might result from any inadequacy in the formwork.

Falsework shall be designed to withstand the worst combination of self-weight, formwork weight, formwork forces, reinforcement weight, wet concrete weight, construction and wind loads, together with all incidental dynamic effects caused by placing, vibrating and compacting the concrete.

Joints between sections of formwork shall be sufficiently tight to prevent loss of grout or mortar from the forms.

Top formwork shall be provided to concrete faces where the slope exceeds one in three unless otherwise approved by the Engineer's Representative.

Re-use of formwork shall be at the discretion of the Engineer's Representative having regard to the specified surface finish.

Prior to the inspection by the Engineer's Representative for approval for concreting the formwork shall be thoroughly cleaned to remove all dirt, debris and standing water.
Surfaces, which will be in contact with concrete, shall be treated with an approved non-staining release agent applied strictly in accordance with the manufacturer's instructions. Release agent shall not be allowed to come into contact with adjacent concrete or the reinforcing steel.

Temporary openings to facilitate cleaning and inspection shall be provided at the base of column, wall and deep beam formwork. Formwork for walls and other thin sections of considerable height shall be provided with openings, to the approval of the Engineer's Representative, for placing and compacting the concrete.

5.27.3 Formwork Material

All shuttering material shall 19mm water-resistant plywood/ readymade pre-fabricated board, plastic coated plywood in new or like new condition and bottom or side supporting runners shall be either of wood, mild steel pipe (40mm) or adjustable steel truss-type. The runners shall be absolutely straight on the face supporting the shuttering. Props, struts and other supporting members shall be standard adjustable 50mm mild steel pipe supports. The props shall be clean the adjusting mechanism well lubricated and in proper working order.

5.27.4 Tie-bolts, etc.

Formwork shall be designed and constructed such that concrete can be properly placed and thoroughly compacted without any deflection in the formwork. Formwork shall be firmly supported and adequately strutted, braced, or tied. It shall be erected in such a manner as to facilitate adjustment to conform to the lines and dimensions of the finished concrete. It shall be sufficiently strong to resist without distortion any loads to which it may be subjected including pressure of concrete during placing and compaction. The formwork shall be durable and not vulnerable to distortion or other damaging effects of the weather. When concrete is to be vibrated special care shall be taken to ensure that the formwork will remain stable and the joints tight. The safety and adequacy of centering and shuttering shall be the sole responsibility of the Contractor.

The Contractor, at the discretion of the Engineer, shall supply design drawings and calculations for the formwork he proposes to use.

5.27.5 Deflection and Camber

The Contractor shall make allowance for any settlement or deflection of the formwork that is likely to arise during construction, such that the finished concrete conforms accurately to the specified line and level. The Contractor shall also make allowance in the formwork for any camber specified by the Engineer to allow for the elastic deflection of structural members and deflection due to creep of the concrete. In the absence of any specified camber, the soffit of all beams and slabs shall be given a camber equal to 1/240 of the span length to ensure that the structure has the prescribed shape after removal of the forms.

5.27.6 Supports

Formwork shall be constructed in such a manner as to allow the formwork on vertical faces to be removed without disturbing the soffit formwork or its supports. Props and supports must have a mechanism to allow the formwork to be adjusted accurately to line and level and to be erected and removed in an approved sequence without damage to the concrete. The supporting structure shall rest on solid foundation or other construction work that is sufficiently strong to resist all loads without any damage whatsoever to any portion of the structure. This may require in some cases that the supporting structure be carried down to the foundations or other suitable bases. Props and bracing shall be provided for the temporary support of composite construction where separately specified.

5.27.7 Joints and Edges

All joints in the formwork shall be close fitting to prevent leakage of grout from the concrete. At construction joints formwork shall be tightly secured against previously cast or finished concrete to prevent the formation of steps or ridges in the concrete. Formwork shall be constructed to provide straight and true angles, rises and edges. Where chambers are required to provide a smooth and continuous accurate alignment at sides and provide a clean line at construction joints in the concrete, these shall be fixed with their joints either vertical or horizontal unless otherwise specified.
5.27.8 Sundries

Formwork shall be provided to the top surface of concrete where the slope or the nature of the work is such that concrete would not retain its proper shape and dimensions during placing and compaction unless the formwork is provided. Provision shall be made for forming holes and chases to install service lines, pipes, conduits and other fixings as shown on the drawings. The material and position of any formwork ties passing through the concrete shall be to the approval of the Engineer. Except where corrosion of a metal tie is unimportant, ties shall removed such that no part of it remaining embedded in the concrete shall be nearer to the finished surface of the concrete than the specified thickness of cover to the reinforcement. Any holes left after removing ties shall be filled with concrete or mortar of approved composition.

5.27.9 Cleaning and Treatment of Formwork

Space to be occupied by concrete shall be absolutely clean and free of all rubbish, chipping, shaving, sawdust, dirt, tying wire, water, etc., before concrete is placed. The formwork to be in contact with the concrete shall be cleaned and treated with suitable non-staining form oil or other approved releasing agent. Care shall be taken that oil or agent is kept away from contact with the reinforcement or with concrete at any construction joints. Surface retarding agents shall not be used except with the permission of the Engineer. Formwork shall be thoroughly cleaned after each use. Bent, dented, warped or otherwise damaged or distorted formwork shall not be used.

5.27.10 Tie-bolts, etc.

Tie-bolts or other formwork devices built into concrete shall be approved by the Engineer. Only tie bolts, which avoid embedding any metal parts permanently within the specified cover to reinforcement, will be permitted.

Tie-bolt holes shall be filled with suitable fine aggregate cement mortar to match the colour of the surrounding concrete. The mortar shall be well worked in and thoroughly cured.

5.27.11 Striking and Removal of Formwork

The Engineer's Representative shall be informed in advance when the Contractor intends to remove any formwork. The time at which the formwork is removed shall be the Contractor's responsibility.

Formwork shall be removed with the permission of the Engineer's Representative and the work of removing it after receipt of such permission shall be carried out under the personal supervision of a competent foreman. Great care shall be exercised during the removal to avoid shocks to or reversal of stress in the concrete. No part of the formwork or falsework shall fall on the concrete surface from a height more than 0.5m.

Provided the concrete strength is confirmed by tests on cubes stored under the same conditions, formwork supporting cast-in-situ concrete in flexure may be removed when the cube strength is 10 N/sq. mm, or twice the stress to which it will then be subjected, whichever is the greater.

Formwork shall not be removed where unacceptable deflections are likely to result. The Contractor shall supply the Engineer's Representative with the necessary calculations in support of the above.

Materials and plant shall not be stored on any newly constructed member without the permission of the Engineer.

In the absence of cube test results, Table 5.6 below shall be followed for the minimum period before removing formwork for concrete using ordinary Portland cement and admixtures.

Unless soffit formwork has been designed so that it can be removed without disturbing the props, it shall be retained in position for the minimum period given in Table 5.3 for the removal of the props.
TABLE 5.3: Minimum Period Before Removing Formwork

<table>
<thead>
<tr>
<th>Minimum Period since casting of concrete for removal of formworks</th>
<th>24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Columns, Walls and Beams</td>
<td></td>
</tr>
<tr>
<td>Soffit</td>
<td></td>
</tr>
<tr>
<td>Slabs</td>
<td></td>
</tr>
<tr>
<td>Soffit</td>
<td></td>
</tr>
<tr>
<td>Beams</td>
<td></td>
</tr>
<tr>
<td>Props</td>
<td></td>
</tr>
<tr>
<td>Slabs</td>
<td></td>
</tr>
<tr>
<td>Props</td>
<td></td>
</tr>
<tr>
<td>Beams</td>
<td></td>
</tr>
</tbody>
</table>

Where cements other than ordinary Portland are used, or surface temperatures differ significantly from those shown or for any other reasons the periods may be adjusted at the discretion of the Engineer's Representative.

5.27.12 Tolerances

The formwork shall be so made as to produce a finished concrete true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified elsewhere in this specification or drawings or directed by the Engineer.

a. Sectional dimension - 5 mm
b. Plumb - 1 in 1000 of height
c. Levels - 3 mm before any deflection has taken place

5.27.13 Reusing Forms

Formwork that in any way has been damaged in removal, handling or storage, or shuttering that is not absolutely clean and free of foreign matter and old concrete shall not be reused unless approved by the Engineer. Formwork shall not be used or reused if declared unfit or unserviceable by the Engineer.

5.27.14 Rate

Rate shall include the supply and storage of all material, equipment and labor to erect, align, apply form oil, seal and remove formwork for any shape, size and quantity of concrete work as specified in the design and bill of quantities, all complete.

5.27.15 Measurement

Measurement for payment shall be the length and width of the area in contact with the finished concrete.

5.28 DIMENSIONAL DEVIATIONS IN SITU CONCRETE WORK

Deviations from the specified dimensions locations and levels for the various classes of insitu concrete finish shall not exceed the limits shown in Table 5.4. Deviations exceeding these limits will render the structure, member or section of a member concerned liable to rejection by the Engineer's Representative.

TABLE 5.4: Dimensional Deviations in In-Situ Concrete Work

<table>
<thead>
<tr>
<th>Typical Structure</th>
<th>Type of Deviation</th>
<th>Maximum Permissible Deviation for Classes of Finish, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buried concrete in foundations,</td>
<td>Departure from alignment and level</td>
<td>Back</td>
</tr>
<tr>
<td>retaining walls, etc.</td>
<td>+25 - 10</td>
<td>+10</td>
</tr>
<tr>
<td></td>
<td>Variations in cross sectional dimensions (1)</td>
<td>+10</td>
</tr>
<tr>
<td></td>
<td>-5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Deviation from template in long dimensions (2)</td>
<td>+10</td>
</tr>
<tr>
<td></td>
<td>-5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Abrupt (3)</td>
<td>+10</td>
</tr>
<tr>
<td></td>
<td>-5</td>
<td>-</td>
</tr>
<tr>
<td>Exposed concrete in piers, columns,</td>
<td>Departure from alignment and level</td>
<td>-</td>
</tr>
<tr>
<td>retaining walls, etc.</td>
<td>+10</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-5</td>
<td>+10</td>
</tr>
<tr>
<td></td>
<td>-5</td>
<td>+5</td>
</tr>
<tr>
<td>Floor slabs, bridge</td>
<td>Deviation from template in</td>
<td>-</td>
</tr>
<tr>
<td>Typical Structure</td>
<td>Type of Deviation</td>
<td>Maximum Permissible Deviation for Classes of Finish, mm</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Back</td>
</tr>
<tr>
<td>decks, waterways, etc.</td>
<td>long dimensions (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abrupt (3)</td>
<td>-</td>
</tr>
<tr>
<td>Floor slabs to receive finishes</td>
<td>Departure from alignment</td>
<td>±10</td>
</tr>
<tr>
<td>Bridge docks</td>
<td>Departure from longitudinal level</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Departure from transverse cross sectional template</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Deviation from 3m straight edge on longitudinal section</td>
<td>-</td>
</tr>
</tbody>
</table>

**Note:** The numbers in brackets under the type of deviation refer to:

(1) The cross sectional dimensions of structural members such as walls, columns, beams, etc. where, for structural or other reasons, it is necessary to keep the tolerances within closer limits than those for alignment and level.

(2) Gradual deviations caused by misalignment of formwork from the dimensions shown on the Drawings and measured from a 3 m long template.

(3) Offsets and fins caused by displaced or misplaced formwork sheathing, lining or support by loose knots in forms or by otherwise defective form work.

### 5.29 JOINTS IN CONCRETE

(a) **General**

Joints shall only be formed in the positions as per Standard and approved by the Engineer.

Construction, contraction and expansion joints shall be formed to the details shown on the Drawings and as specified herein, and from the specified materials.

(b) **Construction Joints**

Whenever concrete is placed on or against previously placed concrete which has become so hard that the new concrete cannot be monolithically compacted therewith the resulting place of separation shall be defined as a construction joint.

Where the locations of construction joints have not been shown on the Drawings then the Contractor shall decide the locations of construction joints to suit the concreting programme. The positions of construction joints shall be to the approval of the Engineer's Representative, which shall be obtained before any concreting takes place. The contractor shall submit to the Engineer drawings showing the positions of constructions of construction joints. Construction joints shall be located so that in conjunction with the programme for concreting, the effects of shrinkage and temperature are minimized.

Construction joints shall be formed in straight lines at right angles to the general direction of the member and shall take account of shear and other stresses, and as far as is practical shall be located at points of least shear. Construction joints shall be formed with clean sharp arises.

Construction joints shall be formed using rigid shuttering or other approved method, with joint lines at exposed surfaces of concrete being straight and continuous, plumb, level or inclined. Before placing new concrete against that which has already set, the latter shall be treated carefully to expose the aggregate over the full section and to leave a sound irregular clean surface free from laitance, loose and foreign matter obtained by green cutting using an air/water jet, by chipping or other approved means.

The cost of forming all construction joints shall be included in the Contract Rates for concrete except where the Engineer requires a water stop to be used in which case the cost of the water stop will be covered by a separate item included in the Bill of Quantities.

(c) **Contraction Joints**

Contraction Joints shall be located as per Standard and approved by the Engineer. The joints shall be made by forming with smooth forms the concrete on the side of the joint and allowing it to set before placing concrete on the other side of each joint shall be given two coats of approved bitumen before the concrete on the other side of the joint is placed.
**Technical Specification**

(d) **Expansion Joints and Isolation Joints**

Expansion joints shall be constructed in the locations and to the details shown on the Drawings. Performed joint filler, bond breaker and joint sealing compound and water stops and bitumen coating shall be placed in the joints in accordance with the Standard and approved by the Engineer.

(i) **Bitumen Boards:**

Bitumen impregnated fiber of approved manufacture as per IS: 1838 - latest revision shall be used as fillers for expansion joints. It must be durable and waterproof. At the exposed end the joint shall sealed with approved sealing compound to a depth of 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

(ii) **Bitumen Compound:**

The cap for expansion joints shall be thoroughly cleaned and the bitumen compound laid as per manufacture specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834 - latest revision.

(iii) **Separation Joints:**

Strong and tough alkathene sheet or equivalent of about 1mm in thickness as approved by the Engineer shall be used. The Contractor shall ensure the concrete surface is clean and dry and shall attach the sheet to the surface by an approved adhesive to cover it fully. Fresh concrete shall be laid against the sheet avoiding any damage to the sheet in any way.

(iv) **Rubber Pad:**

Hard foundation quality rubber pads of required thickness and shape are to be placed below machine or other foundations wherever shown on the drawings or as directed by the Engineer. The rubber shall be the best quality from approved manufactures, durable and capable of absorbing vibration and must be chemically inert capable of withstanding deleterious effects of constant contact with moist or dry earth under normal conditions.

(e) **Installation of Joint Sealer**

The Contractor shall prepare the surfaces of the joint and shall fill or caulk the recess completely with the joint sealer strictly in accordance with the manufacturer's instructions. The application of joint sealer shall not be commenced without the Contractor having first obtained the approval of the Engineer's Representative.

Where a polysulphide joint sealer is used an approved bond breaker shall be provided between the joint filler and the sealer.

(f) **Payment for Contraction and Expansion Joints**

The cost of supplying and fitting all materials for contraction and expansion joints will be covered by separate items in the Bill of Quantities.

5.30 **BORING HOLES INTO EXISTING CONCRETE FOR NEW FIXINGS, DOWELS, ETC.**

The system and plant for boring holes in existing concrete for dowels, anchor bolts and special fixings shall be to the approval of the engineer and strictly in accordance with the recommendations of the manufacturer of the fixing. The method of boring holes shall leave a rough surface finish to the inside of the hole. The holes shall be cleaned out and temporarily sealed to prevent the ingress of debris and/or water, until the dowels, anchor or fixings are installed.

The positions of holes shall be accurately set out and maintained during drilling by strong templates or other approved means. Where the holes are being drilled in reinforced concrete the location of reinforcement shall be ascertained by an approved method in advance of drilling and the hole location shall be suitably adjusted to avoid the reinforcement.

5.31 **EMBEDMENT OF STEELWORK, ETC.**

Blockouts and gaps left for the installation of steelwork, machinery, brackets and other metal items shall be fitted with grout or mortar or fine concrete as shown on the Drawings or as directed by Engineer's Representative.
The concrete surfaces against which grout or mortar or fine concrete is to be placed shall be roughened by chipping to ensure a satisfactory bond between the first stage concrete and the filling material. Immediately prior to placing the filling material the concrete surfaces shall be cleaned with air/water jets.

The filling material shall contain a not-shrink additive manufactured by an approved manufacturer and used in strict accordance with the manufacturer's instructions.

5.32 **CONCRETING OF MASSIVE STRUCTURES**

In concrete masses intended to form a watertight curtain in the ground, the concrete shall be placed in one operation from the bottom of the trench up to ground level or up to general foundation level over the whole length between two pre-arranged construction joints.

In other structures the concrete is to be shuttered off in rectangular sections the width of the block sufficient for the day's work and each section must be completely filled in one continuous operation.

All lift joints in mass concrete structures shall be provided with shear keys unless otherwise ordered by the Engineer. Shear keys of minimum depth 0.15 m shall be formed in the lower lift.

5.33 **PREVENTION OF CRACKING IN MASS CONCRETE**

Without prejudice to the requirements of Clauses 5.20 and 5.31 for mass concrete the Contractor shall control the temperature of the mix and the setting concrete to the satisfaction of the Engineer to ensure a sound uncracked structure.

This shall be achieved by controlling the temperature (a) of the concrete ingredients and the concrete mix and (b) of the concrete during placing and curing. The temperature of the concrete during curing shall not exceed 50°C.

Concreting shall be carried out in alternative blocks. Lifts shall not exceed 1.50 m and shall be poured in 3 layers each starting at the upstream face.

The time interval between lifts shall not be less than two days or, in general, more than seven days. If the period between lifts exceeds ten days the height of the subsequent lift shall not exceed 0.75 m.

At any one time the difference in level between adjacent blocks shall not exceed 4.50 m.

5.34 **WATERPROOFING**

The materials shall conform to the respective American, BS and IS Code - latest revision, where applicable. The Contractor shall obtain the approval of the Engineer's for materials before procuring the items. The Engineer may require the Contractor to supply test certificates for the material and the Contractor shall comply with all such requests. The materials shall be of best quality available indigenous, fresh and thoroughly clean.

5.34.1 **WATER PROOFING ADMIXTURE**

(i) **In Concrete**

The admixture shall be of the type recommended for the job intended and procured fresh. The Contractor shall obtain the Engineer's approval for the type and brand of admixture (if it is other than specified) before procuring and incorporating in the work. The method of application and other details shall conform exactly to the manufacturer's specification. If required by the Engineer the Contractor shall ensure that the manufacturer provides supervisory services, at no extra cost, to advise and guide the Contractor in the correct procedure for using the admixture.

(ii) **In Plaster**

The Contractor will ensure, to the Engineer's satisfaction, that all concrete surfaces to be plastered are roughened (hacked) sufficiently to develop a durable bond between the plaster and the concrete surface. The plaster shall be a mixture of cement and sand as approved by the Engineer. Contractor shall obtain the Engineer's approval for the type and brand of admixture (if it is other than specified) before procuring and incorporating in the work. The method of application and other details shall conform exactly to the manufacturer's specification. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost.
5.34.2 Other Admixtures in Concrete

Other admixture in concrete shall be of type as specified and to be used as per the direction of the Manufactures and the Engineer.

Payment shall be made extra over the price on concrete on the actual quantity of admixture used at the landed cost of the admixture plus 15 percent to cover extra labor, tools, plant, profit, etc.

The contractor may also proposed to the Engineer for his approval to use any admixture other than specified.

5.35 MEASUREMENT AND RATES

All measurements shall be made in cubic meters calculated as per the drawing. The rates for items shall include the cost of all materials consumed in the work at all levels, hire charges of materials, tools and plant, cost of labor, insurance, all transport, taxes and levies, services, accommodations, supervision, storage, protection etc., all complete.

6 MASONRY WORKS

6.1 MATERIALS

a) Cement for mortar
Cement for masonry mortar and grout shall be ordinary Portland cement in accordance with the requirements of Section 5. All cement for mortar for exposed face work shall be of a uniform color as approved by the Engineer and confirm BS 12 or IS 269 or Equivalent NS.

b) Lime for mortar
Lime shall be freshly burnt quicklime or hydrated lime conforming to the requirements of BS 890, or IS 712 and as specified herein or indicated on the Drawings.

c) Sand and water for mortar
Sand and water used shall be in accordance with the requirements of chapter 5 and sand for exposed face work shall be of a uniform color as approved by the Engineer.

d) Bricks
The bricks shall be chimney-made hand cast bricks of first class quality. The bricks shall be of quality approved by the Engineer and free from grit and other impurities such as lime, iron and other deleterious salts. They shall be well burnt, sound, hard with sharp edges and shall emit a distinct ringing sound when struck with a mallet and shall be of uniform size. The bricks shall conform to IS 3495 and be tested in accordance with IS 1077.

Defects in bricks
Bricks shall be free from defects affecting strength and durability. The bricks and with manufacture cracks or cracks and chips due to handling shall be disposed of from the site and in any case shall not be used in brick works. The appearance of exposed brick surface and all face brick to be used on the work shall be an acceptable match with the samples approved by the Engineer.

Handling of bricks
Brick shall be carefully handled at all stages in delivery, stockpiling and construction to prevent breakage or surface damage. Bricks shall be carefully unloaded by hand without dropping it from a height or a distance of 10cm and shall not be dumped or thrown. Special care shall be taken with stacking and storage of brick on the site and with its delivery to the mason. Palette stacking or boxes shall be employed in transporting brick to the site if in the opinion of the Engineer, the brick is being mishandled or unduly damaged.

Make of bricks
All bricks shall be made of good quality brick earth and machine made, thoroughly burnt, and shall be of deep cherry red or copper colour. The bricks when made shall emit a clear ringing sound when struck together and shall not break when thrown on the ground or against other bricks from a height of 1 m. The bricks shall be wholly clean and free from flaw cracks and under burnt lumps of any kind. They shall be uniform in size and regular in shape and have square, straight and sharp edges and even surfaces. The Contractor shall submit to the Engineer sample bricks for approval before the bricks are supplied and all bricks used on the Works shall be equal to the samples approved. The nominal size of the bricks shall be 230 x 110 x 57 mm 2% unless otherwise stated elsewhere in this specification and codes.
Sampling
Brick samples shall be randomly selected for testing in quantities not less than 5 bricks per one thousand for each lot supplied for the construction work.

Acceptance Criteria
1. Compressive Strength: The average compressive strength of the brick shall be minimum of 70 kg/sq.cm. The compressive strength of any individual brick shall not fall below the above mentioned minimum average compressive strength by more than 20%.

2. Water Absorption: The average water absorption of the brick samples shall not be more than 15 percent over the dry weight after immersion in cold water for 24 hours.

3. Efflorescence: The rating of efflorescence shall not be more than “Slight”.

6.2 MORTARS FOR MASONRY

a) Color of mortar joints
The color and texture of all exposed mortar joints shall be subject to the approval of the Engineer and shall be kept uniform throughout the project by strict adherence to the approved mixes and samples.

b) Mortar mixes
Unless otherwise specified or shown on the Drawings the mix proportions by volume shall be as follows and sufficient water to produce the required consistency for use. For increased workability and where approved by the Engineer’s Representative, dehydrated lime putty may be added, but shall not exceed 25% by volume of the dry cement.

1. Mortars for masonry and plaster works
   a) Cement mortars ! Proportion of mix
      CM 1:6  Cement - 1 part, Sand - 6 part
      CM 1:4  Cement - 1 part, Sand - 4 part
      CM 1:3  Cement - 1 part, Sand - 3 part
      CM 1:2  Cement - 1 part, Sand - 2 part
      CM 1:1  Cement - 1 part, Sand - 1 part
   b) Cement - Lime - Sand mortar
      CL 1:1:6  Cement - 1 part, Lime - 1 part, Sand - 6 part
      CL 1:2:9  Cement - 1 part, Lime - 2 part, Sand - 9 part
      CL 1:1:8  Cement - 1 part, Lime - 1 part, Sand - 8 part

2. Waterproof mortars for DPC and plaster works
   WCM 1:4  Cement - 1 part, Sand - 4 part, Waterproof compound - 0.03 part
   WCM 1:2  Cement - 1 part, Sand - 2 part, Waterproof compound - 0.03 part

3. Colored plaster
   DCM 1:2  Cement - 1 part, Sand - 2 part, Pigment - 0.01 part
   DCM 1:1  Cement - 1 part, Sand - 1 part, Pigment - 0.01 part
   DCL 1:1:4  Cement - 1 part, Lime - 1 part, Sand - 4 part, Pigment - 0.01 part
   DCM 1:1:2  Cement - 1 part, Lime - 1 part, Sand - 2 part, Pigment - 0.01 part

(c) Workability of mortar
The mortar shall be of a readily workable consistency with only enough water to obtain a plastic condition suitable for troweling.

(d) Workability of grout
Grout shall be of pourable consistency with a slump of 12cm when tested in accordance with “Slump Test for Mortar and Grout”.

(e) Cement mortar mixing and using period
All cementitious materials and aggregate shall be mixed for a minimum of five (5) minutes in a mechanical batch mixer. Only as much water shall be added as compatible with convenience in using the mortar. If mortar begins to stiffen from evaporation or absorption of a part of the mixing water, the mortar shall be
retempered by adding water and remixed. All mortar and grout shall be used within 2.5 hours of the initial mixing and no mortar nor grout shall be used after it has begun to set.

(f) Hand mixing of mortar
Hand mixing shall be carried out on clean, watertight platforms with approved methods or as directed by the Engineer.

(g) Measurement of sand and its grading
Sand shall be measured in a damp loose condition. All sand for mortar used in 10mm joints shall pass a No. 16 sieve or as directed.

6.3 BRICK MASONRY

(a) Brick Masonry in Superstructure

a.1 Scope
This specification deals with the supply and installation of ordinary chimney-made first class brickwork (min. 230mm thickness) in superstructure work in cement mortar 1:6 (1 part cement to 6 parts sand), including testing; soaking; cutting and laying in any shape, size or quantity; preparation of mortar and curing, all complete.

a.2 Materials
Materials shall conform to the specifications of materials as described in section 3.1 above. In addition to the materials specified in section 3.1, 8mm deformed reinforcing bars conforming to IS 1786-1985 shall be provided for reinforcing the work.

Brick masonry shall comply with British Standard Codes of Practice 121, 101 (or equivalent).

Bricks shall be thoroughly soaked in water before use and shall be set in a full bed of mortar and grouted in every course. Solid brick masonry shall be in English or Flemish or other approved bond. The courses shall be laid level and with parallel neat and regular joints.

Brick masonry shall be carried up evenly and uniformly, no one portion being raised more than 1 m above another at any one time. Vertical joints shall be filled with cement mortar as the bricks are laid. Unfinished brick masonry shall be stepped back in course and immediately before new work is added the previous work shall be thoroughly cleaned. Any holes shall be filled in with bricks identical with those already incorporated in the framework.

The conditions governing the laying of brick masonry in unfavorable weather shall be as specified for concrete in Clause 5.20 hereof. Exposed faces of brick masonry shall be kept moist for ten days after construction.

a.3 Workmanship
The workmanship shall conform to the specifications as described in section 3.1 above. In addition to the workmanship as specified in 3.1, 8mm reinforcing bars, one number at each level, shall be placed horizontally in the brickwork six courses from the bottom and six courses from the top of the work. In the remaining vertical section between the top and bottom bars one bar shall be placed at each level at equal vertical spacing approximately, but not exceeding, 900mm. The bars shall be placed in the center of the width of the work unless otherwise specified. The ends shall be anchored in the end supports according to the following specification:

1. Concrete Columns – the bar shall be inserted at least 50mm into a hole drilled in the end column.
2. Brick Columns – the bar shall be hooked around the vertical bar in the brick column. The hook shall be a standard hook with the return length not less than 50mm.
3. Perpendicular walls – The bar shall be bent in an L-shape with the length of the ‘L’ not less than 200mm. The position of the ‘L’ shall be such that it sits in the center of the end wall.
4. Openings – The bar shall be curtailed 115mm from the face of any opening in the wall.

(b) Placing
All brickwork shall be placed only after the foundation surfaces have been prepared satisfactorily in accordance with these Specifications and instructions of the Engineer’s Representative.
(c) **Wetting of bricks**
Bricks shall be well wetted for a minimum of three (3) hours in advance of being laid or as required so that the rate of absorption when laid does not exceed 1 cc/square centimeter per minute. The method of wetting shall be such that each brick be nearly saturated but surface remain dry when laid.

(d) **Brick Laying**
Bricks shall be laid in running bond with head joints in each course centered over the bricks in the course below and shall be plumb, level & true to line with full head and bed joints. The ends of brick shall be buttered with sufficient mortar to fill the head joints. The top of the joint mortar may be sloped toward the center of the wall to minimize the amount of mortar forced into the grout core space. Mortar protruding from bed joints into the core space shall be removed before pouring the grout, and no mortar shall be placed or allowed to remain in the core space.

(e) **Jointing**
Joints in brickwork shall be uniform and generally 10 mm wide for horizontal and 6 mm wide for vertical joints. Point joints to produce a dense, tooled V joint or as otherwise shown on the Drawings. Cut out defect joints and repoint them with mortar.

(f) **Care for masonry**
Extreme care shall be taken to prevent any concrete, grout, or mortar from staining the face of masonry. If any grout or mortar does contact the face it shall be immediately removed and the surface cleaned with clean water. Masonry work shall be protected against staining, tops of walls shall be covered with waterproof coverings as required when work is not in progress.

(g) **Stopping the brick laying**
All walls shall be carried up at the same time. In no case shall any walls be advanced more than six (6) brick courses above another. If it is necessary to "stop off" a horizontal run of masonry in pyramid form shall be adopted.

(h) **New and old masonry joints**
Where fresh masonry joints that is partially set or totally set, the exposed surface shall be cleaned and thoroughly wetted so as to obtain the best possible bond with the new work. Remove all loose masonry and mortar.

(i) **No. log holes for scaffolding, formwork etc.**
In no case shall put "log-holes" for the erection of scaffolding and formwork or for other construction procedures be made.

(j) **Plumb Bob and Straight Edge**
Where applicable brickwork shall be taken up truly plumb and each set of four bricklayers shall be provided with a plumb bob and straight edge.

(k) **Progress**
Brickwork shall be carried up regularly and no portion of the work shall be left more than 1 m lower than another. Temporary steps left during construction, shall be raked back and not toothed. Straight edges supplied to bricklayers shall have courses marked on them with saw cuts, or measuring rods provided, and heights of courses frequently checked so as to keep them level.

(l) **Cleanliness**
Care shall be taken to keep all brickwork free from mud splashing, mortar and bitumen dropping, etc., and it shall be well cleaned down before being handed over.

(m) **Ducts and Nisches and opening in brick wall**
Particular care shall be taken to provide for all necessary openings for passage of pipes, drains, ducts, conduits, utility lines, flashing, inserts, anchors, outlets, etc. Should such provision be overlooked, that portion of the work required to be dismantled and shall be rebuild to make the final result as good as if it had been done as the work progressed.

(n) **Scaffolding**
The Contractor is responsible for providing, erecting and dismantling and removing safe scaffolding wherever required.
(o) Protecting and Curing
Protecting and curing of brickwork shall be carried out in accordance with clause 5.21 hereof. The water used for curing shall be clean and in accordance with Clause 5.6 hereof.

(p) Repairing Brickwork
If, after the completion of brickwork, any of it is out of alignment or level, or shows a defective surface, it shall be removed and replaced by the Contractor at his own expense and to the satisfaction of the Engineer's Representative.

6.4 STONE MASONRY

6.4.1 Stonework in Foundation upto Ground Level

Scope
This specification covers the quality of material and workmanship in random rubble masonry in cement sand mortar for retaining walls and foundations and coursed random rubble masonry in sand cement mortar for superstructure walls.

General
Stone for masonry work in cement mortar shall be clean, hard, free of weathering and angular having plane faces and must be approved by the Engineer. Stones having round surfaces such as river boulders shall not be used in stone masonry work. The length of any stone shall not exceed three times its height. The breadth shall not exceed 150 mm or greater than three-fourths of the thickness of the wall. Projections on the exposed face shall not exceed 40mm from the plane surface. Spalls not exceeding two percent of the total surface area in plan of the wall may be used in a staggered pattern for filling voids and spaces between larger stones.

The work will be constructed on a prepared foundation-surface of lean concrete or random rubble foundation of large selected stones laid with the largest surface area in the horizontal plane. The walls shall be built true to plumb or to the specified incline and exact width. Mortar joints shall not exceed 25mm thickness. Face stones shall extend and bond into the backing. Their height shall not be more than the breadth or the depth. Filling stones shall be rubble stones of any shape and shall not be less than 150mm square or diameter and 100mm thick. Stones shall be individually placed to break joints and to minimize voids and thick mortar joints. The stones shall be well bedded and bonded to adjoining stones. Spaces between large stones shall be filled with spalls and securely rammed into place. Spalls shall not be used to bed large stones. The joints shall be finished in flush or raised pointing as specified or directed by the Engineer. Tops and sides of completed work shall be neatly finished with selected coping stones and a concrete cap as specified. The stones shall be cleaned with water and a brush before any mortar is sets. The work shall be cured by keeping it damp for a minimum of seven days after completion.

Plastering and pointing in between the joints of the stones shall not be admitted. Proper quality of work shall be maintained at the initial age of laying stones & mortar. Mortar joints will be thick enough to prevent stone to stone contact and shall be completely filled up.

Cement mortar shall be prepared from fresh Portland cement, 43 grade, and clean, course sand of proportion as indicated. The ingredients shall be accurately measured by volume and shall be well and evenly mixed together in a mechanical pan mixer. Water shall be added in amounts needed to produce a stiff plastic mixture, neither too much nor too less. River sand shall be used unless otherwise specified. If hand mixing is allowed then it shall be done in brick tanks. The gauged materials shall be put in the tank and mixed dry. Water will then be added and the whole mixed again until it is homogeneous and of uniform color. Mortar shall be prepared only in such a quantity as can be used before the initial set, usually in 30 minutes after adding water. The mix shall be clean and free from any soil, acid, organic matter or other deleterious substances.

Mortar test cubes shall be tested in accordance with IS 2250-1981. In general, one cube test for every 30m3 of mortar and one test of stone for each major masonry structure or at every source of stones yielding up to 100m3 deposit will be made to assess and check their compressive strengths.

Weep holes shall be provided in the work as shown on the drawing or as directed by the Engineer to allow water to drain from behind the structure. In stone masonry walls weep holes shall be 80mm wide by 150mm high. Weep holes shall extend though the full width of masonry structure with slope of about 1:20 towards the draining face. The spacing of weep holes shall be generally 1 m in either direction or
Deformed reinforcing bars conforming to IS 1786-1985 shall be incorporated into the work as specified in the design drawings or as directed by the Engineer.

The following table shows the compressive strength requirement of such stone masonry work.

<table>
<thead>
<tr>
<th>Compressive Strength of Masonry</th>
<th>Mortar mixed by volume</th>
<th>Hardening time</th>
<th>Crushing Strength of Stones in MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cement/Sand</td>
<td>Days</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>1/3</td>
<td>7</td>
<td>1.1</td>
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<tr>
<td></td>
<td>1/4</td>
<td>14</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>1/5</td>
<td>14</td>
<td>0.9</td>
</tr>
</tbody>
</table>

The above compressive stresses hold good for course rubble masonry and block stone masonry. They do not hold good for random or uncoursed rubble masonry. Permissible tensile and shear stresses may be taken one-tenth of the above-tabulated values in each case.

Stone work in foundation up to ground level with random rubble stones approved size and quality, including wetting the stones, packing the joints and curing the work in all types and thickness of walls, columns, etc. in m³.

i. in cement sand mortar (1:4)
ii. in cement sand mortar (1:6)
iii. in cement sand mortar (1:8)

(a) Materials
(i) Stone - The stone shall be hard, tough sound and durable No Stone shall be less than 15 CM (6") and more than 45 CM (18"). Stone less than 0.041 m³ (1/2 cu. Ft) in size should not be used. Face stones shall be comparatively larger and uniform in size and colour to give a good appearance. Breadth of the face stones shall be greater than the height. Face stones should tail into wall to a sufficient depth to bond well. Stones shall be laid with broader face downwards to give a good bedding. Face joints shall be broken and face stones and dressed correct to angle and laid as header sand stretchers.

Random Rubble Masonry
In addition to the general specifications, the following are specific requirements for random rubble stonemasonry work and shall be incorporated in any work of this type.

The stones shall be hammer dressed on the faces, sides and beds and shall be roughly dressed on the beds and sides to a depth at least 25mm from the exposed face. The work shall include at least ten percent (by volume) of bond stones and at least one stone placed for every 0.5 square meters of the exposed surface of the wall. The bond stones shall be at least 150x150mm in cross-section and up to 600mm in length or the full thickness of the wall. The bond stones shall be placed spanning the full width of the wall from front to back. In cases where the wall is wider than the maximum length of the bond stones, pairs of stones should be laid in a line across the width of the wall such that they overlap by at least 150mm in their length. The bond stones shall be hammer/chisel dressed such that their bedding planes are parallel and at right angles to the direction of load.

Coursed Rubble Masonry
In addition to the general specifications, the following are specific requirements for random rubble stonemasonry work and shall be incorporated in any work of this type.

Stones shall be hammer dressed on all beds and joints so as to produce a rectangular shape and square corners on all sides. The joints shall be chisel dressed at least 50mm from the exposed face. Projections on the face shall not exceed 40mm from the plane surface on natural finish faces and 10mm on faces to be plastered.

The height of each course shall not exceed 150mm and be uniform within a tolerance of 50mm. Face stones shall be laid alternating between header and stretcher. No vertical bond stones
shall be placed in the exposed face of the work. The dimensions of the face stones shall such that the breadth is always greater than the height and at least one-third of the stones shall project into the width of the wall to a depth not less than twice their height or the full width of the wall, whichever is less. Bond stones, as specified in the general notes above, shall be placed every 1500 to 1800mm apart in each course. All work shall be raised together but where the work must be curtailed each course shall be stepped back at an angle of approximately 45 degrees. All bed joints shall be perfectly horizontal unless otherwise specified and the face joints shall not exceed 12mm thick. The joints on plaster faces shall be raked to a depth of 15mm and joints on natural face work pointed with raised pointing. The work shall be cleaned with a brush and water periodically to ensure the natural color of the stone is not discolored with cement.

(ii) **Mortar** - Cement mortar shall be as per specification (civil) article 18, and in the following proportions:
- 1:4 (1 Cement : 4 Sand)
- 1:6 (1 Cement : 6 Sand)
- 1:8 (1 Cement : 8 Sand)

The ingredients shall be accurately gauged by measure and shall be well and evenly mixed together in a mechanical pan mixer, care being taken not to add more water than is required. No mortar that has been set shall be used. River sand shall be used unless otherwise specified. If hand mixing is allowed then it shall be done in masonry tanks. The gauged materials shall be put in the tank and mixed dry. Water will be then added and the whole mixed again until is homogeneous and of uniform colour. Mortar shall be prepared in such quantity, at one time, which shall be consumed within half an hour of its mixing. The work shall be well watered for a fortnight.

(b) **Joint**
Joints shall not be thicker than 19mm (3/4”). Face joint shall be thicker. Interstices, if any, may be filled with pipes of spalls of stones embedded in mortar. Not more than 60 cm height of masonry shall be constructed at one time.

(c) **Bond Stones**
Through bond stones of one piece shall be provided one every 10.45 m² (5Sqft) of face. For walls thicker than 75 cm (2 1/2 feet) bond stones may be of two pieces placed side by side overlapping at least 15 CM (6”). Breadth of bond stones shall not be less than 1 1/2 times the height. All stones shall be thoroughly wetted before laying. At the end of a day’s work, masonry shall be flooded with 2.5 CM (1”) water at the upper surface with the help of fillets of mortar about 38 mm (1 1/2) height, made round in edges. The masonry shall be protected from sun, rain, frost and other weather effect.

### 6.5 PARTITION WALLS

(a) **Laying**
For 115 mm brick masonry and or Hollow concrete 100 mm partition walls fair faced one side, the masonry shall be laid in running bond with specified mortar, plumb level and true to line in accordance with Section 6 and as shown on the Drawings.

(b) **Fastening of partition walls**
Top and side ends of partition walls full height shall be securely fastened to beams, slabs and walls with pre-fixed metal fasteners or holdfasts spaced not greater than 75cm apart unless otherwise indicated. Clearance between top and ends of partition wall and beam, slab and walls shall be caulked as indicated or as directed by the Engineer to form a closed continuous joint.

### 6.6 BRICK PAVEMENT ON EDGE

The brickwork in paving in specified cement sand mortar with machine made bricks shall be laid in proper slope, levels and dimension and pointed with cement sand pointing (1:1) in the pattern and bonds as shown in the drawing or as directed by the Engineer.

All bricks shall be soaked in water in a tank for at least 3 hours before use. The surface of the base shall be roughened and watered. Mortar joints shall not exceed 12mm and fully packed with mortar. The brick pavement on-edge shall be laid over a layer of mortar of 12mm thickness. The brick pavement shall not be disturbed at least for 7 days as it is laid and shall be kept wet for minimum 14 days.
6.7 **BRICK SOLING**

Dry brick soling shall be laid flat over a compacted surface as specified. The dry brick soling shall be laid over a cushion of sand of 25mm thickness unless otherwise specified. All the joints shall be duly filled with sand to fill up all voids.

6.8 **RATE**

The rate shall include the supply of all material and labor to erect any size or shape of stonemasonry structure according to these specifications. The rate shall include the cost of labor for cutting, dressing and laying of stones; supply and placing of any reinforcement steel; supply of material and installation to form weep holes; mixing laying and finishing of concrete coping; labor and material for pointing joints; labor and equipment to clean the exposed face; supply of equipment and labor to erect scaffolding; and equipment, water and labor for curing, all complete.

6.9 **MEASUREMENTS**

The measurement of work shall be the product of length and thickness. All thickness of stone shall be measured and will be as per drawings. Deductions for doors, windows, and other openings including lintels shall be made to arrive at the net quantity of work. Nothing shall be paid extra for forming such openings. However, no deductions shall be made for areas less than 0.1 m\(^2\). (1 Sq.ft) over all bearings of lintels, beams, girders, and hold fats blocks but nothing extra shall be paid for embedding these. Similarly, no deductions shall be allowed for rendering the flue opening specified. Stone work covering to the figures shown in the drawing. Unless otherwise specified nothing extra shall be admissible for cutting in stone works to suit R.C.C. structure, walls in any shape other than straight, any cutting necessary for shaping the walls to structural design.

7. **METALWORK**

7.1 **MATERIALS FOR METAL WORKS**

Materials shall be the best of their respective kinds for the services for which they are required. Materials not specifically described herein or shown on the Drawings shall comply with following standards:

a) Standards

<table>
<thead>
<tr>
<th>Materials for Metal Works</th>
<th>BS</th>
<th>IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Steel Section</td>
<td>4</td>
<td>800</td>
</tr>
<tr>
<td>Covered Electrodes for the Manual Metal-Arc Welding</td>
<td>639</td>
<td>814</td>
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<tr>
<td>Mild Steel</td>
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<td>1442</td>
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<tr>
<td>Black Bolts, Screws and Nuts</td>
<td>709</td>
<td>1367</td>
</tr>
<tr>
<td>Cast Steel for General Engineering Purpose</td>
<td>3100</td>
<td>1056</td>
</tr>
<tr>
<td>Weldable Structural Steels</td>
<td>4360</td>
<td>2062</td>
</tr>
<tr>
<td>High Strength Friction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grip Bolts</td>
<td>4395</td>
<td>3757</td>
</tr>
<tr>
<td></td>
<td>4604</td>
<td>4000</td>
</tr>
<tr>
<td>Hot-rolled Structural Steel Sections</td>
<td>4548</td>
<td>808</td>
</tr>
<tr>
<td>Steel windows &amp; doors</td>
<td>990 or 1787</td>
<td>1938</td>
</tr>
<tr>
<td>Mild Steel Doors and windows</td>
<td></td>
<td>1038</td>
</tr>
<tr>
<td>Primer Paint</td>
<td></td>
<td>IS:</td>
</tr>
<tr>
<td>Erection of Steel Structures</td>
<td>BS</td>
<td>IS:</td>
</tr>
</tbody>
</table>

(b) **Welding**

Welding shall be metal-arc welding complying with the requirements of BS 5135 or IS 815 as appropriate. All welds shall be continuous.

The Contractor shall supply samples to the Engineer when required for examination or test.
7.2 PRIMER PAINTS FOR METAL WORKS

Primer paint shall be material which will be compatible with the finish coats to be applied as recommended by the manufacturer for the surface to be painted. The contractor shall submit their proposal with manufacturers’ recommendation to the Engineer for his approval.

7.3 METAL FIXTURES FOR DIFFERENT WORKS

All metal fixing devices, anchors, inserts, holdfasts, clips, sleeves, brackets, etc. shall conform to standard specifications and to the size and shapes shown in the drawings or directed by the Engineer. Samples, along with any relevant manufacturers’ specifications or installation instructions, shall be submitted to the Engineer for approval before installing. Fixtures and fittings shall be provided well in advance to facilitate timely installation in the work of other trades so as not to cause any delays to the work on other items. Fixtures and fittings must be embedded or otherwise installed as specified in the design drawings or as directed by the Engineer. Attaching or in any other way incorporating into the work after the work to which the item is to be incorporated has been completed is not acceptable.

7.4 DETAILS OF METAL WORKS

All exposed work shall be finished smooth and machined where required. Form metals to shape and size, with sharp lines and angles, and with smooth surfaces and faces. Thickness of metal and details of assembly and support shall provide ample strength and stiffness.

7.5 WELDED JOINTS FOR METAL WORKS

Welded joints shall be neatly made, smoothly filled, ground to flush level with the adjacent surfaces so that the resultant weld provides member of uniform thickness with all welds at intersecting members ground to sharp lines. Adequate means shall be employed for temporarily fastening the parts to be welded together until the joints are welded.

7.6 ERECTION OF METAL WORKS

All metal items shall be carefully erected in proper position, securely fastened, plumb in line and level. The completed installations shall be free of sharp edges and rough spots. All abrasions in prime coats and all metal cuts, bolts and nuts in ferrous shall be painted up with the approved priming material.

7.7 SHOP DRAWING FOR METAL WORKS

Shop drawings shall show gauges, thickness, sizes and construction of all members as well as the manner of assembling the various members which make up different items, show true profiles, connections, and relationship to adjoining work methods of anchoring and all other pertinent information. No work shall be fabricated until shop drawings have been approved by the Engineer.

The Contractor shall prepare and submit, for approval by the Engineer, all shop drawings of work to be fabricated before the fabrication is started. Shop drawings shall show gauges, thickness, sizes and construction of all members as well as the manner of assembling the various members which make up different items, show true profiles, connections, and relationships to adjoining work methods of anchoring and all other pertinent information.

7.8 PRIMER COAT AT DISSIMILAR CONTACT

Dissimilar metal contact or metal-to-masonry contact shall be separated by one (1) coat of bitumen paint or approved primer.

7.9 SUPPLY OF PAINT AND PAINTING AT SITE

All metal items shall be painted with one coat of anti-corrosive paint before dispatching to the site or, if fabricated at site, painted with one coat of anti-corrosive paint before erection. Any rust shall be completely removed before applying the primer coat.

Following installation of the Work, the Contractor shall repaint with primer any surfaces on which the primer has been scratched or otherwise damaged. After the primer has been retouched, two coats of enamel or other paint as may be specified in the design drawings or by the Engineer shall be applied to
the Work. Light sanding with fine grit sandpaper shall be applied between coats of paint to roughen the surface and improve adhesion of subsequent coats. Special attention shall be given to faces of adjoining members to ensure they are painted with one coat of anti-corrosive paint and two coats of enamel or other paint as specified before the members are joined. The Contractor will prepare the surfaces and apply the finishing coats of paint during erection at site.

The Contractor shall supply and deliver to the site a sufficient quantity of priming paint to make good any damage during delivery, handling and erection. The contractor shall also supply and deliver to the site sufficient enamel or other paint as specified for two finishing coats. The supply and delivery of the paint shall be in accordance with programs that the contractor shall have previously agreed with the Engineer having proper regard to the shelf life of the paints and all to the approval of the Engineer.

The paint shall be delivered in the paint manufacturer’s drums with seals unbroken. Each drum shall be clearly and indelibly marked with a description of its contents, its date of manufacture, and the date before which it should be used. Each drum shall have a different serial number. The Contractor shall keep a record of the delivery dates of each drum and shall make copies of the record available for use or request by the Engineer.

7.10 **METAL DOORS, WINDOWS, VENTILATORS AND GLAZING ETC.**

Glazing units shall be made from mild steel sections free from rolling defects. All steel doors, windows and glazings shall conform to IS. 1038 unless otherwise directed. Steel sections shall be cold straightened and such as to be easily punched and welded.

7.11 **WINDOW GRILLS, FENCES, RAILING**

Mild steel grill, fences and railing of approved pattern and manufacture, finished with one coat or red lead primer followed by one coat of aluminum paint, all complete, as per drawing and shall comply with the requirements of IS 800.

The mild steel grill, fences and railing shall be made according to pattern as per drawing. Welded joints shall be neatly made, filed smooth and left clean. The Engineer is to be informed when the welded work is ready for inspection and any such work must be left unprimed until the Engineer gives his approval. The Contractor shall furnish at his own expense all necessary tools and all materials which he may require for the safe erection of the work, and remove the same when the work is completed. The Contractor shall be solely responsible for any damage done to the structure during erection. Non of the structure or other works are allowed bend or otherwise distort either before or after the erection. The grill work shall be finished with one coat of red lead followed by one coat of aluminium paint and fixed in the opening, as per instructions of the Engineer.

7.12 **COLLAPSIBLE GATES, ROLLING SHUTTERS RAILING**

These shall be double or single collapsible gates depending upon the size of the opening. These shall consist of vertical channels 20 x 5 mm and top and bottom rails of T-section 40 x 40 x 6 mm with 38 mm dia. steel pulleys or ball bearings in every 4th double channels unless otherwise specified. Where collapsible gate is provided with the opening and is fixed along the outer surface T-sections at the top may be replaced by flat iron 40 x 10 mm. The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like springs, catches and locks, shall be provided as described in the nomenclature of item in the Schedule of Quantities.

Shall be "Swastik", "Standard" or equivalent approved manufacture suitable for fixing in the position ordered i.e. outside, inside, on or below lintel or between jambs., Shutters upto 12 sq. meter in area shall be manually operated or push up type while bigger sizes shall be of reduction gear type mechanically operated by chain or handles.

Laths shall be of 18 gauge best quality mild steel 75 mm, wide strips interlocking, rolling centres, machine rolled and straightened with an effective bridge depth of 16 mm. Side guides and bottom rail shall be built up mild steel rolled section. The spring assembly shall be supported on strong mild steel or malleable cast iron brackets shaped to fit the lintel. The rolling springs shall be from tested unbreakable high tensile steel wire or strip of adequate strength to balance the shutter in all positions. The shutter shall be complete with door suspension shafts, locking arrangement, pulling hooks, handles and other accessories.
7.13 **STRUCTURAL STEEL WORK**

**GENERAL**

7.13.1 **Description of work**

This work shall consist of the material supply, Fabrication, Galvanization, Transportation, Erection at site and Completion of the work as detailed in BOQ and drawings.

7.13.2 **Standard and Specification**

If not otherwise specified, the standards for the work shall be as noted below:

- General Fabrication – IS 800 - 1984
- Welding – IS 816 - 1969

All the works specified otherwise in this specification should be carried out as per relevant IS codes.

7.13.3 **Testing and Inspection**

7.13.3.1 **Test Certificates**

The Mill Test Certificate of Steel used for the purpose shall be provided by the contractor, otherwise, shall be tested in a reputed laboratory and the report shall be submitted to the satisfaction of consultants.

7.13.3.2 **Inspection by the consultant’s Engineer**

The Engineer will inspect, examine and test materials, workmanship and performance of any part of the works at the manufacture’s works or the site of fabrication.

The Engineer will certify that all works up to the stage of fabrication shop painting after trial assembly have been carried out in accordance with these specifications and the approved shop drawings. The consultant’s certificates shall not relieve the Contractor of any of his obligations under the Contract.

The contractor shall also provide necessary assistance required for the consultant whenever it desires to inspect the goods at any stage of execution.

7.13.3.3 **Inspection by the Contractor**

The Contractor shall himself inspect or have inspected all materials, shop work and field work to determine that the requirements of the Drawings and Specifications are met and that the Works are carried out in a first-class and workmanlike manner.

To maintain the quality, the contractor shall make a Quality Control Scheme to implement the Works. The contractor shall provide the system to the consultants and the all documents including the Logs of the internal inspections shall be allowed to the consultants for inspection at any stage and time of the implementation of the work.

7.13.4 **Submittals:**

- **Overall Schedule:** The contractor shall submit an overall schedule meeting the requirement of clients within a week of signing the contract.

- **Production and Quality control Plan:** The contractor shall submit the Production procedure and Quality Control Scheme for the project work within a week of signing the contract.

- **Shop drawings:** The contractor shall submit two copies of shop drawings prior to start of the real fabrication. During submission of drawing contractor shall submit the design of connection system.

- **Erection Plan:** The contractor shall submit the Erection plan showing the followings:
  - Sequence of Erection
  - Use of temporary supports/ scaffoldings.
  - Type of equipment to be used in various stages of Erection
The Consultant’s approval for above will not relieve the Contractor of his contractual obligations or of his responsibility for providing proper methods, and safety precautions, equipment and workmanship.

**As-built drawings:** The contractor shall submit two copies of As-built drawings within a month of completion of the project.

**Necessary Approvals:** All the submittals shall be get approved by the consultant.

### 7.14 MATERIAL AND WORKMANSHIP

#### 7.14.1 Materials

- Structural Steel: IS 2062 - 1984
- Steel Tubes: IS 1161-1979
- Steel Beams, Channels: IS 808-1957
- Structural Fasteners: Hexagonal bolts, 4.6 Grade
- Welding rod: Any make confirming grade E 6013 or equivalent.

#### 7.14.2 Workmanship

The work shall be carried out by skilled manpower required for each activity. Necessary Jigs, Templates, Shop drawings etc. shall be used for standard fabrication processes.

#### 7.14.3 Tolerance

The contractor shall, though appropriate planning and continuous measurements in the workshop and at the erection site ensure that the tolerance limits given in IS: 7215-1974.

### 7.15 CONSTRUCTION REQUIREMENTS

#### 7.15.1 Fabrication:

##### 7.15.1.1 Templates and Measurements

The contractor shall be fully responsible to supply all templates, jigs and other appliances necessary to ensure the accuracy of the work.

##### 7.15.1.2 Straightening

All the material shall be checked and straightened as required prior to start fabrication work. Any corrective action shall be taken so that when assembled, adjacent surfaces shall be in close contact throughout. The methods adopted for the work above shall be such as not to damage, mark or impair the strength of the material.

##### 7.15.1.3 Cutting

Cutting shall be done automatically or semi automatically. Hand cutting may be used exceptionally, if approved by the consultant.

Cutting by shearing machine can be used for plates not exceeding 12 mm in thickness provided that the plate edge be fully enclosed in a weld.

Gas and / or Plasma cutting may be used provided a smooth and regular surface free form cracks and notches is secured and provided that the roughness of gas and / plasma cut surfaces shall not be high.

All plate edges that will not be welded shall be ground to plainness and rounded to the appropriate radius for painting.

##### 7.15.1.4 Holing

Holes for bolts shall be drilled. Punching of holes shall not be permitted. If not otherwise indicated on the drawings, the diameter of holes shall be in accordance of IS 800.
7.15.1.5 **Welding**

All welding shall be planned and executed using the most suitable materials and working method for particular purpose. Site welding will only be permitted for special condition after the approval of consultants.

Welding requirement shall be in respect to IS: 816

The contractor shall be fully responsible for the inspection and corrective measures for the physical as well as structural defects of welding. In no case, unmatched with the design concept and inferior connections shall be allowed.

7.15.1.6 **Bolting**

Bolting shall be done in accordance to the relevant Indian standard for high strength shear bolts. The tightening of the bolts shall also confirm the relevant codes.

7.15.4 **Transportation and Erection:**

7.15.4.1 **Transportation of goods**

The contractor shall be fully responsible to assure that the goods including its painting shall not be damaged in any form during any mode of transportation. Proper safety measures etc. shall be used during transportation of goods.

7.15.4.2 **Erection**

Erection at site shall be done manually with no disturbances to the existing structures.

7.16 **PAINTING AND RUST PREVENTION PROCESS**

7.16.1 **Hot Dip Galvanizing**

The material which has to hot dip galvanized shall be done so in accordance with the IS 2629 – 1966. The zinc used for the purpose shall be of not less than 95% purity.

The thickness of galvanization shall be 610 g/m² for all surfaces. The fitness after galvanizing regarding all physical imperfections etc. shall be referred to IS 4759 – 1979.

7.16.2 **Aviation Paint**

Tower shall be painted by alternative strip of signal red and white color to warn the aero planes flying over the tower.

7.16.3 **Storage of paints**

The paints shall be stored in sealed containers in a store where it is not exposed to extreme temperatures. Any special storage conditions recommended by the manufacturer shall be observed.

Paint which has not been used within the ‘self life’ period specified on the containers or within 12 months of the date of manufacture, which is longer shall be replaced.

7.16.4 **Application of Paints**

The execution of the painting works shall be carried out in the most perfect and workmanlike manner by experienced labor using brush, spray or rollers to the satisfaction of the consultant. Furthermore, the application of the paints shall be carried out in accordance with the manufacturer’s recommendations.

Planning and execution of the painting work shall be in conformity with the supplier’s specifications in respect to minimum and maximum intervals between the applications of the individual coats.

Each coat shall be applied uniformly over the entire surface. Skips, sags, drips shall be avoided. When these occur, they shall be brushed out immediately or the material shall be removed and the surface re-
coated. Each coat shall be allowed to dry for the time specified by the manufacturer or as directed by the consultant before application of any succeeding coat.

The surface must be completely dry, and its temperature should be above the dew point. Paint should only be applied in suitable weather conditions and any fresh paint damaged by weather shall be repainted or replaced. Measures shall be taken to prevent dust or the extraneous matter from adhering to wet paint.

Brushes, when used, shall have sufficient body and length of bristle to spread the paint in a uniform film. Paint shall be evenly spread and thoroughly brushed out on all surfaces, which are inaccessible for painting, by regular means. Rollers, when used, shall be of a type which does not leave a stippled texture in the paint film.

The dry film thickness shall be measured in place with a calibrated film thickness gauges. Wet film gauges may be used for checking but shall not be permitted as a means of predicting the dry film thickness.

7.16.5 Thickness of coatings

The following shall be the thickness of coatings:
- Galvanization - Not less than 85 μm
- Wasp Primer - Not less than 15 μm
- Enamel Paint-1 - Not less than 35 μm
- Enamel Paint-2 - Not less than 35 μm for each coat

Touchup at site shall be done wherever necessary to the satisfaction of the consultant.

7.17 OTHERS

7.17.1 Method of measurement:

The all measurements shall be calculated by theoretical means and shall be followed relevant Indian standard of the method of measurement.

The measurement of structural steel work shall be done in Kg unit. The weight of Nuts, Bolts and washers shall also be measured in the same criteria and shall be in the item of Structural Steel in Bill of Quantities.

The galvanization and painting shall also be measured in the unit specified in Bill of Quantities.

8. ALUMINIUM WORK

8.1 GENERAL

The window shall be made out of extruded aluminum section (Al. Mg. Si.) and shall conform to IS – 63400, AA-6063 unless otherwise directed. Aluminum sections shall be anodized and the anodic film shall be 12-15 microns. The colours shall be as directed. The 2-3 tracks on outer frame of standard size otherwise directed shall be fixed in the position by using heavy duty plastic grips with necessary plugs and fillers. All the sliding shutters shall be provided with two ball bearing rollers and ratting pieces/guides one each at the top and bottom, weather strips all around. For openable window shall be double weather stripped, one strip shall be provided in outer frame and other shall be in the shutter frame. The hinges or stay hinges of openable window shall be strong. Pin of the hinges shall be of non-corroding materials, preferably nylon/steel. All the joints shall be mechanically fixed. All the window shutter shall be provided with special locking arrangement. Glass shall be fixed in the shutter by means of rubber gaskets.

8.2 MATERIALS

8.2.1 Sections

All items shall be fabricated from aluminium sections conforming to alloy 50 SWP, IS 63400 (WP), AA: 6063 T6 (WP), and BS: HE 9 (WP) with a natural anodized finish of 25 micron thick of mat texture non-directional and non-specular.
All aluminum sections shall be Indal brand or equivalent conforming to the quality as above codes and standards and same size, shape, specified below.

<table>
<thead>
<tr>
<th>Ref No</th>
<th>Description</th>
<th>Size &amp; Thickness in mm</th>
<th>Weight kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>4096</td>
<td>Side and top frame section</td>
<td>62.0 x 29.7 x 1.6</td>
<td>0.778</td>
</tr>
<tr>
<td>4095</td>
<td>Bottom frame section</td>
<td>62.0 x 29.7 x 1.6</td>
<td>0.875</td>
</tr>
<tr>
<td>9778</td>
<td>Interlock section</td>
<td>28.9 x 39.0 x 1.5</td>
<td>0.632</td>
</tr>
<tr>
<td>9777</td>
<td>Handle section</td>
<td>20.0 x 39.0 x 1.5</td>
<td>0.493</td>
</tr>
<tr>
<td>9152</td>
<td>Frame section</td>
<td>44.0 x 33.6 x 1.6</td>
<td>0.577</td>
</tr>
<tr>
<td>9838</td>
<td>Sash section</td>
<td>44.0 x 46.0 x 1.6</td>
<td>0.654</td>
</tr>
<tr>
<td>9846</td>
<td>Transom section</td>
<td>59.0 x 38.0 x 1.6</td>
<td>0.814</td>
</tr>
<tr>
<td>9774</td>
<td>Flyscreen frame section</td>
<td>14.9 x 43.0 x 1.2</td>
<td>0.435</td>
</tr>
<tr>
<td></td>
<td>U-Channel</td>
<td>12.0 x 12.0 x 1.6</td>
<td>0.160</td>
</tr>
<tr>
<td></td>
<td>Angle</td>
<td>12.0 x 12.0 x 1.6</td>
<td>0.100</td>
</tr>
<tr>
<td>9809</td>
<td>Plain tube frame section</td>
<td>63.0 x 37.0 x 1.5</td>
<td>0.786</td>
</tr>
</tbody>
</table>

Main members shall be of such strength that a wind pressure of 1.16 kPa shall cause a deflection of not more than 1/240 of the span of the member. No permanent deflection shall result from such conditions of loading. Joints shall be sufficiently robust to withstand the above loading without causing failure or movement. The aluminum fabricator shall guarantee that all fabricated aluminum work shall comply with the above conditions.

8.2.2 Hardware, Glass and Accessories

All hardware shall conform to the brand name or foreign manufactured items listed below or of an equivalent quality brand. The responsibility of demonstrating equivalent quality for alternate brands shall rest on the fabricator.

1. Rollers French polyamide-coated on needle bearings
2. Weather Strips British 100 percent polypropylene weather piles
3. Locks Japanese Reliance hook locks
4. Gaskets Indian EPDM marine quality
5. Louvers Indian ‘Wind-Roll’ sections
6. Flyscreen Net Bangkok ‘Polymate Co.’ fiber net
7. Silicon Wacker & Quilosa brand
8. Screws Nickel-coated pan head
9. Rawal Plugs Plastic ferruled grips 8mm diameter (Locally produced grips not acceptable)
10. Shims Neoprene plastic shims
11. Clear Glass Modi float glass 5mm thick
12. Opaque glass Tribeni ‘figure glass’ 4mm thick

8.3 Fabrication

Fabricated aluminum work covered by this specification shall be supplied and installed by the well-known local aluminum fabricators as approved by the Engineer. Before placing any orders the Contractor shall state the name of the window manufacturer he has selected from the list of approved manufacturers. The nominated manufacturer shall not be changed without prior approval of the Engineer.

Fabrication shall be according to best practices and all cutting and shaping shall be made with properly functioning machinery manufactured for the purpose of fabricating aluminium products. Hand cutting, shaping and slot cutting by hand will not be acceptable.

Joints shall be mitered or coped and shall be provided with extruded corner reinforcement. All joints shall be tight fitting, flush with the adjoining member, neat and sealed. Slots shall be provided in all vertical guides and sides of the bottom track to allow water to be flushed out.

All fabrication shall conform to the configuration of windows and ventilators shown in the design drawings or as directed by the Engineer. The size of individual windows and ventilators shall be measured after the rough openings have been plastered. The dimensions of the windows and ventilators shall allow a 5-7mm gap between the frame and rough opening to provide space to inject a silicon seal. The Contractor shall
assume full responsibility to ensure the dimensions of the windows and ventilators match size of the openings.

All surfaces shall be adequately protected during fabrication, transportation and storage to prevent any damage. Bent, dented or scratched sections and scratched glass will not be accepted and all such items shall be replaced. The Contractor shall arrange for the preparation of complete workshop drawings of all fabricated aluminum work and shall submit same to the Engineer for approval.

8.4 ASSEMBLING

The whole assembling process is done in the factory on assembling tables. The frames and sash are assembled using screw and silicon in the corner joints to ensure perfect water proofing.

8.5 INSTALLATION

The fabricator shall be responsible for all window and ventilator installation and shall well-trained and competent staff for this work.

Before installation all rebates shall be fully painted with type and color of paint specified for the adjacent walls or ceiling. The tracks shall be installed with 40mm pan head screws and plastic grips at sufficiently close intervals to rigidly secure the tracks to the walls, lintels and sills. Neoprene plastic shims shall be placed on both the interior and exterior side between the aluminum tracks and the sides of the window opening at all screw locations. The tracks shall be perfectly plumb, level and square forming exact 90-degree angles at the corners and parallel with walls. The 5-7mm gap between the tracks and the rough opening shall be filled with a thermocol plastic filler and sealed with silicon in a neat, smooth bead flush with the face of the track. Following completion of the installation the aluminum section faces shall be cleaned of all silicon, finger marks and other matter and the tracks shall be vacuumed to remove all aluminium fillings, dust and other matter. The window and ventilator glass shall also be cleaned.

8.6 ASSEMBLING AND FITTING ACCESSORIES

- Architectural Silicon
- Backing Rod
- Plastic Wedges
- Stainless Screw

8.7 DETAILS OF EQUIPMENTS

- Elumatec Cutting Machine (TS 161).
- Elumatec Routing Machine (AS 70/44).
- Drilling Machines.
- Portable Cutting Machine.
- Assembling Tables.

8.8 MEASUREMENT

Windows shall not be measured but rate shall be based on a fixed cost for each style of window and ventilator. The rate shall include the cost of all material, fabrication, installation and cleaning, all complete.

9. CARPENTRY AND MILL WORK

9.1 SCOPE OF CARPENTRY WORK

Provide all labour, materials, equipment, transportation and operations necessary for and incidental to the completion of all woodwork as herein specified or shown the Drawings.

9.2 MATERIALS FOR CARPENTRY WORKS

Generally all hardwood timber used shall be of best quality salwood (Robusta shoria) or other species as shown on the Drawings or directed by the Engineer. Only heartwood shall be used, and sapwood shall be allowed. Softwood shall not be used anywhere unless specified or shown on the Drawings or as approved by the Engineer.
9.3 TIMBER

9.3.1 Quality

Timber shall generally conform to IS 287-1960. Timber to be used for the work shall be from the heartwood. It shall be uniform in substance, straight in fiber, free from large, loose, dead or cluster knots, flaws, shakes, warp, cup spring, twist, bends and defects of any kind. It should be free from spongy, brittle, flaky or brushy condition, sapwood and borer holes.

All timber shall be seasoned and be free from decay, harmful fungi and insect attacks and from any other damage of harmful nature which will affect the strength, durability, appearance or its usefulness for the purpose for which it is required.

Any timber rejected shall be removed immediately from the work site.

9.3.2 Type

The timber shall be of best quality timber as specified in the item. The samples of the approved timber to be used shall be deposited in the office of the Engineer for the future reference.

9.3.3 Colour

The color shall be uniform as far as possible. Darker colors among color species of timber are generally a sign of strength and durability.

9.4 SEASONED TIMBER

All timber shall be well-seasoned, air-dried or kiln-dried, to maximum allowable moisture content of 12% by weight. Generally seasoned timber shall be considered fit for carpentry work when it has lost 1/5 of its original weight and fit for millwork when 1/3 of its original weight has been lost in seasoning. At all times after the materials have been kiln-dried they shall be handled, stored, worked, transported and installed under conditions such that the moisture content provided by the dry kiln will be maintained.

9.5 STORAGE OF TIMBER AND WOODWORKS

General
All timber and assembled woodwork shall be protected from the weather and stored in such manner as to maintain not more than the maximum allowable moisture content, prevent attack from insects and decay and prevent physical injury.

Implementation
As soon as the foundation of buildings are laid, all necessary timber and scantlings shall be brought to site and stacked as laid down in IS. 401-1967 till required.

Timber for the work shall not be brought to site until seen and approved by the Engineer. The Engineer may reject timber that has been plugged, painted, or otherwise altered to hide defects. Timber presented for inspection shall be clean and free from dust, mud, paint or other material that may conceal the defects. Cut ends may be protected after inspection with raw linseed oil or any other materials approved by the Engineer. No timber shall be painted with any substance without the previous permission of the Engineer.

9.6 VENEERS

Plywood, blackboard, chipboard, cork board, etc. shall be waterproof conforming to IS standards and as approved by the Engineer.

9.7 WOOD PARQUET

Wood parquet flooring shall be of best quality conforming to the quality and material mentioned above.
9.8 **Preservatives for Wood**

Preservatives shall be of coal or creasote type or its variations conforming to IS 218 or approved wood primer.

9.9 **Finishing of Woodworks**

Finishing of woodwork shall be as specified in chapter 16 of this specification or as directed by the Engineer.

9.10 **Adhesive for Timber**

Adhesive or glue shall be synthetic resin of good, waterproof and high strength quality for load bearing joints or where damp conditions may be expected. For non-load bearing joints or where dry conditions are guaranteed resin or organic glues may be used.

9.11 **Workmanship and Layout of Woodwork**

All work shall be executed with best quality workmanship and shall conform in all aspects to approved assembled wood-work samples. The contractor shall also layout, fit, cut and erect framing for rough and finished work, blocking, nailing, furring and all other rough carpentry. All members shall be in true alignment, braced plumb and level closely fitted, and rigidly secured in place. Defects shall be removed and replaced.

9.12 **Sawing and Surface Finish**

All scantlings and boardings shall be accurately sown and shall be of uniform thickness and width throughout. Sawing shall be left with sawn surface except where exposed or indicated to be wrought and all millwork exposed surfaces shall be wrought and sanded to an approved finish suitable to the specified treatment.

9.13 **Provision of Hardware**

The work shall be accurately set out in strict accordance with the Drawings and as specified herein and shall be framed together and securely fixed in the best possible manner with properly made joints. All necessary brads, nails, screws and bolts rough hardware etc. shall be provided as directed and approved.

The hardware materials shall be of brass of approved quality unless otherwise specified.

9.14 **Door and Window Hardware**

Providing and fixing all hardware in the doors and windows as specified in the design drawings.

**Material**

All hardware shall be new, of robust design and of the best quality as per instruction of Engineer. Tower bolts, aldrops, hooks, and sliding latches shall be of heavy-duty aluminium. Door handles and locks shall be the best quality Godrej or equivalent. Hinges shall be of heavy-duty steel. The buffer plate shall be fabricated from well-seasoned sal wood. All items shall conform to the size and description in the design drawings and BOQ and samples shall be approved by the Engineer before installation.

**Installation**

All fixtures shall be fixed to the jointing in a secure and efficient manner. Any of the fixtures damaged during fixing shall be removed and new ones fixed in their place and the surface of the joinery made good where affected at the Contractor's expense. Whenever the type of hardware is not mentioned on the drawing or BOQ the decision of the Engineer shall be followed. The fastening and fixtures shall be provided as per the fastening and fixture schedule.

**Measurement**

These items are not to be measured separately. The cost of all material and labor for these items shall be included in the rate for doors and windows.

9.15 **Tolerances in Dimensions**

Actual dimensions of scantling and boarding for carpentry work shall not vary from the specified dimensions by more than 1.5mm and must be uniform throughout. Dimensions for boards of 2.5 cm thickness or less
and for all millwork shall hold up to the specified sizes. All timbers shall be full length required with no joining to occur in any framing, shutter or bead member unless otherwise shown in the Drawings.

9.16 **SETTING OUT FOR INSPECTION**

All millwork shall be accurately set out on boards to full size for information and guidance to the artisans before commencing the respective works with all joints, fasteners, hardware and other work connected therewith fully delineated. Such setting out shall be inspected for approval before work commences.

9.17 **JOINTS IN WOODWORK**

All work shall be properly morticed, tenoned, housed, shouldered, dovetailed, notched, wedged, pinned, screwed bradded or glued as shown on the Drawings or as approved by and to the satisfaction of the Engineer. Joints must be as specified or detailed and so designed and secured as to resist or compensate for any stresses to which they may be subjected. Loose joints shall be made where provision must be made for shrinkage, glued joints where shrinkage need not be considered and where sealed joints are required.

9.18 **JOINT BETWEEN WOOD AND OTHER WORKS**

All doors, windows and partition frames, sills, etc. which are to be fixed to brickwork or concrete shall by means of grounds, lugs, holdfasts etc. bedded solid in mortar and pointed as directed. All portions of timber abutting or embedded shall be painted with hot coal tar or approved wood primer before installation. Any gaps between the frame and masonry or brickwork shall be shimmed and wedged and caulked as indicated on the Drawings or as approved by the Engineer. Generally joints 10 mm and less shall be caulked with suitable approved materials to form continuous weatherproof joints. Joints greater than 10 mm width shall be filled with continuous wood or other suitable material before caulking.

9.19 **FASTENING OF DOORS AND WINDOWS**

Doors, windows and partition of all frames shall be secured head, jambs and sill with screws, lugs or 40 x 12 mm wrought iron holdfasts or 12 mm bolts as indicated in the drawings unless otherwise indicated. All rough hardware shall be galvanized iron unless otherwise stated.

9.20 **PAINTING OF WOODWORK**

All millwork, trim and finish shall be primed and back painted thoroughly as indicated in the Drawings or as directed by the Engineer. All concealed surfaces of millwork shall be protected with two (2) coats of bitumen paint.

9.21 **INSTALLATION OF WOODWORK**

Wood grounds, nailors and similar items shall be provided as required for the support, proper erection or installation of the work, and blocking inserts cast into concrete shall be formed to accommodate the fastening requirements.

9.22 **FITTING OF HARDWARE**

Hardware shall be fitted prior to the application of finishes, removed during the finishing operation and rest after completion of the finish or shall be protected by using suitable wrappers against the staining of the hardware with the finishing materials and operation.

9.23 **INSTALLATION OF HARDWARE**

All hardware shall be accurately and securely installed. Metal knobs and handles shall be protected by wrappers of tough paper or cloth and maintained in place until acceptance of the work.

9.24 **INSTALLATION OF HARDWARE NOT TO DAMAGE OTHER WORKS**

During installations of items of hardware care shall be taken not to damage other works. Locations and positioning of hardware shall be in accordance with the Drawings and the directions of the Engineer.
9.25 **BOARDINGS, ETC.**

Cork surfaced bulletin boards, black boards, and other similar or miscellaneous items shall be in accordance with the details shown on the Drawings.

9.26 **TIMBER STANDARDS**

Grading and general requirements for timber shall conform to the Indian Standards.

9.27 **SAMPLE OF WOODWORK AND HARDWARE**

Before any work is started the contractor shall submit for approval representative samples of finished, assembled woodwork showing kind of wood, color, graining, finish and typical detailing and joints. All finished woodwork shall conform to the approved samples. The samples shall be maintained at the site for reference.

All finish hardware shall conform to approved samples. Samples shall be furnished by the Contractor for approval.

9.28 **SHOP DRAWINGS OF MILLWORK**

Shop drawing shall be furnished by the Contractor on all millwork except that shows full size on the drawings. Separate shop drawings shall be used to properly separate the work as it will be produced and used.

9.29 **STORAGE OF MILLWORK**

Particular care shall be taken to protect carpentry and millwork against dampness during the progress of the work. Store in well-ventilated space and where not exposed to extreme changes in temperature and humidity.

9.30 **PROTECTION OF WOODWORK**

Particular care shall be taken to protect woodwork against damage during installation, the progress of construction and cleaning operations. Woodwork shall be in perfect conditions and subject to the approval of the Engineer.

9.31 **MAINTENANCE OF WOODWORK**

Care shall be taken to maintain woodwork in clean state. All cleaning shall be carried out in a manner approved by the Engineer.

9.32 **WOODEN HAND RAIL**

Seasoned Seasam wood hand rail of approved pattern and quality including 3mm x 40mm mild steel flat connector to be welded to balusters with screws, nails and bolts all as shown in the drawings.

9.33 **WOODEN DOOR SHUTTERS**

9.33.1 **General**

The shutters shall conform to the relevant specification for the type and grade as specified in IS 2202-1973. The flush door shutters as specified shall be manufactured by a reputed factory such as Sitapur Plywood Flush Doors, Madras; the Indian Plywood manufacturing Co. LTD., Bombay or companies offering equivalent quality product and having hot press and all modern equipment. The shutters shall be produced from well-seasoned wood and shall have a factory warranty against warping, twisting and lamination separation. Samples shall be submitted for the approval of the Engineer.

**Construction**

The limping cum frame (style and rail) shall be 50mm wide of required thickness and shall be of an approved, good-quality, semi-hard wood such as sissom. There shall be three numbers of horizontal wooden spacers of 100mm width with one in middle. Lock block of 50mm wide shall be provided vertically
on both sides between the wooden spacers. Wooden batten shall also be provided. The shutter shall be of the size and dimensions shown in the drawing.

The veneer shall be of good quality commercial plywood, waterproof plywood or teak-faced plywood not less than 4mm thick as specified in the design drawings or as approved by the Engineer.

**Bonding Medium**
Liquid phenol formaldehyde synthetic resin shall be the bonding medium.

**Finish**
There shall be no visible joint of the plywood on the finished side. Shutters with chipped, cracked or other defective material or workmanship shall be rejected. The door shutters shall be hung in position with 3 nos. 150mm mild steel butt hinges. The shutter shall be finished with all necessary hardware as shown in drawing and mentioned in BOQ such as aluminium aldrops, aluminium tower bolts, magnetic door stoppers, aluminium kick plates, buffer plates etc.

**Measurements**
Shutters shall be measured in net length and width and the area calculated there from. The rate shall be inclusive of supply and installation of the shutter all specified hardware and fixtures per according to the design drawings.

Solid - core flush shutters shall be of waterproof and antitermite commercial or teak veneered type as specified in drawings and of approved quality. An approved sample shall be deposited in the office of the Engineer.

### 9.33.2 Types of Shutters

**Teak wood paneled shutters:** Solid 25 mm thick water and weather proof veneer finished with mechanically pressed 3 mm thick teak ply on both sides Wherever possible each panel shall be in a single width piece. But where two pieces are used, width of each piece should not be less than 12.5 cm. In order to avoid warping, splitting and cracking, normally pieces not exceeding 20 cm. in width should be used. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint and glued together and reinforced with metal dowels. The grains of solid panel shall run along the longer dimension of the panel. Panels shall be framed into grooves to the full depth of the groove leaving an air space of 1.6 mm and the faces shall be closely fitted to the sides of the grooves. Mouldings to the edge of panel openings shall be scribed at the joints.

**Glazed shutters:** They shall be similar to paneled shutters except that such parts as are directed shall be glazed with sheet or ground glass or plain glass as specified. Styles and rails shall be rebated 12 mm to receive glass, flash bars shall be moulded and rebated and metered on sides, to receive the glass. Glass panes shall be fixed with putty and beads.

Providing and fixing in position 38mm thick factory made solid core flush door shutters single or double leaf, including the supply and fixing of hardwood beading and all hardware – door handles and locks, tower bolts, door stoppers, hinges, aldrops, buffer plates and kicker plates.

**Panel and Louver Doors**
Providing and fixing in position 38mm thick panel door shutter single or double leaf, including the supply and fixing of all hardware – door handles and locks, tower bolts, hinges, aldrops, buffer plates and kicker plates. The fabrication and installation shall conform to IS 1003 Part I-1966 for door shutters.

**Frame**
The shutter frame shall be fabricated from top quality sal wood with side, top and intermediate members finished to a width of exactly 38mm and width of not less than 95mm. The bottom member shall be finished to an exact thickness of 38mm and width not less than 195mm. The internal edges shall be grooved as required to accept wooden panels or louvers as shown on the design drawings. The members of the frame shall be joined with mortise joints and secured with good quality wood glue and at least two wooden pins, minimum 8mm diameter, at each joint. All corners shall be square at exactly 90-degree angles.

**Louvres**
The wooden louvers shall be fabricated from top quality sal or sisau pieces 12mm thick and shall conform to the size and shape shown on the design drawings. The louver frame shall be of 12 x 30mm
sal or sisau joined at the corners by tongue and groove joint glued and nailed. The corners shall be square at exact 90-degree angles. The louver slats shall be attached to the frame with glue and nails at the specified gap and slope as shown in the design drawings. The louver assembly shall be set in the shutter frame and attached with flathead wood screws, countersunk and holes filled with wood filler. Vertical slats if required shall be provided as per instruction of the Engineer.

**Panels**
Shutter panels shall be Modi float glass of specified thickness or 19mm plywood, either waterproof or commercial as indicated on the design drawings. The glass panel shall be set either in the rebate or on the edge of the molding fixed to the frame by first placing a small bead of silicon in the rebate or on the edge of the molding to provide a uniform bearing and seal between the wood and glass. A silicon bead shall then be placed on the fixing side of the glass and a molding strip of the size and shape as indicated on the design drawings pressed into the silicon and nailed to the shutter frame. The plywood panel shall be set in the rebate cut in the shutter frame and attached with flathead wood screws. Molding of the shape and size indicated on the design drawing or as directed by the Engineer shall be attached at the joint of the frame and panel to cover the screws and gap between the panel and frame. The molding shall be attached with good quality wood glue and nails countersunk and holes filled with wood filler.

**Installation**
The door shutters shall be hung in position with 3 nos. 150mm mild steel butt hinges. The shutter shall be finished with all necessary hardware as shown in drawing and mentioned in BOQ such as aluminium aldrops, aluminium tower bolts, magnetic door stoppers, aluminium kick plates, buffer plates etc. All hardware shall be approved by the Engineer before installation. The clearance between the finished shutter and the doorframe and between any adjacent shutters shall not exceed 2mm unless otherwise specified in the drawing.

9.33.3 Glazing in Doors and Windows
Providing and fixing glass in clerestory and window ventilator shutter with silicon and wooden molding as shown in the drawing.

**Material**
Silicon shall be fresh and of the best quality available. The glass shall be Modi float glass or equivalent quality of the size, shape and thickness as specified in the design drawings or by the Engineer. The glass shall be free from shacks, bubbles, air holes, veins, blisters or any other defects. It shall be uniform thickness. Samples shall be approved prior to use.

**Workmanship**
All windows shall have glazing fixed outline and as shown on the Drawings with wooden beads and putty. The glass shall be cut to size to fit slightly loose. The molding shall be of sal wood or other hard wood as shown in the design drawings. Installation shall be executed by first placing a thin bead of silicon in the rebate and then pressing the glass into the bead to provide a uniform bearing. A bead of silicon is then placed at the edge of the glass and a wood molding is pressed into the silicon to obtain a uniform bearing and seal. The molding shall be fixed with panel pins spaced not more than 150mm apart.

**Measurement**
The measurement shall be in square meters calculated on the actual size of glass installed. The rate shall include the supply and installation of glass, silicon, moldings and panel pins, all complete.

9.33.4 Aluminium Protective Sheet
Providing and fixing aluminum protective sheet on door shutter as per the design drawings.

**Material**
The sheet shall be fabricated from 20 SWG aluminium sheet to the exact dimensions specified in the design drawings or BOQ. The edges of the plate shall be lightly ground with fine carborundum stone to remove all burrs and produce a smooth rounded edge.

**Installation**
The sheet shall be fixed such that the edges are flush with the edges of the door shutter. The aluminum sheet shall be fixed on the shutter with rubber cement and 25mm anodized screws placed at each corner and equally spaced along each edge at approximately 200mm intervals.
Measurement
This item is not to be measured separately. The cost of all material and labor for this item shall be included in the rate for door shutters.

9.33.5 Measurement
Shutters shall be measured in net length and width and the area calculated therefrom. The rate shall be inclusive of supply and installation of the shutter all specified hardware and fixtures per according to the design drawings.

10. MOISTURE PROTECTION WORKS

10.1 WATERPROOFING OF STRUCTURAL CONCRETE BY CRYSTALLIZATION

10.1.1 SCOPE OF WORK:
Waterproofing of Structural Concrete by Crystallization (non-polymeric, Water based treatment). The manufacturer of the waterproofing compound shall be of international repute acceptable to the Engineer.

The materials shall be applied in accordance with the instructions provided in the manufacturer's instructions manual and shall be carried out by an appropriate applicator licensed or authorized by the manufacturer to expertly carry out the installation. Supplementary products and other ancillary products shall also be used as may be necessary to ensure that treatment fully matches the quality standards specified and guaranteed by the manufacturer.

10.1.2 AREAS TO BE TREATED:
Basement Floor Slab and Retaining Wall areas, (Additionally, optional Treatment as may be required of horizontal P.C.C. slab area with one coat approved Concentrate-DS), RCC Drinking Water Reservoir Tank Walls and Floor areas, Roof and Terrace Slab areas, exposed Foam Concrete surface, Toilet and Kitchen/Pantry Floor areas, construction joint area, External Face of exposed areas of Beams and Columns, Shear Walls and other surfaces prior to commencing Brick or Metal cladding works, as well as additional areas where structural concrete is exposed and/or comes into direct contact with water or ambient moisture.

10.1.3 METHODOLOGY:
A. Mixes:
   i. General: Mix waterproofing material by volume with clean water, which is free from salt and deleterious materials. Mix waterproofing material in quantities that can be applied within 20 – 30 minutes from time of mixing. As mixture thickens, stir frequently, but do not add additional water. Do not mix bonding agents or admixtures with crystalline waterproofing materials.

   ii. Brush Application Mix: Measure dry powder and place in mixing container. Measure water and mix into the dry powder with a paddle on a slow speed electric drill (250 RPM) or other type mixer which is acceptable to manufacturer. Mixing proportions shall be as follows:

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Proportions (by Volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8 Kg/m2</td>
<td>5 powder to 2 water</td>
</tr>
<tr>
<td>1.0 Kg/m2</td>
<td>3 powder to 1 water</td>
</tr>
</tbody>
</table>

   iii. Spray Application Mix: Mixing shall be same as specified for brush application except that mixture shall be thinner. Use following proportions as a guide only. Adjust proportions to match type of spray equipment and pressures used. Mixing proportions shall be as follows:

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Proportions (by Volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8 Kg/m2</td>
<td>5 powder to 3 water</td>
</tr>
</tbody>
</table>

   iv. Dry-Pac Mixes: Using a trowel, mix 1 part clean water with 6 parts approved Concentrate powder for 10 - 15 seconds. It is acceptable that lumps may be present in mixture. Mix only as much as can be applied in 15 minutes.
B. Execution

1. Concrete Finish: Concrete surfaces to receive approved waterproofing treatment shall have an open capillary system to provide tooth and suction, and shall be free from scale, excessive form oil, laitance, curing compounds and foreign matter. Horizontal surface shall have a rough wood float or broom finish.

2. Surface Preparation: Smooth surfaces to be treated shall be thoroughly clean of deleterious materials, excessive form oils and other contaminants and shall be lightly sand blasted, water blasted or acid etched with muriatic acid as necessary to provide a clean, absorbent surface.

3. Repair of Concrete Defects: Surface defects such as rock-pockets, honeycombs, or other defects such as tie-holes, construction joints, cracks, etc., shall be repaired in accordance with manufacturer’s instructions stated in its manuals.

4. Wetting Concrete: Prior to application of the waterproofing treatment, thoroughly saturate concrete surfaces with clean water as stated. In case of application on “Green” Concrete, light cleaning and pre-watering may be required to ensure the migration of necessary moisture and the subsequent treatment into the concrete.

C. Application:

1. Construction Joints: Apply approved Concentrate in slurry form @ 1.08 Kg./m² to joint surfaces between concrete pours. For inaccessible joint surfaces, consult the manufacturer or the appropriate authority.

2. Sealing Strips and Coves: Prepare concrete surfaces that will come into Contact with sealing strips and coves by applying one coat of approved Concentrate in slurry form @ 0.8 Kg/m². Then apply approved Concentrate in Dry-Pac form (for sealing strips) or approved Modified in mortar consistency (for cove) after the slurry coat has reached an initial set but is still “green”. Where Coves are indicated on drawings, trowels apply and pack approved Modified mortar into a cove shape.

3. Surface Application: After repairs, surface preparation, treatment of construction joints and sealing strip placements have been completed in accordance with the manufacturer’s product data and as specified herein, apply approved treatment uniformly to concrete surfaces with a semi stiff bristle brush or broom, or suitable spray equipment. Application rates and locations shall be as indicated in the drawings and in accordance with manufacturer’s product data. When brushing, work slurry well into the surface of the concrete, filling surface pores and hairline cracks.
   i. First Coat (of one or two coat application): Apply approved Concentrate slurry coat to locations specified or indicated on drawings in accordance with manufacturer’s product data.
   ii. Second Coat (of two coat application): As specified in the manufacturer’s data or indicated on drawings, apply approved Modified slurry coat while first coat of approved Concentrate is still “green” but has reached an initial set. Lightly pre-water when rapid drying conditions exist.

D. Curing:

a. General: Begin curing as soon as approved coating has hardened sufficiently so as not to be damaged by a fine spray. Cure approved treatment with a mist fog spray of clean water three times a day for 2 – 3 days, or cover treated surfaces with damp burlap for the prescribed period. In warm climates, more than three sprayings per day may be necessary to prevent excessive drying of coating.

b. Air Circulation: Do not lay plastic sheeting directly on the waterproofing coating as air contact is required for proper curing. If poor circulation exists in treated areas, it may be necessary to provide fans or blown air to aid in curing of waterproofing treatment.

c. Holding Structures: For concrete holding structures such as swimming pools, reservoirs, water treatment tanks and wet wells, cure approved treatment for three days and then allow treatment to set for 12 days before filling structure with liquid. For structures holding hot or corrosive liquids, cure waterproofing treatment for three days and allow to set for 18 days before filling.

d. Protection: During curing period, protect treated surfaces from damage by wind, sun, rain and temperatures below 2 degree Centigrade. If plastic sheeting is used for protection, it must be raised off of waterproofing coating to allow sufficient air circulation.

e. Curing Agent: If moist curing is not possible, use a chemical curing agent that is specifically designed for or compatible with the approved crystalline waterproofing treatment. Curing agent shall have at least two years of successful field use and shall be approved by waterproofing manufacturer in writing.
TESTING REQUIREMENTS FOR CRYSTALLINE WATERPROOFING:
All materials and accessory products shall be supplied directly by the approved manufacturer, with its
labels and instructions intact as per the manufacturer's instruction/specs. Manuals and shall rigidly
conform, before commencing actual application works, for inspection and formal approval by the
Engineer along with authentic Certification of Tests, conducted by internationally renowned independent
laboratories, against the following quality test standards that are capable of meeting or exceeding the
performance requirements as under:

i. The Independent Laboratory undertaking such independent tests mentioned hereunder,
   shall meet the standards set under ASTM E 329-95 and be certified by the US Bureau of
   Standards.
ii. Concrete Permeability Test: conforming to CRD-C-48-73 of the US Army Corps of Engineer
iii. Chemical Resistance Test for Mortars and Concretes as per ASTM C267-77 demonstrating
    Compressive strength increases.
iv. Freeze-Thaw and De-icing, and other Chemical Resistance Test to De-scaling of Concrete
   Surfaces exposed to such chemicals as per ASTM C672-76
v. Radiation Exposure Test Report as per “Protective Coating for the Nuclear Industry under US
vi. Potable Water Approval shall conform to Independent testing conducted in accordance with
    NSF Standard 61 for use of waterproofing material on structures holding potable/drinking water.
vii. Crystallization Penetration Test shall be evidenced by independent SEM (Scanning
    Electron Microscope) photographs documenting penetration of crystal-forming
    waterproofing material to a depth of minimum 50 mm.
viii. Waterproofing material for Crystallization of concrete shall be free of polymer and/or other
    solvents. It shall be cement, silica sand and water mixing slurry based.
in. Crystallization treated concrete shall comparatively exhibit marked increase in comprehensive
   strength depending on strength design and comparative analysis provided by the
   manufacturer.
x. Crystallization material shall be capable of withstanding extreme conditions of temperature
   within range –32 degrees C to +130 degrees C at constant temperature or within –185 degrees
   C to + 1530 degrees C periodic temperature.
xi. Crystallization material shall have no effect on its treatment resulting from extreme conditions of
    Humidity, Ultraviolet exposure, or Oxygen levels (oxidation).

10.2 WATERPROOFING OF STRUCTURAL CONCRETE BY USING MENBRANE

10.2.1 General

The waterproofing system in basement will be a ready to use membrane of HY 400 (400 grams/M2)
Polythelene Polypropylene Polymer compound with a bonding of special building glue like Rheomix-141,
a MBT product.

Water proofing protection treatment in the basement foundation shall be carried out just before the
laying of steel reinforcement for raft concrete. The flexible membrane barrier of HY 400 grade-PPPCWM
to control the infiltration of water shall be laid on the entire RCC surface with the normal overlapping of
100mm on edge to each other layer.

10.2.2 Application Procedures

10.2.2.1 Water proofing protection treatment system to basement

The sub-base (P.C.C.) of the ground structure shall be cleaned and all dirt, loose materials should be
removed thoroughly. Then after, a 25mm thick cement sand plaster (1:5) should be applied to make the
surface smooth and leveled. The plaster should be done with smooth finishing. During the application of
product the surface should be kept dry by continuous pumping water.

After laying of membrane smoothly on the green plastered surface it should be pressed smoothly. The
overlapping joints are glued by specified glueing system. When the entire basement surface is covered
by HY series membrane, the joints of each rolling membranes shall be extra protected by laying of 100%
synthetic brushable rubber coating of RC 2000/2200 on the 75 mm wide along the joints to provide monolithic bond on the overlapping areas.

After completion of laying of HY series apply the extra protective plaster screed with 25 mm (1:5).

10.2.2.2 Water Proofing Protection Treatment System for Shear Wall:

When the construction of RCC works for raft and shear wall is over, the HY protective membrane system applied earlier below the raft concrete section shall be exposed and this is further extended on the vertical surface upto the plinth level. The joints of the applied membranes on the vertical wall also shall be sealed with specified glueing system as well as rubber coating along the joints (75 mm wide). The water proofing membrane is further protected by plastering with cements sand mortar in 1:4 ratio. In addition to this the application of HY 400 grades of protective membrane system on the surface of positive hydrostatic pressure, all construction joints between the raft and shear wall shall be considered for extra protection by pressure grouting (injection) treatment with an expanding plasticizing grout admixture Flowcable-50 inside of basement so as to seal the honey combs and joints between shear wall and raft. Water proofing protection treatment system for shear wall shall be carried out as follows:

- The outer surface of shear wall structure shall be cleaned of all dirt, loose materials thereafter a 25 mm thick plaster (1:4) should be applied to make the surface smooth and leveled. The plaster should be finished smooth.
- Apply the Pheomix – 141 cement bonding coat or any approved building glue on the entire outer plastered surface of shear wall.
- After laying HY series membrane smoothly on the green bonding layer it should be pressed smoothly.
- The overlapping joints are glued by specified glueing system. When the entire surface is covered by HY series membrane, the joints of each rolling membranes shall be extra protected by laying of 100% synthetic rubber coating of RC 2000/2200 on the 75 mm wide along the joints to provide monolithic and on the lapping area. After completion of laying of HY series membrane, the extra protective plaster screed of 12 mm thick in 1:4 shall be applied in the treated surface of shear wall.

11. GLASS WORKS

11.1 SCOPE FOR GLASS

Provide all labor, materials, equipment, transportation and operation necessary for and incidental to the fixing of glass panes in windows, doors, ventilation and partitions as herein specified or shown on the Drawings.

11.2 GLASS

All glass shall be of standard quality free from flaws, bubbles, specks and other imperfection. Clear sheet glass shall be of O.Q. quality and plate glass shall of S.G. quality or "Float" glass.

a) Reflective Type Colored Tinted Float Glass
   - 0 Arctic Blue Eclipse Reflective Glass, coating on #2 Surface, or 1/4" Pilkington Arctic Blue High - Performance Tinted Float Glass
b) Glass Box (Brick)
c) Frosted Glass
d) Float Glass
e) Toughen Glass

11.3 THICKNESS OF GLASS

Generally glass for glazed doors shall be 4mm thick and for windows 4 mm thick for length of glazing less than 1.5 m. For length of glazing greater than 1.5 m the thickness shall be 5mm unless otherwise indicated on the Drawings or herein specified.

11.4 PUTTY FOR FIXING GLASS

Putty for glazing in wood frames shall be prepared by mixing (1) part white lead with three (3) parts finely powdered chalk powder and then adding pure unadulterated boiled linseed oil and mixing into a stiff, knife - consistency paste. Approved glazing compound prepared and applied in accordance with manufacturer's specifications and as herein specified may be used.
11.5 **CUTTING THE PANES**

Glass panes shall be cut to have square corners and straight edges to sizes to fit slightly loose in the frames with not more than 3mm clearance all round.

11.6 **INSTALLATION OF GLASS**

All glass shall be installed securely bedded in putty in the following manner.

a) A thin layer of putty is first put in the rebate of the frame and glass is then placed and pressed into the putty to a solid bearing.

b) The glass is then face-puttied after which the wood beads fastened in place and any spaces that may occur between the glass and wood are filled by forcing putty into such voids and surplus putty is removed with the putty-knife.

c) All putty joints shall be continuous and for all exterior glazing shall be absolutely watertight.

d) Putty shall be painted approximately ten days after glass is fixed to prevent the putty from cracking.

11.7 **CLEANING OF GLASS**

Prior to acceptance of the building clean all glass throughout. Remove labels, grease, paint and other foreign substances, leaving the work in perfect condition.

Methods of cleaning glass panes other than as listed below are to be approved by the Engineer and in no account shall windows be cleaned by scraping with glass or by other harmful means.

a) Cleaning with methylated spirit and soft clean cloths.

b) Painting the glass panes with lime wash and leaving it to dry and then washing with clean water.

c) Rubbing with finely powdered chalk.

d) Rubbing with damp salt for cleaning paint spots.

12. **FINISH HARDWARE WORKS**

12.1 **SCOPE FOR HARDWARE**

Furnish all finish hardware necessary to complete the project, in sufficient quantities to meet the project requirements, even though every such item is not specifically mentioned, including the correct number of screws of proper size, materials and finish for each pieces of hardware in perfect operating conditions.

12.2 **STORAGE OF HARDWARE**

Storage, installation, condition and operation of all hardware shall be provided for under chapter 8 of this specification and as indicated on the Drawings or directed by the Engineer.

12.3 **HARDWARE MATERIALS**

All hardware shall be of the approved manufacturer's standard for first quality and in accordance with the standards as established by ISI.

a) Door Locks: (A) Bolt/Cavier (B) Suro Vigil/Eureka Forbe (C) Dorma

b) Anodized Aluminium Hardware: (A) Arkey (B) Essel (C) Everite

c) Floor Spring For Aluminium Door: (A) Geze (B) Dorma

d) Door Closer: (A) Geze (B) Dorma

e) Brass/Powder Coated Hardware: (A) Eribehri (B) Parmar (C) Palladium

f) Hinges, Drawer Slides, Trays: (A) Cavalier, (B) Ebco

g) Push & Kick plates: Push plates and kick plates shall be made of brass or as indicated on the Drawings.

h) Handrails: Handrails of all types for Stair Case Handrails wall shall be made up of Stainless Steel with different Diameters as per standard IS - Grade 304 Standards. The handrail pipes of stainless steels are to be selected and samples shall be approved from the Engineer as per aforesaid Standards.
13. **PLASTER WORKS**

13.1 **MATERIALS FOR PLASTER WORK**

Lime, cement, sand and water used shall be in accordance with the requirements of chapter 5 and chapter 6 of this Specification. Sand shall be graded to a suitable fineness to produce smooth, even steel troweled finished surface.

Cement: The cement shall conform to the specifications under concrete work grade 43.

Sand: Sand shall conform to the general specifications for sand under concrete work. Sand mix shall consist of approximately 50 percent course sand as specified for concrete mix and 50 percent fine sand as specified by the Engineer. Sand shall be washed and free of all mica, clay, silt, organic and any other foreign matter.

Wire Mesh: Wire mesh over joints of dissimilar material shall be 19mm chicken wire mesh of 20 SWG galvanized wire or any other material approved by Engineer.

13.2 **MIX OF PLASTER**

Plaster mix shall be in accordance with the requirements of Section 6.02.

13.2.1 **Wall Plaster**

Wall rendering with 12mm thick cement plaster 1:6 (1 part cement to 6 parts sand) over a spatter dash coat of 1 part cement to 1 part course sand.

13.2.2 **Ceiling, Soffits and Exterior Plaster**

Ceiling, soffits and exterior rendering with 12mm thick cement plaster 1:4 (1 part cement to 4 parts sand) over a spatter dash coat of 1 part cement to 1 part course sand.

13.3 **PREPARATION OF SURFACE TO BE PLASTERED**

The surface to be plastered shall be brushed clean mortar joints of brick masonry or hollow concrete walls or any other surface to be plastered shall be raked to a depth of approximately 12mm, and the surface brushed down with a stiff brush and thoroughly wetted. The surface shall be free of all dust, loose materials, grease etc. Ceiling surface should be hacked with close proximity to the satisfaction of the Engineer.

13.4 **METHOD OF PLASTERING**

Plaster shall be applied in two coats. The thickness of the first cost shall be just sufficient to fill all unevenness of the surface and shall be applied with even, firm pressure to insure good bond, cross scratched and moist cured. After the first coat has properly cured, let dry thoroughly, then dampen and apply the finish coat. The finish coat shall be steel trowel finished to a smooth, even, burnished surface, completely free from defects or trowel marks. The thickness of plaster in total shall not be less than 12 mm. Wall plastering shall be started from top and work down bond to the floor. Ceiling plastering shall be completed before starting the wall plastering. To ensure uniform thickness and vertical plaster face plumb guider strips may be applied as required.

**Application:**

Surface shall be brushed clean of all foreign matter. Mortar, concrete or any other material projecting from the plane surface of the wall shall be removed. Chicken wire mesh shall be placed over the joints between brick or stone masonry and concrete columns, beams or other concrete structural members and between brick and stone masonry walls to prevent cracking of plaster. The mesh shall lap on each side of the joint by at least 200mm and fixed to the masonry with masonry nails placed no more than 300mm apart in the mortar joints. The mesh shall be attached to concrete surfaces by 19mm grips and screws spaced nor more than 300mm apart. Concrete nails may be used in place of grips and screws only if the nails can be securely fastened in the concrete. All concrete surfaces shall be hacked to produce a rough surface to ensure the plaster will properly adhere to it.

The plaster shall be applied in two coats, the first a spatter dash and the final coat. The spatter dash coat shall consist of a slightly liquid mixture of 1 part cement to 1 part course sand and thrown forcefully onto the wall surface. This coat shall be left to set for at least 12 hours before applying the final finish coat of 1:6.
plaster. This application of the spatter dash is to produce a rough surface on which the final coat of plaster will adhere.

The final coat shall consist of cement mortar in proportions of 1:6 for Wall (1 part cement to 6 parts sand) and 1:4 for ceilings (1 part cement to 4 parts sand) by volume. The cement and sand shall be accurately measured and dry mixed in a mixing machine. The mix shall be kept dry and hand mixed with water as the work proceeds, mixing only the quantity of plaster that can be consumed within a 30-minute period. Water shall be carefully added to the mix to produce a stiff plastic mixture, care being taken not to add more water than is required. Mortar that has started to set shall not be used.

The finished surface shall be minimum 12mm thick, uniform in texture with adjacent walls truly perpendicular to each other, corners at 90 degrees and the plaster on each wall truly vertical and absolutely plane without waves. The surface shall be finished at once by being rubbed over with trowel till the cement appears on the surface. All corners, angles and junctions shall be truly vertical and horizontal as the case may be and carefully and neatly finished. Rounding of corners and junctions as required and directed shall be without extra charge. The finished plaster shall be cured for 7 days and protected against damage. Sample of workmanship shall be approved prior to commencement of work.

**13.5 ADDITIONAL STRENGTH OF CORNERS**

To give additional strength to external angled corners, the corners shall be dusted with neat cement during the steel trowel finishing of the finish coat.

**13.6 FINISHED PLASTER SURFACE**

Care shall be taken to insure that finished plaster surfaces shall be plumb, square, straight and true to line. All arises and corners shall be straight clean and sharp.

**13.7 CURING OF PLASTER WORKS**

Moist curing shall be accomplished by keeping the plaster uniformly damp by suitable means. Moist curing shall start during application and continue for not less than 7 days.

**13.8 APPROVAL BY THE ENGINEER**

All plaster work shall be subject to approval of the Engineer, and work failing to meet the requirements of these specifications to the satisfaction of the Engineer shall be dismantled and replaced at the Contractor's expense.

**13.9 SAMPLE OF PLASTER WORK**

Before starting plaster work, the contractor shall prepare a sample panel of plastering at least one square metre for the approval of the Engineer. The sample shall be prepared in an area designated by the Engineer. The Contractor shall obtain approval before starting work and preserve the approved sample intact until all plastering is completed.

**13.10 MEASUREMENT**

Measurements shall be in square meters of the finished plaster surface. Opening shall be deducted in full and jambs and soffits shall be measured in square meters. Openings less than 1 square meter shall not be deducted nor shall payment be made for jambs, soffits or the sides of such openings. The rate shall include all materials (including supply and installation of wire mesh), scaffolding and curing for both spatter dash and final plaster coats; hacking concrete surfaces; rounding of all corners and junctions; making grooves and forming drip courses wherever required. Unless otherwise specified nothing extra shall be allowed for plaster on independent columns and beams, any short width or on curved surfaces and difficult location. No extra payment shall be made for extra lift.
14. **TILES AND STONE FINISHING WORKS**

14.1 **VITRIFIED FLOOR TILE**

14.1.1 **Material**

A) **TILES:** All the Tiles sizes and shades shall be as per pattern approved by the Engineer. Tiles shall be either manufactured by Johnson or any other approved brand.

B) **TILE FIXING:** Use Grey polymer modified cementitious adhesive from approved manufacturer for vitrified floor tile fixing.

C) **TILE JOINT FILLING:** Use Polymer modified cementitious Grout from conjunction with **BAL ADMIX-GT1** for filling tile joints.

D) **CEMENT:** OPC – 43 Grade, Sand: fine preferably of Zone II or III of IS: 383, potable water. **(EPOXY GROUT should be used where Chemical resistance & hygiene is Important).**

14.1.2 **Tools**

A) **TILE FIXING:** Use Metal Trowel for Adhesive beds spreading on substrate. 6mm Round notched trowel for all floor tiles

B) **TILE JOINT FILLING:** Use a Rubber Pad or Squeeze for filling BAL Grout with ADMIX-GT1 in the tile joints.

14.1.3 **Preparation:**

Surface Back ground substrate should be neatly plastered with 1:3 Cement Sand without scratch coat, in plumb & level, cured with water for at least two weeks. (Tiles are need not to be soaked in the water but simply cleaned by a cloth)

14.1.4 **Application**

A) **TILE FIXING:**

1. Mix adhesive powder with clean & potable water (approx. 2 parts powder & 1 part water by volume) to achieve a smooth & lump free paste.
2. Apply the adhesive paste on prepared substrate for tiling, with suitable trowel. (Check Tools A) holding trowel @ 45 to 50 degrees to floor.
3. Spread adhesive paste 1 sq. m. at a time & check intermittently wetness of paste before placing tile.
4. Slide & push tile into spread paste with a slight twisting action to achieve complete coverage behind tile within 15-20-min time.
5. Keep suitable joints.
6. Clean the surplus Adhesive paste from joints.

B) **TILE JOINT FILLING:**

1. Mix ADMIX-GT1 or equivalent with water in proportion 100ml Admix GT1 to 250 ml Water to make homogeneous liquid mixture.
2. Mix GROUT with Liquid mixture (Approx. 1kg Grout to the 350 ml liquid mixture) to achieve a smooth & lump-free paste.
3. Fill up the tile joints with Grout paste without breaks or gaps into tile joints using Squeeze.
4. Use Paste within 20 minutes time period
5. After 30 minutes remove the excess Grout on tile surface with a wet sponge & then with a dry sponge.

**(PRECAUTION: Joint filling with GROUT should be carried out after complete setting of Adhesive paste).**

14.1.5 **Joints in Tile Work**

Joints in tile work shall be accurately aligned with horizontal joints level and vertical joints plumb. Joints shall be maintained uniformly wide by aligning spacer lugs on tile edges if tiles are so manufactured or by use of wetted strings.
14.1.6 Tile Layout

Layout tile work so that no tile less than half size occurs, where tile must be cut at edges or penetrations, the cut edges shall be carefully fitted and neatly ground. No chipped, cracked or broken tile shall be used and all defective work shall be replaced and repaired to the satisfaction of the Engineer and at the Contractor's expense.

14.1.7 Coverage

A) TILE FIXING: For a good substrate following coverage are possible.
   - 6mm Round notched trowel for all floor tiles - Approx. 40-50 Sq. ft

B) TILE JOINT FILLING: Please refer to BAL ENDURA or any other approved manufacturer's Grout Data Sheet.

14.1.8 Curing

Use Products including Adhesives & Grouts that are self cured products & need NO WATER CURING.

14.1.9 Trafficking

Trafficking can be carried out after 24 HOURS.

14.2 VITRIFIED CLADDING TILE

14.2.1 Material

A) TILES: All the Tiles sizes and shades shall be as per pattern approved by the Engineer. Tiles shall be either manufactured by Johnson or any other approved brand.

B) TILE FIXING: Use Grey polymer modified cementitious adhesive in conjunction with ADMIX AD1 or equivalent for vitrified tile cladding.

C) TILE JOINT FILLING: Use Polymer modified cementitious Grout available in multi natural shades in conjunction with ADMIX GT1 or any equivalent for filling tile joints.

D) CEMENT: OPC – 43 Grade, Sand: fine preferably of Zone II or III of IS: 383, potable water. EPOXY GROUT should be used where Chemical resistance & hygiene is Important.

14.2.2 Tools

A) TILE FIXING: Use Metal Trowel of following sizes for Adhesive beds spreading on substrate.
   1. 3mm Trapezoidal notched trowel for wall tiles (Size upto 8"x12")
   2. 6mm Round notched trowel for all floor tiles & wall tiles above size 8"x12"

B) TILE JOINT FILLING: Use a Rubber Pad or Squeeze for filling Grout with ADMIX-GT1 in the tile joints.

14.2.3 Preparation:

Back ground substrate should be neatly plastered with 1:3 Cement Sand without scratch coat, in plumb & level, cured with water for at least two weeks.
(Tile are need not to be soaked in water but simple cleaned by a cloth).

14.2.4 Application

A) TILE FIXING:
   1. Mix ADMIX-AD1 or equivalent to clean potable water in proportion 1.25 Lit. ADMIX-AD1 to 5 Lit water to achieve a homogeneous liquid mixture.
   2. Mix adhesive powder with the homogeneous mixture (approx. 20 Kg adhesive powder to 6.25 liquid Mixture) to achieve a smooth & lump-free paste.
   3. Apply the adhesive paste on prepared substrate for tiling, with suitable trowel.( Check Tools A)
   4. Spread adhesive paste 1 sq. m. at a time & check intermittently wetness of paste before placing tile.
5. Slide & push tile into spread paste with a slight twisting action to achieve complete coverage behind tile within 15- 20-min time.
7. Clean the surplus Adhesive paste from joints.

B) TILE JOINT FILLING:
1. Mix ADMIX-GT1 or equivalent with water in proportion 100ml Admix GT1 to 250 ml Water to make homogeneous liquid mixture.
2. Mix GROUT with Liquid mixture (Approx. 1kg Grout to the 350 ml liquid mixture) to achieve a smooth & lump-free paste.
3. Fill up the tile joints with Grout paste without breaks or gaps into tile joints using Squeeze.
4. Use Paste within 20 minutes time
5. After 30 minutes remove the excess Grout on tile surface with a wet sponge & then with a dry sponge.

(PRECAUTION: Joint filling with GROUT should be carried out after complete setting of Adhesive paste).

14.2.5 Coverage

A) TILE FIXING: For a good substrate following coverage are possible.

1. 3mm Trapezoidal notched trowel for wall tiles (Size upto 8"x12")- Approx. 50-60 Sq. ft
2. 6mm Round notched trowel for all floor tiles & wall tiles above size 8"x12"- Approx. 40-50 Sq. ft.

B) TILE JOINT FILLING: Please refer to BAL ENDURA or any equivalent approved manufacturer's Grout Data Sheet.

14.2.6 Curing

Use Products including Adhesives & Grouts that are self cured products & need NO WATER CURING.

14.2.7 Trafficking

Trafficking can be carried out after 24 HOURS.

14.3 GRANITE CLADDING (INTERNAL)

14.3.1 Material

A) GRANITE SLAB: All the Granite Slabs should be from Karnataka (INDIA) and 18-20 mm thick pre-polished on all visible side and machines cut in shapes and sizes to design shown on drawings.

B) GRANITE FIXING: Use Grey polymer modified cementitious adhesive for Internal Granite cladding.
(Note: Use of ADMIX- AD1 or equivalent is essential for large format Granite slabs.)

C) GRANITE JOINT FILLING: Use Polymer modified cementitious Grout available in multi natural shades for filling granite joints.
(EPOXY GROUT should be used where Chemical resistance & hygiene is Important).

D) CEMENT: OPC - 43 Grade, Sand: Fine preferably of Zone 2 or 3 of IS: 383, potable water.

TOOLS

A) GRANITE FIXING: Use Metal Trowel for Adhesive beds spreading on substrate.
6mm Round notched trowel for all floor granite & wall granite above size 8"x12".

B) GRANITE JOINT FILLING: Use a Rubber Pad or Squeeze for filling Grout in granite joints.

PREPARATION: Surface back ground substrate should be neatly plastered with 1:3 Cement Sand without scratch coat, in plumb & level, cured with water for at least two weeks.
APPLICATION
A) GRANITE FIXING:
1. Mix adhesive powder with clean & potable water (approx. 2 parts powder & 1 part water by volume) to achieve a smooth & lump-free paste. (Note: Use of ADMIX-AD1 or equivalent is necessary for large Granite slabs, Ref: "External Cladding With Granite" to know application of Admixture).
2. Apply the adhesive paste on prepared substrate for tiling, with suitable trowel. (Check Tools A) holding trowel @45 to 50 degrees to wall.
3. Spread adhesive paste 1 sq. m. at a time & check intermittently wetness of paste before placing granite.
4. Slide & push Granite into spread paste with a slight twisting action to achieve complete coverage behind tile within 15-20 min time.
5. Clean the surplus Adhesive paste from joints.

B) GRANITE JOINT FILLING:
1. Mix GROUT with water (Approx. 3 parts Grout To 1 part water by Weight) to achieve a smooth & lump-free paste.
2. Fill up the tile joints with Grout paste without breaks or gaps into tile joints using Squeeze.
3. Use Paste within 20 minutes time
4. After 30 minutes remove the excess Grout on Granite surface with a wet sponge & then with a dry sponge.

(PRECAUTION: Joint filling with GROUT should be carried out after complete setting of Adhesive paste).

COVERAGE
A) GRANITE LAB FIXING: For a good substrate following coverage are possible. 6mm Round notched trowel for all floor granite & wall granite above size 8"x12"- Approx. 40-50 Sq. ft.

B) TILE JOINT FILLING: Please refer to BAL ENDURA or any other approved manufacturer's Grout Data Sheet.

CURING
Use Products including Adhesives & Grouts that are self cured products & need NO WATER CURING.

TRAFFICKING: Trafficking can be carried out after 24 HOURS.

GRANITE CLADDING (EXTERNAL)

MATERIAL
A) GRANITE SLAB: All the Granite Slabs should be from Karnataka (INDIA) and 18-20 mm thick pre-polished on all visible side and machines cut in shapes and sizes to design shown on drawings.

B) GRANITE FIXING: Use Grey polymer modified cementitious adhesive in conjunction with ADMIX-AD1 or equivalent for External Granite cladding.

C) GRANITE JOINT FILLING: Use Polymer modified cementitious Grout available multi natural shades in conjunction with ADMIX-GT1 or equivalent for filling tile joints.

(EPoxy GROUT should be used where Chemical resistance & hygiene is Important).


TOOLS
A) GRANITE FIXING: Use Metal Trowel for Adhesive beds spreading on substrate.
   1. 3mm Trapezoidal notched trowel for wall Granite (Size upto 8"x12").
   2. 6mm Round notched trowel for all floor Granite & wall Granite above size 8"x12".

B) GRANITE JOINT FILLING: Use a Rubber Pad or Squeeze for filling Grout with ADMIX-GT1 in the tile joints.
**PREPARATION:** Back ground substrate should be neatly plastered with 1:3 Cement Sand without scratch coat, in plumb & level, cured with water for at least two weeks.

Cement: OPC – 43 grade, Sand: Fine preferably of Zone 2 or Zone 3 of IS: 383, potable water.

**APPLICATION**

A) **TILE FIXING:**
1. Mix ADMIX-AD1 or equivalent to clean potable water in proportion 1.25 Lit. ADMIX-AD1 to 5 Lit water to achieve a homogeneous liquid mixture.
2. Mix adhesive powder with the homogeneous mixture (approx. 20 Kg Adhesive powder to 6.25 liquid mixture) to achieve a smooth & lump-free paste.
3. Apply the adhesive paste on prepared substrate for tiling, with suitable trowel. (Check Tools A) holding trowel @45 to 50 degrees to wall.
4. Spread adhesive paste 1 sq. m. at a time & check intermittently wetness of paste before placing.
5. Slide & push Granite into spread paste with a slight twisting action to achieve complete coverage behind tile within 15- 20-min time.
6. Clean the surplus Adhesive paste from joints.

B) **GRANITE JOINT FILLING:**
1. Mix ADMIX-GT1 or equivalent with water in proportion 100ml Admix GT1 to 250 ml Water to make homogeneous liquid mixture.
2. Mix GROUT with Liquid mixture (Approx. 1kg Grout to the 350 ml liquid mixture) to achieve a smooth & lump-free paste.
3. Fill up the granite joints with Grout paste without breaks or gaps into granite joints using Squeeze.
4. Use Paste within 20 minutes time.
5. After 30 minutes remove the excess Grout on Granite surface with a wet sponge & then with a dry sponge.

(PRECAUTION: Joint filling with GROUT should be carried out after complete setting of Adhesive paste).

**COVERAGE**

A) **GRANITE FIXING:** For a good substrate following coverage are possible.
   6mm Round notched trowel for all floor tiles & wall tiles above size 8”x12”- Approx. 40-50 Sq. ft.

B) **GRANITE JOINT FILLING:** Please refer to BAL ENDURA or any other approved Brand’s Grout Data Sheet.

**CURING:**

Use Products including Adhesives & Grouts are self cured products & need NO WATER CURING.

**TRAFFICKING:**

Trafficking can be carried out after 24 HOURS.

**15. CAST IN SITU FLOORS, SCREEDS AND SKIRTING WORKS**

**15.1 SUB-FLOORING - R.C.C**

Providing and laying 75 mm thick reinforced cement concrete 1:2:4 (1 part cement, 2 parts sand and 4 parts stone aggregate 20mm and down) sub-floor with 8mm reinforcing bars damp-proof membrane and brush finish.

**Material**

**Concrete:** The concrete mix shall be in the proportion of 1:2:4 with 20mm aggregate and shall conform to the specifications for structural concrete as stipulated in clause 2 of these Specifications. If 20mm round river aggregate of good quality is available at the same or less cost, the Contractor shall use this aggregate in place of the crushed aggregate.

**Water Proofing Membrane:** The plastic sheet for the waterproof membrane shall be 500-gauge clear polythene sheet of approved quality or HY series 400 grade Material.
Reinforcing Bars: The reinforcing bars shall be 8mm diameter CDT or TMT conforming to the specifications for reinforcing steel as stipulated in clause 2.11 of these Specifications.

Welded Wire Mesh: The welded wire mesh shall be 25mm square pattern with 14 SWG wire conforming to IS 4948:1974.

Installation
The surface of the sub-grade whether sand/gravel fill, stone soling or brick soling shall be cleaned of all foreign matter and made free of all sharp objects that could puncture the water-proof membrane.

The polythene sheet or HY series shall be laid over the sub-grade and plinth beams with a minimum 200mm overlap on all edges. The sheet shall be carefully laid around the floor dowels by slitting the ends of the sheet ensuring the sits align with the position of the bars. For sheets laid continuous over the interior plinth beams, holes may be punched in the sheet at the corresponding position of the reinforcing dowels and the sheet carefully slid over the dowels ensuring they do not tear the sheet. Care must be taken that no punctures are made or created on the sheeting. The punctured portions shall be properly sealed. Traffic should be avoided over the sheeting once it is laid. The sheet must be held in position until the concrete floor is cast.

The plinth beam dowels shall be bent to their correct horizontal position as shown in the design drawings and the 8mm reinforcing bars shall be laid and tied in place at the spacing indicated in the design drawings. Care must be taken to ensure the polythene sheet is not torn or displaced during installation of the reinforcing bars. The bars shall be supported by cover blocks staggered in rows 500mm apart in both directions. The blocks shall be 35mm high to support the bars at the approximate center of the 75mm thickness of the concrete floor. The bars shall be cleaned of all oil, grease, earth and other foreign matter before laying the concrete. To prevent cracks in the floor over plinth beams, welded wire mesh shall be placed over the portion of plinth beams on which no superstructure wall is to be erected. The mesh shall be placed such that the edges extend beyond the edges of the plinth beam by 300mm. The mesh shall be laid on top of the reinforcing bars and securely fastened to the bars with binding wire. The ends of the mesh shall be lapped a minimum of 200 mm.

The concrete shall be of the specified mix with just sufficient water to facilitate hand compaction with only mild tamping. The concrete shall be carefully placed so as not to displace or puncture the plastic sheet, leveled and mildly tamped to consolidate the concrete and to bring the slurry to the surface. After the initial set the surface shall be brushed with a stiff brush (Khareto) to produce deep scratches in the surface for bonding with the finish floor. Any smooth cement film visible on the surface of the concrete must be removed by brushing and washing with water. The work should be completed in one operation or at the direction of the Engineer. The sub-floor shall be cured for at least seven days.

Measurement
The measurements shall be in cubic meters calculated from the length, width and thickness of the concrete sub-floor. Nothing shall be admissible for slope, small areas, corners and work in any shape. Deductions will be made for columns and any other area exceeding 0.05 square meters not concreted. Rate The rate shall include the cost of all material, labor for installation, delivery and storage, all complete, except the supply and installation of reinforcing bars and welded wire mesh that will be separate items measured in kilograms and running meters, respectively.

15.2 CAST IN SITU MOSAIC FLOOR (NOT APPLICABLE )

15.3 IPS FINISH FLOOR

Providing and laying 40 mm thick plain cement concrete 1:2:4 (1 part cement, 2 parts sand and 4 parts stone chips 10mm) finished floor with a smooth punning finish.

15.3.1 Material

Concrete: The concrete mix shall be in the proportion of 1:2:4 with 10mm stone chips and shall conform to the specifications for concrete as stipulated in clause 2 of these Specifications. If 10mm round river gravel of good quality is available at the same or less cost, the Contractor shall use this gravel in place of the stone chips.
15.3.2 Installation

The surface of the sub-floor must be absolutely clean of all foreign matter. Any plaster or other cement material must be chipped from the surface so as to reveal the original brush finish. After thoroughly cleaning the surface, a cement slurry shall be brushed over the sub-floor on which finished floor is to be immediately installed. The slurry must not set before the top finish layer is poured and should be applied just prior to laying the concrete of the finish floor.

The concrete shall be of the specified mix with just sufficient water to facilitate hand compaction with only gentle tamping. The concrete shall be laid to the specified levels and slope (if required) in thickness not less than 40mm. The surface shall be worked to bring the cement slurry to the surface and fill all voids. A 1mm layer of 1:1 cement/sand punning mixture shall be uniformly spread over the surface of the floor and troweled smooth. At the initial set the surface shall be finished with a steel trowel producing a smooth, uniform surface. The surface shall be without float mark or air holes.

After the final finish and before the surface fully sets, lines shall be imprinted on the surface with a heavy cord approved by the Engineer and in the pattern indicated in the design drawings or as approved by the Engineer. The finish surface shall be cured for 7 days. A sample of the finished floor shall approved by the Engineer before starting the actual work.

15.3.3 Measurement

The measurements shall be in square meters calculated from the length and width of the finished floor. Nothing shall be admissible for slope, small areas, corners and work in any shape. No deduction shall be made for protruding or independent columns occurring in the floor, doorframes embedded in the floor or any other item when the area does not exceed 0.1 square meters. The rate shall include the cost of all material and labor for installation and finishing, all complete.

15.4 CEMENT PLASTER SKIRTING

Providing and laying 18mm thick cement plaster skirting of any height in cement mortar 1:3 (1 part cement and 3 parts sand) finished with a floating coat of neat cement and hardening liquid.

15.4.1 Material

The mortar mix shall be in the proportion of 1:3 cement/sand and shall conform to the specifications for these materials as stipulated in clause 2 of these Specifications.

15.4.2 Installation

The thickness of the skirting shall be governed by the thickness of internal plaster. It shall project by 6 mm. from the finished surface of the plaster. The receiving surface shall be prepared as per the plastering on walls.

Mortar shall be well mixed and applied as per cement plaster. When the surface becomes even it shall be uniformly covered with a 1mm coat of neat cement finish mixed integrally with a hardening liquid 2 liters to 50 kg of cement and troweled to a smooth finish. The corners, angles, junctions shall be truly vertical and or horizontal. Rounding of corners and junctions as required shall be done without any extra charge. The finished surface shall be cured for 7 days. The Engineer shall approve samples of workmanship prior to execution of work.

15.4.3 Measurement

The measurements shall be in square meters of the work done and rate shall include material and labor, all complete.

15.5 CEMENT SKIRTING AND DADO

The cement skirting shall consist of 20 mm thickness of 1:3 cement and mortar as specified in the drawings. The cement skirting shall be applied to the wall surface to the line, levels and dimensions, and finished with a floating coat of neat cement.

The cement skirting and dado shall comply with the general requirements of this chapter and chapters 5,6. The measurements shall be in running meters of the work done and rate shall include material and labor, all complete.
15.6 Mosaic Skirting

Providing all materials and laying 20mm thick mosaic (terrazzo) skirting of any height with a 8mm thick white cement and marble chips finish over a base of plain cement mortar in 1:3 (1 part cement and 3 parts sand). Thickness of base course (screed/plaster) - backing shall be of 22 - 25 mm thick. The measurements shall be in running meters of the work done and rate shall include material and labor, all complete.

15.6.1 Materials

Mosaic: Materials are the same as in item 8.4 with the exception of glass strips that are not required. Cement Plaster: Materials are the same as in item 9.1.

15.6.2 Installation

The thickness of the skirting shall be governed by the thickness of internal plaster. It shall project by 6 mm. from the finished surface of the plaster. The receiving surface shall be prepared as per the plastering on walls.

The base plaster shall be of 1:2, one part cement and three parts sand, and applied as per the specifications for wall plaster ensuring that the thickness will allow for the finished mosaic surface to extend exactly 6mm out from the surface of the adjacent wall plaster. The finished surface shall be roughened to ensure good bond with the mosaic finish.

Marble chips constitute at least 70% of mosaic surface and shall be mixed in equal proportions with the white cement and marble dust, i.e. one part marble chips, one part white cement and one part marble dust. The thickness of the mosaic finish shall be minimum 8mm. The required quantity of marble chips, marble dust and white cement for the complete work shall be thoroughly mixed and carefully stored to be used as the work progresses. Only the amount of mix that can be laid in one hour shall be mixed with water. Water shall be added in quantities to produce a stiff plastic mix such that the cement can be easily worked into all voids.

The mosaic finish shall be applied no later than 24 hours after the application of the base plaster. The mosaic mix shall be troweled onto the surface of the bedding plaster and worked until the surface is smooth true to line. The corners, angles, junctions shall be truly vertical and or horizontal. Rounding of corners and junctions as required shall be done without any extra charge. The finished surface shall be cured for 7 days. The mosaic shall be hand ground with roughing stone of no. 60 grit followed by a finishing stone of no. 80 grit. Neat cement grout shall be applied to the cleaned surface to fill the surface voids. Not less than 72 hours later all surplus grout should be removed by regrinding using no. 100 grit stone. The surface shall be ground evenly with finest grade. After final grinding with uniform line and level, oxalic acid shall be dusted over the surface, sprinkled with water and rubbed hard with pad and woolen rags. The finished surface shall be completely dried and a sealing compound of 1kg wax to 5 liters turpentine applied as the finished coat.

The Engineer shall approve samples of workmanship prior to execution of work.

15.7 Curing and Protection of Cast in Situ Floor

Curing, protection of cast in situ floor shall be in accordance with the requirements of chapters 5, 6.

16. Punning and Pointing Works

16.1 Materials

The materials required for punning and pointing works as cement, sand and water shall be in accordance with the requirements of chapters 5 and 6.

16.2 Mortar Mix

The mortar mix for the works shall be in accordance with the requirements of Chapter 6. Cement used per unit area to be given.
16.3 **PREPARATION OF THE BASE SURFACE**

Before applying the punning and pointing, the base surface shall be cleaned, any dust or loose particles removed. The average thickness of the punning and pointing work shall not be less than 3 mm. The pattern shall be as per instruction of the Engineer or as shown in the drawings.

The coat shall be finished by rubbing with a steel trowel and any depression shall be filled in and rubbed to shining surface.

16.4 **SAMPLE WORK**

The contractor shall prepare samples of 1 square meter of the punning and pointing works until the quality, texture and finish required is obtained and approved by the Engineer. The approved sample shall be preserved until the punning and pointing works are executed to the conformity with the approved sample.

16.5 **CURING**

The works shall be kept wet at least for 7 days.

17. **PAINTING AND COLOUR WASHING WORKS**

17.1 **MATERIALS AND WORKMANSHIP**

The materials and workmanship for painting and colour washing of internal and external surfaces shall confirm to the respective Indian standards or equivalent.

17.2 **PRIMER COAT**

Supply and application of priming paint for wood, concrete and metal surfaces including surface preparation.

17.2.1 **Material**

The primers shall be in seal tins of Asian Paints P. Ltd, Berger, Jenson & Nicholson P. Ltd., Nerolac Paints P. Ltd. or as approved by the Engineer.

17.2.2 **Surface Preparation**

All surfaces shall be sanded and cleaned. The surface for cement plaster shall be patched with the thick paste of the same primer and smoothed with fine carborundum stone after drying.

In case of timber having knots and nails holes, they should be filled with stopping and knotting materials. The knotting material shall consist of pure shellac dissolved in methylated spirit. For stopping, Russian talc or putty shall be used. The stopping shall consist of two parts of whiting (powdered chalk), one part of white lead mixed together in double boiled linseed oil and well kneaded. The surface thus treated shall be allowed to dry up and then sanded, or a readymade approved putty may be used.

In case of metal, all rust shall be removed with a rotary steel brush grinding machine, sanded and properly cleaned.

17.2.3 **Application**

After preparing the surface, the priming coat shall be applied with natural bristle brushes and as per manufacturer's printed instructions.

17.2.4 **Measurement**

Measurements shall in square meters for surface widths greater than 150mm and in running meters for surface widths less than 150mm according to the following convention. The rate shall be included in the finish painting work unless otherwise specified.
17.3 PLASTIC EMULSION PAINT

The surface shall be prepared as specified for oil paints. First a priming coat of primer as specified by the manufacturer shall be applied and scrapped off.

The second and third coats of plastic emulsion paint of approved shade and manufacture shall be applied to achieve an even surface. If the finish is not to the satisfaction of the Engineer then more coats shall be applied to achieve smooth and even surface.

17.4 READYMADE ENAMEL PAINT

Surface to be painted shall be dry, free from dust and dirt and rubbed smooth by means of sandpaper or pumic stone to the satisfaction of the Engineer.

The paint shall be ready mixed synthetic enamel or oil paint of approved make and manufacture. The primary coat shall be ready mixed of approved make and manufacture and shall be applied even with brushed. After the primary coat is applied and perfectly dried all holes, cracks etc. Shall be filled with putty and the surfaces sand papered. Then a second coat of paint of approved shade and manufacture shall be evenly applied and allowed to dry. The third coat shall be carefully applied as and when required, to achieve smooth and even surface.

17.5 FRENCH POLISH

The work shall be first cleaned and scrapped thoroughly with sandpaper. It then will be painted with a "Filler" composed of chalk and whiting Methylated spirit and sand papered.

A thin coat of French polish shall then be applied and sand papered. Subsequent coats of French polish not less than 5 coats shall be applied till the proper finishing is achieved to the satisfaction of the Engineer.

18. FALSE CEILING WORKS

18.1 PLASTER OF PARIS

These shall be made out of best plaster of Paris powder of approved quality. The boards shall be of 60 x 60 cm. size of 12 mm. thickness, plain or perforated or any other decorative pattern, as specified in the drawings.

The boards shall be fixed on 60 x 60 cm. salwood batten framework of suitable sizes as shown on drawings by brass screws. The screw face shall be sunk 3 mm deep in the board face and the head of screw shall be covered by spotting with plaster of paris paste trowelled flush. The joint in the boards shall be flush and will be filled with plaster of paris paste or as specified.

The battens on which the boards are fixed on salwood runners of designed section as shown on drawings by iron screws. The runners will be 120 cm. centre to centre cross wise and will be supported from the ceiling by WI clamps of suitable length having threads and suitable nuts to hold the runners with necessary washers.

18.2 ACOUSTIC BOARDS

The boards shall be 60 x 60 cms. size 20 mm thickness as specified in the schedule of quantities. Other specifications shall be the same as for Plaster of Paris.

The acoustic boards may be made of
(a) 12 mm thermocaustic board
(b) 3 mm commercial ply board and shall confirm to IS.

18.3 GYPSUM BOARDS

The Fibrous Gypsum Boards shall be 60 x 60 cm. thickness as specified in the schedule of quantity. Other specification shall be same as plaster of paris.

The Gypsum boards shall be made of fibre gypsum reinforced with hessianment and shall confirm to IS.
19. PARTITION WORKS

19.1 ALUMINIUM PARTITIONS

These shall be from proven, simple and elegant material made from a reputed and approved manufacturing unit. The boards shall be made from partly laminated and partly glazed with glass of thickness 4mm. Variation in other decorative texture/pattern finish designs should also be a possibility.

Partitions will be made from aluminium confirming to IS standards and to BS. The partition shall be either square edge or tapered edge finished. The frames of aluminium partition should be best quality of powered coated.

The partition is to be out of various manufactured sizes of boarding/lining material adequately and rigidly strengthened by metal studs and nogging. The partition material should be carefully handled and stored and never dragged while moving.

20. JOINTS SEALERS, WATER STOPERS

20.1 JOINTS IN CONCRETE

The requirement of joints and joint sealers in concrete works shall in general fulfill the requirements of chapter 5.

20.2 WATER STOPS

The Contractor shall supply and fix waterstops in all contraction and expansion joints in members which are to be water-retaining and where shown on the Drawings.

Waterstops built into joints shall be made of rubber or similar approved material and shall have a hollow centre bulb. They shall be obtained from manufacturers approved by the Engineer and shall be stored, fixed and jointed in accordance with the manufacturer's instructions. They shall be fabricated into the longest practicable units complete with angles and junctions at the manufacturer's works and shall be made continuous throughout the structure below highest water level and where shown on the drawings. The number of joints in the waterstop made on Site shall be kept to a minimum.

Where water stop joints are vulcanized site jointing shall be performed strictly in accordance with the supplier's recommendations. The tensile strength of the spliced waterstop at a factory-made splice shall be at least 90% of the waterstop's tensile strength, when tested according to BS 703 with the spliced joint in the middle portion of the dumb-bell test specimen and the tensile force applied normally in the direction of the splice. The tensile strength of a waterstop spliced at the site shall be 80% if the original strength of the waterstop.

The edge bulb section shall be circular. The webs shall be plain without serration. The waterstop shall be carefully maintained in the position shown on the Drawings and properly protected from damage and the harmful effects of light and heat during all stages of construction. The stop-boards on each side of the waterstop shall be accurately wrought to match the profile of the waterstop. The concrete shall be carefully compacted under and around the waterstop so as to leave no cavities.

The Contractor shall supply the manufacturer's test certificates for each consignment of waterstop delivered to site and shall, in addition, supply to the Engineer sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure, if ordered.

The rubber for rubber waterstop shall satisfy the following requirements when tested as moulded sheet in accordance with BS 903:

- Minimum tensile strength: 20 N/mm² (204 kg/cm²)
- Minimum elongation at break: 500%
- BS Hardness (BS 903/Part A7/1957): 60 to 65 degrees
- Maximum compression set by constant deflection method: 20% of original deflection
20.3 JOINTE FILLERS

The Contractor shall supply and fix pre-moulded joint fillers in all expansion joints and where shown on the Drawings. Unless otherwise specified, the joint filler shall be of resin or bituminous bonded cork. The filler shall be obtained from a manufacturer approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions. The joint filler of the thickness specified shall be cut to shape and fixed to fill the whole space between the concrete faces of the joint which is not otherwise filled by waterstop and joint sealer. Abutting pieces shall be placed in close contact and the joints covered on each side to prevent the passage of cement grout.

The Contractor shall supply the manufacturer's certificate for each consignment of joint filler delivered to Site and shall, in addition, supply to the Engineer sufficient of each consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure, if ordered.

The filler shall comply with United States Federal Specification HH-F-34 le Type II Class B for the resin bonded cork and HH-F-34le Type I Class B for the Bituminous bonded cork.

The filler shall also comply with the American Society for Testing of Materials Specification as follows:
(a) For resin bounded cork - specification ASTM D1752 - 67 Type II
(b) For bituminous bonded cork - specification ASTM D1751-73

20.4 JOINTE SEALERS - GENERAL

The Contractor shall construct recesses at expansion and contraction joints on both faces of the concrete work except on the underside of continuously supported work and on faces backfilled with earth. The recesses shall be accurately formed to the lines and dimensions shown on the Drawings.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it.

Unless otherwise shown on the Drawings or ordered by the Engineer the joint sealer shall be a hot poured rubber/bitumen compound for horizontal joints, and a bituminous putty for sloping, vertical and soffit joints.

Where shown on the Drawings, or ordered by the Engineer, an elastomeric two-part polysulphide sealer shall be used. Such joint sealers and the requisite priming materials shall be obtained from manufacturers approved by the Engineer and shall be used in accordance with the manufacturer's instructions. The application of joint sealer shall not be commenced without the contractor having first obtained the approval of the Engineer.

The Contractor shall supply the manufacturer's test certificate for each consignment of each type of joint sealer delivered to Site and shall, in addition, supply to the Engineer sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure, if ordered.

21. MISCELLANEOUS WORKS

21.1. DISMANTLING WORKS

The contractor shall dismantle the existing structure of all kind and take away from the site on contractor's own cost and possible amount shall be paid by the contractor for the scrapped materials received from the dismantling works. The resulting material shall be the property of the Employer and all suitable materials shall be stockpiled for reuse purposes within a lead of 30 m as directed by the Engineer.
21.2 GRAVEL PILING

The contractor shall supply crushed aggregate and apply gravel packing for gravel piling works of diameter 800mm as per drawings and instruction of Engineer. A proper compaction shall be done by the contractor using appropriate tools and equipment to make the surface good for the construction of foundation as per design. This work shall be done as per guidance of Engineer as well as Geotechnical Engineer.

21.3. SHEET PILE

The contractor shall supply and use sheet piling sheets with necessary supports for safe excavation of foundation soil with proper guidance of Engineer as well as Geotechnical Engineer. A design of sheet pile shall be provided by the contractor and checked by the Geotechnical Engineer before execution of the earthwork excavation works at the site. All kind of necessary safety precautions shall be taken by the contractor for this work. Any losses of property and lives shall be the contractor’s responsibility.

22. SANITARY, PLUMBING AND WATER SUPPLY WORKS

22.1 SCOPE

This Specification covers the construction of internal and external water supply, soil, waste, vent and rain water system, installation of toilet fixtures.

22.2 REFERENCE DOCUMENT

The work specified in this section shall be in accordance with the following standards, or approved equal, except as they are modified and supplemented herein:

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS:778</td>
<td>Specification for gunmetal gate, globe and check valves for water, steam and oil only.</td>
</tr>
<tr>
<td>IS:780E</td>
<td>Specification for sluice valves for various purposes.</td>
</tr>
<tr>
<td>IS: 781E</td>
<td>Specification for sand cast brass screw down bib taps and stop taps for water services.</td>
</tr>
<tr>
<td>IS:1171</td>
<td>Basic requirement of water supply, drainage and sanitation.</td>
</tr>
<tr>
<td>IS:1239</td>
<td>Specification for M. S. or G. I. Pipes and fittings.</td>
</tr>
<tr>
<td>IS:1703</td>
<td>Specification for cast iron manhole covers and frames intended for use in drainage work.</td>
</tr>
<tr>
<td>IS:2065</td>
<td>Code of practice for water supply in building.</td>
</tr>
<tr>
<td>IS:4985</td>
<td>Specification for UPVC pipe</td>
</tr>
<tr>
<td>IS:5382</td>
<td>Specification for rubber seal ring.</td>
</tr>
<tr>
<td>ASTM : D 2846</td>
<td>Specification for CPVC pipes</td>
</tr>
</tbody>
</table>

22.3 RELATED WORK

The Contractor shall become familiar with other Divisions of the specifications affecting work of this trade.

22.4 GENERAL REQUIREMENT

The scope of work covered by this Chapter shall be deemed to comprise the furnishing and installation of all cold and hot water supply pipe work, soil, waste, rain and vent pipe work, vitreous china
sanitaryware, CP fixtures etc as shown on plans and as specified. It shall also include the supply of the appertaining materials and parts, scaffolding, off loading on site and all operations in connection with civil works, unless otherwise specified in the Bills of Quantities.

Materials and parts, which the Contractor shall supply and install, shall be new and unused. They shall comply with the regulations regarding quality and dimensions. Materials and parts that are not standardised shall be used only with the approval of the Engineer.

The materials shall be protected from rain and inclement weather all to the satisfaction of the Engineer. The cost of covering materials shall be deemed to be included in the unit prices for the brickwork and masonry.

22.5 SAMPLES/SUBMITTALS

Representative samples to be used shall be submitted to the Engineer and his approval taken before bulk purchase. The samples shall be kept with the Engineer for future reference and comparison. All materials supplied shall conform to these approved samples in all respects.

22.6 BASIC MATERIALS AND METHOD

All materials provided for the contract will be in strict accordance with the latest version of the applicable Indian Standards. All manufacturer’s data, specifications and relative information together with samples will be submitted to the Engineer or Site In-charge for approval prior to being purchased, otherwise at the contractor’s own risk.

22.7 MATERIALS TRADE NAMES VARIATIONS

Tenders shall be based upon complete installations. Products required which are not shown or mentioned, or not specified herein as to manufacturer; quality, etc. shall be furnished of the highest quality. Materials shall be new and free from all defects. All materials, apparatus or equipment called for on the plans or in the specifications by trade names, or the name of a particular manufacturer, or by catalogue reference are the materials, apparatus, or equipment which should be allowed for in the Tender, or qualification submitted at the time of Tender submission.

22.8 REGULATIONS

The work shall be carried out in accordance with all rules, regulations, by-laws and requirements of all authorities having jurisdiction. All changes and alterations required by an authorized inspector of any authority having jurisdiction should be carried out at no cost to the Owner.

22.9 DRAWINGS AND SPECIFICATIONS

These specifications shall be considered as an integral part of the drawings, which accompany them. Neither the plans nor the specifications shall be used alone. Any item or subject omitted from one, but which is mentioned or reasonably implied in the other shall be considered as properly and sufficiently specified and therefore must be supplied by the contractor. Misinterpretation of any requirements of either the drawings or specifications shall not relieve the contractor of his responsibility for properly completing his work. The contractor shall apply to the Engineer or Site In-charge for any explanation, which he may require in regard to the meaning and intent of any clause in the specification and contract. He shall be held responsible for any errors or losses consequent upon failure to obtain such explanation. The contractor shall consult with the Engineer or Site In-charge to obtain detail drawings or instructions for exact location of equipment as work progresses, before installing fitting or equipment and will be responsible for coordination with all other work trades including finishes. Drawings show general location and routes to be followed by pipes, ducts, etc. where not shown, or shown diagrammatically, the contractor shall install them in accordance with best trade practices.

22.10 SHOP DRAWINGS

The contractor shall submit to the Engineer or Site In-charge all shop and setting out drawings or diagrams necessary in order to make clear the work intended or to show its relation to adjacent work of other trades. The contractor shall make any changes in such drawings or diagrams, which the Engineer or Site In-charge may require, consistent with the contract. Details of shop drawings submitted for approval shall show clearly the relations of the various parts to the main members and lines of the structure, and where correct fabrication of the work depends upon field measurements, such
measurements shall be made by the contractor and noted on the drawings before being submitted for approval.

22.11 AS BUILT DRAWINGS

Three months prior to the end of the Defects Liability Period, the Contractor shall submit As Built Drawings based on AUTOCAD printout and corresponding digital files as per Division 1 – General Requirements.

22.12 MAINTENANCE MANUAL

The Contractor shall submit a draft outline of the proposed format and contents within 30 days after the issuance of the virtual completion certificate by the Engineer. The submitted manual will conform to the approved outline.

The Manual shall be contained in a black three ring loose-leaf binder and be subdivided into sections according to the various divisions of this specification. Material shall be fully indexed, with a typed contents page located at the front of the Manual. Tabbed sheets shall be used to subdivide the contents as required. All material shall be neatly and legibly presented. Photocopies will be used only if original documents are not available.

All materials shall be clearly labeled according to manufacturer, manufacturer’s reference, source, location of use, and quantity.

Include in the Maintenance Manual a list of all materials submitted indicating quantities, source, manufacturer, manufacturer’s reference(s), and location of use. Also include printed manufacturer or supplier’s instructions on use, application, and maintenance of all products and materials.

22.13 CUTTING AND PATCHING

Openings not indicated on the Engineering or Structural drawings, which are required for bringing equipment into the building or for other temporary or permanent service, shall be approved by the Engineer or Site In-charge. The contractor will provide maintain and restore these openings and shall pay for their provision and restoration. Ample notice shall be given of size and location of such openings. The contractor shall ensure that he does not undertake any cutting that may impair the strength of the building. No holes, except expansion bolts and small screws may be drilled into the structure without obtaining prior approval. Persons, skilled in the trades, shall do all cutting and patching work in a neat and workman like manner.

22.14 PAINTING

All equipment supplied under this specification shall be delivered to the site with a factory applied prime coat of paint unless noted otherwise. All supports and hangers shall receive a prime coat of paint. Painting where required for pipe, duct services, equipment identification, including stenciling shall be carried out by a paint tradesman under this division in accordance with the workmanship and material specification. All factory prime-coated or finish coated equipment shall be touched up or repainted if equipment is marred during shipment or installation.

22.15 EXPANSION AND CONTRACTION

Unless shown otherwise, the contractor shall be responsible for measures to control the thermal movement of piping and apparatus. Piping shall be erected in such manners that strain and weight does not come directly upon connections, joints or apparatus. Where possible, the effect shall be obtained by providing changes in direction and loops in pipe runs, supplemented by the necessary guides, anchors and limit stops.

22.16 PIPE SLEEVES

An adequate number of sleeves (pipe inserts) of mild steel shall be provided where pipes pass through concrete, masonry and similar work. The pipe inserts shall have a flange welded in the center around its circumference, in order to provide water tight and secure fixing into the structure. The sizes of the pipe sleeves (pipe inserts) shall be as per the drawings supplied and / or as given below.
22.16.1 SLEEVES THROUGH EXTERIOR WALLS BELOW GRADE

i. Sleeves in exterior foundation walls below grade shall project 25 mm beyond the outside surface of the wall and be flush with the inside surface.

ii. The annular space between the sleeve and the pipe shall be caulked with un-tarred oakum and sealed with approved caulkling compound. The sealing shall be 25 mm deep from each side. The pipe and sleeve surfaces shall be cleaned to enable good bonding. Allow 24 hours for setting of the compound. The contractor shall adhere strictly to the manufacturer's recommendation.

22.16.2 SLEEVES THROUGH INTERIOR WALL, FLOOR AND CEILINGS

i. Sleeves through interior masonry walls and partitions shall be set flush with finished wall surfaces.

ii. Sleeves through floors in finished areas shall terminate 25 mm above the finished floor.

iii. Sleeves through floors in service area (e.g., mechanical rooms) shall terminate 50 mm above the finished floor.

iv. The annular space between sleeves and pipes shall be packed with Silicon Rubber. In Machine Room, the packing shall be finished at both ends of the sleeve with 6 mm deep caulking compound. In other areas the finishing may be on the room side only.

v. Pipe insulation shall be carried full thickness through pipe sleeves.

Unless otherwise specified elsewhere, the sleeves size shall be as follows:

<table>
<thead>
<tr>
<th>Out Side (OD) Diameter of Pipe (If Insulated, OD of Insulation)</th>
<th>Sleeve Size (Nominal Bore of the Pipe for Sleeve)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD 20 mm to OD 32 mm</td>
<td>NB 2&quot; (50 mm)</td>
</tr>
<tr>
<td>OD 33 mm to OD 75 mm</td>
<td>NB 4&quot; (100 mm)</td>
</tr>
<tr>
<td>OD 76 mm to OD 125 mm</td>
<td>NB 6&quot; (150 mm)</td>
</tr>
</tbody>
</table>

22.17 CLEAN UP

The contractor shall clean all exposed metal surfaces from grease, dirt or other foreign materials. Chrome plated and polished work shall be left bright and clean. All openings in pipes and fixtures shall be properly capped and plugged during construction. Fixtures and equipment shall be properly protected from damage during the construction period and shall be cleaned in accordance with the manufacturer's instructions.

22.18 SANITARY FIXTURES, RUNS, PIPES

The recommended positions of the sanitary fixtures, runs of all piping etc. as shown in the layout drawing will be adhered to as far as possible or as far as practicable.

Should there be any discrepancy or incomplete description, ambiguity or omission in the drawings and other documents, whether original or supplementary forming the Agreement, completion or maintenance of the installation, the Contractor shall immediately on discovering the same, draw the attention of the Engineer to this.

Prior to the installation of all fittings, pumps, traps, etc. The finial position shall be ascertained from the Engineer.

22.19 PROPRIETARY OF MATERIALS

Where proprietary of materials are specified hereafter, the Contractor may propose the use of similar materials of other manufacture but of equal quality for approval by the Engineer. Should the price of alternate materials proposed be lower in price, the Contractor shall a revise schedule of price for the particular item along with his proposal for the use of alternate material in lieu of the one specified.

All materials and goods, where specified to be obtained from a particular manufacturer or supplier, are to be used or fixed strictly in accordance with their instructions.
22.20 PACKAGING

The Contractor is to provide special packaging according to standard practices to project materials or parts of materials from damage, and his rates will be deemed to include for all such protection.

22.21 SPECIFIED MATERIALS

The source of materials stated in the Specifications are those from which materials are generally available. However, materials not conforming Specifications shall be rejected even if they come from the stated sources. The Contractor should satisfy himself that sufficient quantity of material of acceptable Specification is available from the stated or other sources.

22.22 STANDARDS

All materials, Workmanship and components shall where applicable and unless otherwise stated in the Agreement or comply with Indian standard or code of practice in use. The Indian Standards referred to here are:

Indian Standards (I.S.), Published by Bureau of Indian Standard, India.

Should there be any discrepancy or incomplete description, ambiguity or omission in the drawings and other documents; whether original or supplementary forming the Agreement, completion or maintenance of the installation, the Contractor shall immediately on discovering the same draw the attention of the Engineer to this. The Works shall be carried out according to this Specification whether specifically mentioned elsewhere or not. No extra in any form will be paid unless it is definitely stated as it is in the Bill of Quantities. Whenever the Specifications are not given or when the Specification is ambiguous, the relevant Indian standards or British Standards and further amendments will be considered as final and binding.

22.23 QUANTITIES

The Works shall be related to the drawings which the Agreement is presumed to have studied. Nothing extra will be paid for any items because of its shape, locations or other difficult circumstances, even if the schedule makes no distinction, as long as the item is shown in the drawings. The quantities given in this schedule are provisional. The Contractor will be paid for the actual quantity of Works executed as measured at Site and priced at the rates in the schedule. The Engineer reserves the right to increase or decrease any of the quantities or to totally omit any item or Works. Any claim by the Contractor on these accounts will not be entertained.

22.24 EXCAVATION FOR PIPE LINES

In excavating trenches for pipe lines, slight rails shall be erected, before excavation is commenced, at every 100 meters and at all change of direction or gradient. The sight rail shall consist of a board, not less than 10 centimeters deep, with the top edge planed true and straight. This shall be supported by a stout wooden post at each end, and its top edge accurately fixed to a definite and, as far as practicable, uniform height above the level of the pipe to be laid. The centre line of the pipe shall be denoted on each rail thereon, and the rail on one side of the centre line painted rail, and on the other side white. The depth of the excavation and the level of the pipe invert shall be checked by means of boning rods of appropriate length. The boning rods used are to be accurately made to the various lengths required, the lower and being provided with a shoe of sufficient projection to rest on the centre of the invert of the last pipe laid.

The excavation shall be carried out to the lines and levels shown on the plans or as ordered by the Engineer, and shall be deep enough to permit a minimum cover as specified hereunder.

<table>
<thead>
<tr>
<th>Pipe</th>
<th>Minimum Cover in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Ground</td>
<td></td>
</tr>
<tr>
<td>Galvanized Iron</td>
<td>600</td>
</tr>
<tr>
<td>CPVC / Multilayer</td>
<td>600</td>
</tr>
<tr>
<td>PVC/ DWV</td>
<td>600</td>
</tr>
<tr>
<td>RCC Hume</td>
<td>900</td>
</tr>
</tbody>
</table>

The Contractor shall be responsible for and shall at his own cost, make up all subsidence or slips whether arising from its nature of the materials in embankments, from the nature of the ground or from
The Contractor shall, his own expense keep the whole of the Working Site dry and from water and construct such temporary water courses and drain as may be surface of the Works. The Contractor shall include in his rates the cost of providing all tools, machinery and all temporary Works such as staging, struts, shoring, planks and poling boards and their removal on the completion of the Works and the cost of pumping and trenches. Whenever pumping is necessary, the whole Works shall be executed as quickly as possible, due care being taken to avoid excessive pumping, which may cause settlement of surrounding land and property.

Any trench or excavation which may have been taken to a great depth than necessary shall be filled into the required level with suitable material approved by the Engineer and rammed solid with watering at the Contractor's expense.

Special care shall be taken provide a solid even bed for the barrel of the pipe, and the floor of the trench shall be properly shaped to received the socket it and the barrels of the pipes. Where lock is met within the trenches, the excavation shall be taken to a depth of 15 cm of selected filling (approved by the Project Engineer) placed on the rock and consolidated to form a firm even bed for the pipe where required, socket holes shall be cut in the rock. In narrow trenches, socket holes shall be cut in the rock. In narrow trenches, the width of the excavation shall be increased. The sides of trenches shall be allowed a slope not exceeding 1 to 12, the width at the bottom being at least 30 cm wider than the socket of the pipe, so as to allow room for ramming the refilled materials under and at the sides of the pipe.

22.25 RE-FILLING

No refilling shall be carried out until the construction Works has been tested and approved. The re-filling on the top and around the sewers shall be done with great care and in such a manner as will obtain the greatest amount of compactness and solidity possible. For that purpose, the earth shall be laid and rammed in regular layers not more than 230mm (9”) thick up to the surface and also watered and rammed at each layer. The top soil shall be carefully replaced to match the existing.

22.26 DISPOSAL OF SURPLUS SOIL

The contractor shall, at his own costs and charges, provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

22.27 TESTING OF PIPES LINES

CPVC Water Supply Pipes

After each section of the pipeline has been laid and jointed and anchorage's built in for the bends, the pipeline shall be tested in lengths of 2 kilometers or less as directed by the Project Engineer, by and at the expense of the Contractor. Before testing, the trench shall be partially backfield except at the joints. The accessories nodded viz. Test pump, pressure gauge, end pieces including connecting valves and piping etc., for carrying cut the hydraulic tests shall be provided by the Contractor's. The Contractor shall provide the supply of necessary labour and water for testing at his expense, the cost of this shall be included in the unit rate for lying and jointing of pipes. The pipes and joints found to be defective during the test shall be replaced and or reduce by the Contractor and the related labour cost be met by the Contractor.

The two tests that shall be carried out are –

(i) Pressure test: a pressure of at least double the maximum Working pressure, pipes and joints shall be absolutely watertight under the test.

(ii) Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the Engineer for a duration of two hours. Unless otherwise specified the leakage test pressure shall be the lower or ½ times the maximum static pressure that will be experienced by the pressure after installation.

Where any section of the main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was caste.

The procedure to be followed are as follows:
Pressure Test:

- Each valved section of the pipe shall be slowly filled with water and all air shall be expelled from the pipe through hydrants and blow-offs. If these are not available are not available at high places, necessary tapping may be made at points or highest elevation before the test is made and plugs inserted after the tests have been completed.

- If the trench has been partially back-filled the specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the point in a manner satisfactory to the Engineer. The duration of the test shall not be less than 24 cm.

- All exposed pipes, fittings, valves and joints should be carefully examined. Any cracked or defective pipe, fitting and valve discovered in consequence of this pressure test shall be removed and replaced by sound material and the test shall to repeat. All joints showing visible leaks shall also be recalled or redone until tight.

(ii) Leakage Test:
- Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure.

The pipe installation will not be accepted until the leakage is less than the number of cm3/h as determined by the formula:

\[
q_1 = \frac{N D P}{3.3}
\]

Where,
- \(q_1\) = the allowable leakage in cm³/h.
- \(N\) = number of joints in the length of the pipeline.
- \(D\) = diameter in mm, and
- \(P\) = the average test pressure during the leakage.

22.28 SANITARY AND SEWER PIPES

22.28.1 Gully Traps

Gully traps shall be as per the drawing supplied.

Gully traps shall be fixed in cement concrete 1:5:10 and a brick masonry chamber 300 mm x 300 mm inside in cement mortar 1:5 with 150 mm x 150 mm grating inside and 300 mm x 300 mm CI sealed cover and frame weighing not less than 7.3 kg to be constructed as per standard drawings.

22.28.2 Sewer Drainage and Site Drainage

The work covered under this section comprises of the supply and installation of the following:

- Night Soil and Waste Water drainage system complete
- Storm Water drainage system complete

Pipes for these works shall be as follows:

- Pipes up to OD 110 mm size should be of PVC / DWV Pipe having working pressure of 4.0 and 6.0 kgf per sq cm and carried out as described herein.
- Pipes over OD 110 mm and up to OD 250 mm should be of PVC / DWV and carried out as described herein.

22.28.3 Manholes and Grease Trap Collection Chambers

Manholes and Chambers shall be constructed as shown in Detail Drawings, and where shown on Site Services layout. Materials shall be of not less than 225 mm Brickwork, cast-in-place concrete, or pre cast concrete. Concrete shall be M: 20 strength. All brickwork shall be plastered in cement, sand (1:2). Gratings, lids and castings in general shall be in Cast Iron in accordance with IS 5961 and built in or fixed as detailed.

All manholes designated to be constructed shall be as specified in the Schedule of Quantities.
All manholes shall be supported on a base of cement concrete of such thickness and mix as given in the Schedule of Quantities or shown on the drawings.

Where not specified, manholes shall be constructed as follows:

<table>
<thead>
<tr>
<th>Maximum Depth in mm</th>
<th>Internal Dimensions of Manhole Chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 450 mm</td>
<td>450 mm x 450 mm</td>
</tr>
<tr>
<td>Over 450 mm and Up to 600 mm</td>
<td>600 mm x 600 mm</td>
</tr>
<tr>
<td>Over 600 mm and Up to 1200 mm</td>
<td>Dia 900 mm or 900 mm x 900 mm</td>
</tr>
<tr>
<td>Over 1200 mm and Up to 3000 mm</td>
<td>Dia 1200 mm or 900 x 1200 mm</td>
</tr>
</tbody>
</table>

All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 100 mm towards the channel. The depth of the channel shall be the full diameter of the pipe. Benching shall be finished with a floating coat of neat cement.

The manhole chamber covers and frames shall comply with the following ratings:

<table>
<thead>
<tr>
<th>Manhole Cover</th>
<th>Out Side Size of Frame</th>
<th>Inside Size of Frame</th>
<th>Weight in Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>27&quot; x 27&quot;</td>
<td>24&quot; x 24&quot; or Ø 500 mm</td>
<td>78.5 kg</td>
</tr>
<tr>
<td>Heavy</td>
<td>27&quot; x 27&quot;</td>
<td>24&quot; x 24&quot; or Ø 600 mm</td>
<td>216 kg</td>
</tr>
</tbody>
</table>

All manholes shall be plastered with 12 mm thick cement mortar 1:3 (1 cement & 3 coarse sand) and finished inside with a floating coat of neat cement. Manholes shall be plastered outside as above cut with rough plaster.

All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab weight of cover and frame thickness of slab shall be as specified in the Bill of Quantities or given above.

22.28.4 Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connections; contractor shall remove all sewage and water if encountered in making the connection without additional cost.

22.29 SOIL, WASTE, VENT AND RAIN WATER PIPING

22.29.1 Soil, Waste and Vent Pipes

22.29.1.1 Polyvinyl Chloride (PVC) Pipes and Fittings:

All soil, waste, vent and rain water pipes shall be Un-Plasticized Rigid Polyvinyl Chloride (uPVC) pipes unless specified otherwise. All pipes shall be straight and smooth and inside free from irregular bore and other manufacturing defects.

All fittings shall conform to Standard DIN: 19531 or BS: 4514. Fittings shall be of the required degree with or without access door. All access doors shall be made up with rubber gasket, while screw cover to make the fitting air and water tight.

The recommended joints of uPVC pipes shall be solvent cement joints or with rubber ring socket joints. The rubber rings shall confirm to Indian Standard IS: 5382.

22.29.2 Storage and Handling

uPVC Pipes: The pipes should be given adequate support at all time. Pipes should be stored in a reasonably flat surface free from stones and sharp projections 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 spigot pipes should be stacked in layers with socket end 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 the heat. Pipes should not be stacked more than 1.5 meters high and pipes of different sizes and classes should be stacked separately.

The ends of pipes should be protected from abrasion and particularly those specially prepared for jointing either by spigot or socket solvent cement joints.

If due to unsatisfactory storage of handling a pipe becomes 'kinked' the damaged portion should be cut out completely. 'Kinking' is likely to occur in very thin walled pipes.

22.29.1.3 Jointing of uPVC Pipes

Methods of Jointing:

i) Solvent Cement Joints

The technique is used with spigot and socket type joint, in which the socket is made specially to form a close fit on the pipe end and with injection molded fittings.

Solvent Cement of the pipe manufacturer make shall be used as per the recommendations of the manufactures.

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 rifting 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. For warm place in summer month joints shall be made preferably early in the morning or in the evening, when it is cooler and for cold place in winter joints shall be made preferably during the day (sunny) when it is warm.

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

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

ii) Rubber Ring Joints or 'O' Ring Shrink Joints (Shaft Piping)

uPVC pipe and uPVC pipe fittings may be jointed with approved rubber ring to provide the watertight seal. The ring may be housed in groove formed in the socket housing. The rubber is compressed and makes a seal between the pipe and the housing. It is advisable to use uPVC Lubricant for proper sliding of the pipe end to the rubber socket piece.

22.29.1.4 Fixing to Supports

The pipes and specials (fittings) before being laid of fixed shall be examined to see that there are no cracks or defects. The pipes and fittings shall be thoroughly cleaned of all dust and dirt. After laying or fixing the pipes in position they shall be arranged in such a way that centre line of pipes coincide with the centre line of the alignment. Fittings, cleanout and floor drains shall also be laid in their position as stated above uPVC Pipes shall be fixed vertically in shaft by means of uPVC clips anchored to walls using uPVC washers, Galvanized Screws and Plastic dowels. In case of pipes laid horizontally, pipe shall be supported on M.S. Brackets / Hangers of approved design clamped with uPVC Clips.
All pipes laid shall have their open ends securely closed with appropriate plugs during progress of work. Pipes and fittings shall be fixed by using proper approved holder bat clamps and special hangers. The pipes shall be fixed perfectly vertical or in a line as directed or as shown in the drawings. The pipes, lay vertically or horizontally shall have the supporting clamps, hangers, Brackets, etc., as per the specification or as directed by the Engineer. uPVC bat clamps holders shall be used to fix all vertical uPVC pipes in truly vertical position. Branch pipes shall be connected to the stack at the same angle as that of the fittings. Each stack shall be terminated at top for vent. Horizontal pipes running below the ceiling shall be fixed on structural with adjustable clamps. Horizontal pipes shall be laid to uniform slope as mentioned in the drawings and the clamps adjusted to the proper levels so that the pipes fully rest on them. As per the site condition, if required or directed by the Engineer, pre-fabricated semi circular (half the diameter of the said pipe) made out of Plain GI Sheet of proper thickness shall be provided below the horizontal running pipes along with above-mentioned adjustable clamps.

22.29.1.5 Testing

All uPVC Soil, Waste, Vent, Rain Water (SWR) pipes and uPVC pipe fittings shall be tested by 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 SWR pipes at the lowest level from a smoke machine, which consists of a blower and a burner.

The materials usually burnt are greasy cotton waste which form clear pungent smoke which is easily detectable by sight 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 & to the satisfaction of the Engineer-in-charge.

22.29.2 Nahani or Floor Traps

Nahani or floor traps shall be uPVC, deep seal with an effective seal of 50 mm. As per drawing, Waste pipes may be discharged over the trap. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate) and extended 35 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 300 mm x 300 mm and of the required depth.

22.29.3 Cutting and Making Good

Pipes shall be fixed and tested as building work proceeds. Contractor shall provide all necessary sleeves, holes 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 mix (1 cement: 2 coarse sand: 4 stone aggregate) and the surface restored as in original condition. No additional payment shall be made for cutting and making good of holes.

22.30 WASTE PIPES FROM APPLIANCES

22.30.1 Waste Pipes from Appliances

Waste pipe from appliances e.g. wash-basins, shower, bath tub, sinks, drinking fountain, urinals, water closets, etc. shall be of uPVC as given in the Schedule of Quantities or drawings. "Galvanized or Black Wrought Iron Pipes or Pipe Fittings should not be used for Soil Pipes, Waste Pipes, Rain Water Pipes, Anti-Siphon Pipes, Vent Pipes or Drain Pipes from any appliances."

All pipes shall be fixed in gradient towards the out fall drain. Pipes inside a toilet room shall be chased unless otherwise shown on the drawings. Where required pipes may be run at ceiling level in suitable gradient as mentioned in the drawing or directed by the Engineer and supported on structural clamps.

22.30.2 Clean Outs

Clean-outs shall be full pipe size up to 110 mm and a minimum of 110 mm on larger pipe. A clean out shall be installed at, or as close as possible to, the base of every vertical waste, soil and drain stack. A clean out shall be installed at the up-slope of each pipe at which a building drain or branch changes direction by more than 45°.

Clean-outs in horizontal drainage piping shall be at intervals not greater than:
- 15 m where the piping is of dia 100 mm and smaller.
- 30 m where the piping is of larger than dia 100 mm.
- 6 m where waste pipes are horizontally connected to sinks.

Nickel Bronze or Stainless Steel Floor Plates with Frames shall be installed on finished floors for access to clean-outs. Clean-outs on horizontal lines in finished areas shall be as per IS specifications.

22.31 WATER SUPPLY

22.31.1 Pipe Line

All Water Supply Pipe Line shall be as mentioned in the drawings and Bill of quantities. The Pipes will be:

22.31.2 Chlorinated Polyvinyl Chloride (CPVC) Pipe & Fittings

Chlorinated Polyvinyl Chloride (CPVC) Tubes / Pipes of Class 11 in Copper Tube Size (CTS) dimensions conforming to ASTM: D 2846 of approved brand. Pipe Fittings shall be of Chlorinated Polyvinyl Chloride (CPVC) of Class 11 in Copper Tube Size (CTS) dimensions conforming to ASTM: D 2846 of approved brand. The Pipe Fittings are Couplings, Elbows, Bends, Tees, Transition Coupling, Transition Bushings, etc. Manufacturer's Trademark should be stamped on the CPVC Pipe Fittings.

CPVC Pipe and CPVC Pipe Fittings shall have cold weld joints by CPVC Solvent cement confirming to ASTM: 493. After cutting the pipe, care shall be taken to remove burr from the end of the pipe with appropriate tools. Only with TEFLON tape, threaded Fixtures shall be fitted with CPVC Threaded Adopters.

22.31.3 Laying

All Pipes and fittings shall be of class specified in BILL OF QUANTITIES manufactured under respective Standards.

All main supply pipes and other pipes to be laid under the ground shall be laid over a minimum of 600 mm sand bedding or selected granular material compacted as described herein this specification.

The water main shall be laid and maintained to the required lines and grades with fittings, valves, and connections at the required locations and all valves and stems plumb.

Proper implements, tools and facilities shall be provided and used by the Contractor for the safe and convenient performance for the work.

All pipes, valves and fittings shall be carefully lowered into the trench piece by piece by hand ropes or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings and linings.

Under no circumstances shall water main materials be dropped or dumped into the trench.

Valves, valve covers, meters, tapping sleeves and other accessories shall be installed as per the manufacturer's recommendations and in conjunctions and compliance with the requirements of the Local Government or Public Service Authority specifications.

It will be the responsibility of the Contractor to furnish and install all proper size pipe bends for both horizontal and vertical deflections that are required to construct the water main to the line and grade as shown and specified.

22.31.4 Jointing

The jointing shall be made in accordance with the instructions of the pipe and fitting manufactures. The pressure pipe shall be tested to a minimum of 10 kg / sq. cm. pressure. The setting and arrangement of pipes shall be as per the working drawings. Pipes are cut to size and ends are squared.

The pipes and fittings shall be inspected at the site before use. Where the pipes have to be cut, the end shall be carefully plugged so that no obstruction to bore is effected.
The pipe shall be cleaned and cleared of all foreign matters before being laid. For joining, the out side of pipe and the inside of the socket shall be cleaned. Care should be taken that all pipes and fittings are properly joined so as to make the joints completely watertight.

After lying, the open ends of the pipe shall be temporarily plugged to prevent access of water, soil or any other foreign materials. Jointing of pipes shall be made according to the different kind of pipes by thread screwing, cold welding, flanges, or flexible joints etc. Joints between dissimilar materials, e.g. copper shall be by means of copper-alloy unions or union ferrules, etc.

Care shall be taken to ensure that all piping and fittings are clean internally and free from particles of sand, soil, metal, plastic, filings and chips, etc.

22.31.5 Clamps

All pipes laid shall have its open ends securely closed with appropriate plugs during progress of work. Pipes and pipe fittings shall be fixed by using proper approved holder bat clamps and special hangers. The pipes shall be fixed perfectly vertical or in a line as directed or as shown in the drawings. The pipes laid vertically shall have supporting, the clamps at 1.5 meters centre to centre and the pipes laid horizontally, the clamps at every 1.2 meters centre to centre as shown in the Drawing or as directed by the Engineer. MS bat clamps holders shall be used to fix all vertical pipes in truly vertical position. Horizontal pipes running below the ceiling shall be fixed on structural with adjustable clamps. Horizontal pipes shall be laid to uniform slope as mentioned in the drawings and the clamps adjusted to the proper levels so that the pipes fully rest on them. As per the site condition, if required or directed by the Engineer, pre-fabricated semi circular (half the diameter of the said pipe) made out of Plain GI Sheet of proper thickness shall be provided below the horizontal running pipes along with above-mentioned adjustable clamps. No Iron hooks shall anchor pipes in wall chases.

22.31.6 Testing Water Service Lines

The water service lines shall be hydrostatically tested. Test pressure shall be 10 kg / sq. cm. and the pipes shall be tested for the specified pressure for 24 hours. Defective pipes, pipe fittings and pipe joints shall be replaced or repaired immediately and retested.

22.31.7 Unions

Adequate number of unions shall be provided on all pipelines to enable to dismantle later. Unions shall be provided near each valve, stopcock, and check valve.

22.31.8 Shut-Off Valve

Gate Valves or Ball Valves shall be heavy gunmetal full way type conforming to IS: 778 (Class: II). Valves shall be tested at manufacturer’s works to 21 kg / sq. meter and shall have manufacturer's name stamped on it.

22.31.9 Check (Non Return) Valves

Check Valves / Non Return Valves shall be heavy gunmetal Swing Type conforming to IS: 778 (Class: II). Valves shall be tested at manufacturer's works to 21 kg / sq. meter and shall have manufacturer's name stamped on it.

The Engineer or Site In-charge shall approve all valves before installation work. up to 65 mm and small shall be gunmetal.

22.31.10 Isolating Valves

Isolating valves shall be provided on all branch lines to enable isolation of groups of fixtures and sections of building and as shown on drawings.

22.31.11 Drain Points

Drain valves shall be installed in all liquid carrying systems at the low points to facilitate complete drainage of the system.
22.31.12 **Hose Bibs**

Hose bibs in the building shall be cast brasses with a leather disc, screwed pipe end, 20 mm pipe hose tread. Hose bibs in finished areas shall be chromium plated.

22.31.13 **Insulation**

All internal and external Hot and Cold water supply pipes shall be insulated using closed cell elastomeric nitrile rubber foam. Working temperature of the tube shall be -50°C up to +105°C and the thickness shall be 19mm.

22.32 **EXTERNAL WATER SUPPLY**

22.32.1 **Pipes**

All pipes lay outside of the building and generally underground shall be considered as External Water Supply. The types of Pipe and Pipe Fittings shall be as per drawings and / or as mentioned in the Bill of Quantities. The installation of pipe line shall be properly carried out and should be completely watertight. All fixtures and fittings shall be properly installed and checked against leaks at designated pressure. Necessary Pipe Sleeves in the wall, floor, etc should be provided as per the specification.

22.32.2 **Excavation**

Generally, external water mains pipe shall be laid a minimum of 600 mm below ground level. Excavation for trenches shall be done as specified elsewhere, but the depth of the trenches shall be as follow:

<table>
<thead>
<tr>
<th>Size of Pipe</th>
<th>Width of Trench</th>
<th>Depth of Trench</th>
</tr>
</thead>
<tbody>
<tr>
<td>For dia 15 mm to 50 mm</td>
<td>300 mm</td>
<td>750 mm</td>
</tr>
<tr>
<td>For 65 mm to 100 mm</td>
<td>450 mm</td>
<td>1000 mm</td>
</tr>
</tbody>
</table>

22.32.3 **Backfilling**

Backfilling of trenches shall not commence until the pipes therein have been tested and approved by the Engineer. Under non-paved areas selected excavated materials free from large stones refuse, or organic material as approved by the Engineer or Site In-charge shall do the backfill.

22.33 **INTERNAL WATER SUPPLY**

22.33.1 **Pipes**

All pipes inside the building from Over Head Tank to the Toilets and where specified, shall be considered as Internal Water Supply Pipe Line. The types of Pipe and Pipe Fittings shall be as per drawings and / or as mentioned in the Bill of Quantities. The installation of pipe line shall be properly carried out and should be completely watertight. All fixtures and fittings shall be properly installed and checked against leaks at designated pressure. Expansion of hot water pipes shall be compensated for by flexible piping layouts and / or by utilizing bends in pipe line. Necessary Pipe Sleeves in the wall, floor, etc as well as pipe supports, clamps, brackets, etc should be provided as per the specification and instruction of the Engineer.

22.33.2 **Pipe Supports and Hangers**

The pipes and pipefitting before being laid to fixed shall be examined to see that there are no cracks or defects. The pipes and fittings shall be thoroughly cleaned of all dust and dirt. After laying or fixing the pipes in position they shall be arranged in such a way that centre line of pipes coincide with the centre line of the alignment. Fittings, Valves, etc., shall also be laid in their position as stated above. CPVC Pipes shall be fixed by push fit before any solvent cement is applied and when cleared by the Engineer then only permanent joints to be made. All the horizontal and vertical run pipes should be supported to walls with the help of GI/MS Pipe Clamps that should be anchored by Galvanized Screws and Plastic dowels. In case of pipes laid horizontally under ceiling, pipe shall be supported on M.S. Brackets / Hangers of approved design.
### SPACING FOR SUPPORTS & HANGERS OF FIXING FOR INTERNAL PIPING

<table>
<thead>
<tr>
<th>Kind of Pipe</th>
<th>Size of Pipe Line</th>
<th>Interval for Pipe Supports for Horizontal Run Pipe Line</th>
<th>Interval for Pipe Supports for Vertical Run Pipe Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPVC / PVC</td>
<td>15 mm / ½ &quot;</td>
<td>1.25 m</td>
<td>1.25 m</td>
</tr>
<tr>
<td>Pipe Line for Water Supply</td>
<td>20 mm / ¾&quot;</td>
<td>1.50 m</td>
<td>1.50 m</td>
</tr>
<tr>
<td></td>
<td>25 mm / 1&quot;</td>
<td>1.50 m</td>
<td>1.50 m</td>
</tr>
<tr>
<td></td>
<td>32 mm / 1½&quot;</td>
<td>1.75 m</td>
<td>1.75 m</td>
</tr>
<tr>
<td></td>
<td>40 mm / 1¼&quot;</td>
<td>1.75 m</td>
<td>1.75 m</td>
</tr>
<tr>
<td></td>
<td>50 mm / 2&quot;</td>
<td>2.00 m</td>
<td>2.00 m</td>
</tr>
<tr>
<td>uPVC Pipe Line for Soil, Waste &amp; Rain Water</td>
<td>OD 50 mm</td>
<td>1.50 m</td>
<td>2.00 m</td>
</tr>
<tr>
<td></td>
<td>OD 75 mm</td>
<td>2.00 m</td>
<td>2.50 m</td>
</tr>
<tr>
<td></td>
<td>OD 110 mm</td>
<td>2.00 m</td>
<td>3.00 m</td>
</tr>
<tr>
<td></td>
<td>OD 160 mm</td>
<td>2.50 m</td>
<td>3.00 m</td>
</tr>
</tbody>
</table>

#### 22.33.3 Method of Measurement

GI, CPVC, MS Pipe Line above ground or under ground shall be measured per running meter or running feet and the rate shall be inclusive of all fittings including unions, Hangers, Brackets, Clamps, Pipe Sleeves, cutting chases etc on wall, ceiling, floor and making good the same and testing of pipes and fittings, making good.

Pipes below ground shall be measured per running meter or running feet and the rate shall be inclusive of all fittings and testing of pipes and fittings except the excavation for trenches, refilling and disposal of surplus earth.

Other Fixtures such as Gunmetal valves, non return valves, ball cocks, foot valves, stop cocks, bib cocks, etc., shall be measured by number.

#### 22.33.4 Bathroom Fixtures and Fittings

##### 22.33.4.1 Bathroom Fixtures

All bathroom fixtures, Ceramic and CP fittings shall be supplied free of cost by the Owners at site Store, Contractor shall make his own arrangement at his cost to check, take delivery, store, install in position including transportation to site of work. No allowances shall be made for theft, breakage and defective materials after taking delivery of the materials.

##### 22.33.4.2 Installation of Fixtures

The fixtures and fittings shall be provided with all such accessories as are required to complete the item in satisfactory working conditions, whether specifically mentioned or not in the Schedule of Quantities, Specifications and Drawings.

The Bathroom fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Engineer in-charge/Engineer or Site In-charge/Owners, and shall fully meet with the esthetic and symmetrical requirements as demanded by the Engineer In-charge / Engineer or Site In-charge / Owner.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Engineer-in-charger's requirements. Wherever necessary, the fittings shall be centered to dimensions and pattern as called for.

Skilled workman shall install fixtures with appropriate tools according to the best trade practice. Manufacturer's instructions shall be followed for the installation of fixtures. Fixtures in all toilets shall be standard height, mounting as called for on the drawings. Fixtures shall be mounted rigid, plumb and true to alignment.

##### 22.33.4.3 Mock Up and Trail Assembly

The installation of the bathroom fixtures and fittings shall be as per the shop drawings approved by the Engineer-in-charge.

The contractor shall assemble on trial basis at least one set of each type of bathroom fixture and fittings in order to determine precisely the required supply and disposal connection. Relevant instructions from
manufacturers shall be followed as applicable. This trial assembly shall be developed to facilitate determining the location of punctures, holes, holding devices etc. that will be required for final installation in position of all bathroom fixtures and fittings. The above assembly shall be subject to final approval by the Engineer-in-charge / Engineer or Site In-charge / Owner.

The fixtures in the trial assembly can be reused for final installation without any additional payments for fixing or dismantling of the fixtures.

22.33.4.4 Supporting and Fixing Devices

The contractor at his own cost shall where required, provide all fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly look in the final assembly. These shall be installed complete with appropriate washers and gaskets, jointing Materials and Screws etc. as per manufacture manuals.

22.33.4.5 Final Installation

The contractor at his own cost shall install all bathroom fixtures and fittings in their final position in accordance with approved trail assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between built-in piping system and the bathroom fixtures shall be through proper couplings, unions and flanges to facilitate removal / replacement of bathroom fixtures without disturbing the built in piping system. All couplings, unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and true to alignment. The outlets of water closet bowls and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be arranged as to give visible warning and discharge. A check shall be made to ensure that necessary anchoring devices have been provided for supporting Water Closets, Wash Basins, Sinks and other appliances.

22.33.4.6 Protection against Damage and Theft

The contractor shall take every precaution to protect all bathroom fixtures and fittings issued to them against damage, misuse, crazing, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion and handing over of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all fixtures and fittings. Any fixtures and fittings found damaged, cracked, chipped, stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

22.33.4.7 Testing

All fixtures and fittings shall be tested for their proper performance by the Contractor thoroughly to satisfy himself that they are in order, before applying for virtual completion.

22.34 MISCELLANEOUS WORK

Disinfecting the Piping System

Before commissioning the water supply system the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure through mixing. Sufficient chemical shall be used to give the water a dose of 50 parts of chlorine to one million parts of water. If ordinary bleaching powder is used, the proportions will be 150 gms of powder to 1'000 litres of water. The powder shall be mixed with water in the storage tank. If a proprietary brand of chemical is used the proportions shall be as specified by the makers. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes opened successively working progressively away from storage tank. Each tap shall be closed when the water discharge begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and
pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purposes.

Safety Code

- First aid appliance shall be maintained in a readily accessible place including adequate supply of sterilized dressings and cotton wool.
- An injured person shall be taken on a public hospital without loss of time, in cases where the injury necessitates hospitalization.
- Suitable and strong scaffolds should be provided for all works that cannot safely be done from ground.
- No portable single ladder shall be over 8 meters in length. The width between the side rails shall not be less than 30 cm (clear) and the distance between two adjacent runs shall not be more than 30 cms. When a ladder is used an extra labor shall be engaged for holding the ladder.
- The excavated materials shall not be placed within 1.5 meters of the edge of the trench or half of the depth of trenches whichever is more. All trenches and excavations shall be provided with necessary fencing and lighting.
- Every opening in the floor of a building or in working platform be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one meter.
- No floor, roof or other part of the structure shall be over loaded with debris or materials as to render it unsafe.
- Workers employed on mixing and handling materials such asphalt, cement mortar or concrete and lime mortar shall be provided with protective foot wear and rubber hand gloves.
- Those engaged in welding works shall be provided with welder's protective eye-shields and gloves.
- No paint containing lead or lead products shall be used.
- Suitable facemasks should be provided to the workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scraped.
- The Contractor to the painter shall supply overalls and adequate facilities shall be provided to enable the working painters to wash during the periods of cessation of work.
- Hoisting machines and tackle used in the works, including their attachments, anchorage and supports shall be in perfect condition.
- The ropes use in hoisting or lowering material or as means of suspension shall be of durable quality and adequate strength and free from defects.

22.35 SANITARY FIXTURES AND ACCESSORIES

All sanitary wares and fittings shall be first class quality white glazed vitreous china ceramic and approved by the Engineer.

22.35.1 Water Closet (W.C.)

(a) **European pattern W.C. commode and flushing cistern.**

These shall be of white glazed vitreous china first class quality, double or single trap syphonic water closet suite as specified in the Bill of Quantities, P or S Trap, with attached ceramic flushing cistern as specified conforming to ISO or Indian standard Specification. The commode and flushing cistern shall be free from cracks, blisters and shall have smooth surface.

**Fixing :-** W.C. commode shall be fixed to floor with CP brass screws or by means of 75mm long 6.5mm dia counter sunk bolts and nuts imbedded in concrete or as per the instruction of the Project Engineer. The base of pedestal of the commode shall be filled with white cement mixed with pigment to match the shade of floor or as directed by the Engineer. Following measure shall be adopted for fixing the W.C. commode

1. The central axis of the commode shall be perpendicular to the finished face of wall.
2. The outlet of the commode shall be centrally placed in the rubber gasket of the PVC pipe as per drawing or as directed by the Engineer and shall have not leakage.
3. The distance between centre line of outlet of W.C. commode and finished wall face shall be so adjusted as to rest squarely against the finished wall face.
4. Seat and lid shall be of ISI marked solid of heavy duty quality and fitted exactly on the rim of the W.C. Commode with C.P. brass hinges, rubber buffers and C.P. brass nuts.
**Technical Specification**

**Method of Measurement**
Measurement for the European Water Closet will be made per unit set of complete installation.

**22.35.2 Wash Basins**

These shall be white glazed vitreous china of first class quality with single tap hole as specified in the Bill of Quantities. These shall be free from cracks, crazes, blister and shall have smooth surface.

**Fixing:** The basin shall be supported on brackets as per manufacturer’s instructions. The basin shall be under-counter or wall hung type. There shall not be any gap between top edge of the basin and finished face of wall.

**22.35.3 C.P. Pillar Cock:**

This shall be 15 mm size of C.P. brass central hole cock with fancy knob head.

**Method of Measurement**
Measurement for the Hand Wash basin will be made per unit set of complete installation.

**22.35.4 Urinals**

These shall be white glazed vitreous china of first class quality flat back type. The urinals shall be free from cracks, blisters and shall have smooth surface.

**Fixing:** Urinals shall be fixed on the wall with the help of C.P. brass screws as per the manufacturer's instructions and/or directed by the Engineer. There shall not be any gap between the back edge of the urinal and finished face of the wall. Urinal shall be battery operated sensor type.

**Method of Measurement**
Measurement for the Urinal will be made per unit set of complete installation.

**22.35.5 Water Tanks**

Water tank shall be of HDPE extra heavy type as shown on the drawing and specified in the Bill of Quantities. Tank shall be supplied with manhole covers and locking arrangement as per drawing or as directed by the Engineer.

Water tank shall provide inlets, outlets, scour and overflow pipes, sockets for float level switches and inter connections if required. Overflow pipes shall be provided with a mosquito proof brass grating. Scour pipe of size as specified by the Engineer shall be provided with a bend and pipe piece and plug terminating outside the tank wall.

Ball cocks used for tanks shall be high pressure ball cocks with brass lever rods and polythene ball floats. The ball floats shall conform to Indian standard which shall be hammer tested.

Water tank shall be fixed in position as shown on drawing or as directed by the Engineer.

**Method of Measurement**
Measurement for the Water tank will be made per unit set of complete installation.

**22.35.6 Toilet paper holder**

Toilet paper holder shall be of CP as per BILL OF QUANTITIES. It shall be fixed in wall in a neat Workmanlike manner. Recess in walls, where required, shall be provided. It shall be fix with C.P. brass screws, where required.

**Method of Measurement**
Measurement for the Toilet Paper Holder will be made per unit set of complete installation.

**22.35.7 Soap tray or soap dish**

Soap tray or soap dish shall be CP as per BILL OF QUANTITIES. Soap tray shall be fixed in wall in a neat Workmanlike manner. Recess in walls, where required, shall be provided. It shall be fixed with C.P. brass screws, where required.
Method of Measurement
Measurement for the Soap Dish will be made per unit set of complete installation.

22.35.8 Towel Rod

Towel rod shall be heavy type of C.P. brass with two brackets. The size of the rod shall be as specified on the drawing or Bill of Quantities. The brackets shall be firmly fastened by means of C.P. brass screws firmly embedded in the wall.

Method of Measurement
Measurement for the Towel Rod will be made per unit set of complete installation.

22.35.9 Mirror

Mirrors shall be of approved make 5mm thick. All edged shall be rounded off. Mirrors shall be fixed to wall with brass chromium plated screws and washers. Mirrors shall be of beveled edge of sizes as specified in the Bill of Quantities.

Method of Measurement
Measurement for the Mirror will be made per unit set of complete installation as per size.

22.35.10 C.P. Grating

Floor and urinal traps shall be provided with chromium plated grating, with rim of approved design and shape. Minimum thickness shall be 3mm.

Method of Measurement
Measurement for the CP Grating will be made per unit set of complete installation.

22.35.11 C.P. Fittings

All C.P. fittings, additional bib cocks, cockroach trap etc. shall be of the best quality heavy pattern of approved make. All C.P. fittings shall be fixed in a Works man like manner and shall not carry tool marks and scratches.

Method of Measurement
No Measurement will be made for CP fittings except for the additional items in Bill of Quantities. All CP fittings are presumed to be installed with sanitaryware requirement. Measurement will be made for Additional CP fittings as per Bill of Quantities item per unit of installation.

MAKE OF EQUIPMENT AND APPROVED MANUFACTURES

1. G. I. / M. S. Pipes
   a. Indian Tube Co. (TATA)
   b. Jindal (Hissar)

2. G. I. Fittings
   a. UNIK or R or C Brand

3. Gate / Globe / Butterfly
   a. Leader
   b. Zolotto

4. Sanitaryware
   a. Duravit
   b. Kohler
   c. Cotto

5. C. P. Fitting and accessories
   a. Grohe
   b. Hansgrohe
   c. Viking
   d. Schell

6. Mirror
   a. Modi Float
   b. Asahi Float

7. CPVC Pipes and Fittings
   a. Marvel
   b. Mangalam
   c. Hilltake
23. **FIRE FIGHTING SYSTEM**

23.1 **GENERAL**

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install wet riser fire hydrant system as required by the drawings and specified hereinafter or given in this Bill of Quantities.

Without restricting to the generality of the foregoing, the fire hydrant system shall include the following:

- IS 1239 Mild Steel Pipe (Heavy Grade) including valves, hydrants and appurtenances as given in BOQ.
- Landing valves of 63 mm diameter, canvas hose pipes, hose reels, hose cabinets for external Hydrant, 63 mm diameter fire brigade connections for draw out and inlet, connections to pumps, appliances and pressure reducing devices, 20mm diameter gunmetal nozzle for hose reel.

23.2 **REFERENCE DOCUMENT**

The work specified in this section shall be in accordance with the following standards, or approved equal, except as they are modified and supplemented herein:

- NFPA -14 Standard for the installation of Stand Pipe and Hose system
- NFPA -20 Installation of Centrifugal Fire Pump
  - 4 Fire fighting Provision
  - Hydrant System

23.3 **RELATED WORK**

The Contractor shall become familiar with other Divisions of the specifications affecting work of this trade.

23.4 **SAMPLES/SUBMITTALS**

Representative samples of MS Pipe and fittings, Valves, Fire Hose Cabinet, Hydrant Pipe, Hose Reel, Nozzle, Fire Extinguisher etc to be submitted for approval. All pumps and its accessories to be used shall be submitted to the Engineer and his approval taken before bulk purchase. The samples shall be kept with the Engineer for future reference and comparison. All fire items supplied shall conform to these approved samples in all respects.

All fire protection items shall have to be approved by the Engineer. Any fire items not up to the specification must be removed from the site immediately at Contractor’s own cost.

23.5 **SHOP DRAWINGS**

The contractor shall submit to the Engineer all shop drawings or diagrams necessary in order to make clear the work intended or to show its relation to adjacent work of other trades.
The contractor shall make any changes in such drawings or diagrams, which the Engineer may require, consistent with the contract. Details of shop drawings submitted for approval shall show clearly the relations of the various parts to the main members and lines of the structure, and where correct fabrication of the work depends upon field measurements; such measurements shall be made by the contractor and noted on the drawings before being submitted for approval.

23.6 AS BUILT DRAWINGS

Three months prior to the end of the Defects Liability Period, the Contractor shall submit As Built Drawings based on AUTOCAD printout and corresponding digital files as per Division 1 – General Requirements.

23.7 MAINTENANCE MANUAL

The Contractor shall submit a draft outline of the proposed format and contents within 30 days after the issuance of the virtual completion certificate by the Engineer. The submitted manual will conform to the approved outline.

The Manual shall be contained in a black three ring loose-leaf binder and be subdivided into sections according to the various divisions of this specification. Material shall be fully indexed, with a typed contents page located at the front of the Manual. Tabbed sheets shall be used to subdivide the contents as required. All material shall be neatly and legibly presented. Photocopies will be used only if original documents are not available.

All materials shall be clearly labeled according to manufacturer, manufacturer’s reference, source, location of use, and quantity.

Include in the Maintenance Manual a list of all materials submitted indicating quantities, source, manufacturer, manufacturer’s reference(s), and location of use. Also include printed manufacturer or supplier’s instructions on use, application, and maintenance of all products and materials.

23.8 MATERIALS

23.8.1 General Requirements

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Engineers.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

23.9 INTERNAL & EXTERNAL FIRE HYDRANT SYSTEM

23.9.1 SCOPE

Work under Fire Hydrant System shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install wet riser and fire hydrant system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

All fire mains and branches should be exposed everywhere with necessary pipe truss, supports, hangers, clamps etc.
23.9.2 PIPES AND FITTINGS

All pipes within the building in exposed locations and shafts including connections shall be welded joints as specified by the Engineer.

Pipes shall be given one primary coat of red oxide paint and two or more coats of synthetic enamel paint to give an even look (fire red, shade No. 536 as per IS: 5).

All fittings such as bends, tees, etc. shall be fabricated using the same MS pipe material and as per the site conditions and requirement.

Pipes shall be provided with electrical resistance welding. Jointing shall be butt welded between pipe and pipe and fittings.

Joints between Steel and M.S. pipes shall be made by provided a suitable flanged tail or sockets piece and Steel flanges on the M.S. pipe shall have appropriate number of holes and shall be fastened with nuts, bolts and 1.5mm thick compressed asbestos gaskets.

All equipment and valve connections shall be through flanges (Welded or screwed for Steel).

All welded piping is subjected to the approval of the Engineers and sufficient number of flanges and unions shall be provided.

23.9.2.1 PIPING INSTALLATION

Tender drawings indicate schematically the size and location of pipes. The Contractor on the award of the work, shall prepare detailed working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain valves and all pipe support, structural supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass. Drawings to be got approved from Local Fire Authorities.

Contractor shall submit the Hydraulic calculation for the system in accordance with Fire Authority by-laws.

Piping shall be properly supported on or suspended from stand 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 of Mild steel, adjustable for height and primer coated with rust preventive paint and finish coated back. Where pipe and clamps are of dissimilar materials a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Spacing between Supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm</td>
<td>3.65 meters (12’-0&quot;)</td>
</tr>
<tr>
<td>32 to 150 mm</td>
<td>4.57 meters (15’-0&quot;)</td>
</tr>
</tbody>
</table>

Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars steel structural supports attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the roof floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point. The Contractor shall coordinate with structural.

Pipe sleeves, 50 mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and angular space filled with fire proof materials like putty, fire seal etc.

Piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation and coordination with other agencies work so that particular area work shall be carried out in one stretch.

Piping layout shall take due care for expansion and contraction in pipes.
23.9.3 WELDED JOINTS

In general, the pipe work for Fire Fighting System shall have welded joints. However, other jointing methods may be adopted at places where required so far for certain specific considerations.

The welding of pipes in the field should comply with IS:816, 1969. Electrodes used for welding should comply with IS:814, 1991.

Joints between pipes and fittings shall be made with pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt welded joints shall not be acceptable. Care shall be taken to remove any burr from the end of the pipe after cutting.

All welders must be fully qualified and proof of an operator's qualification shall be either the Contractor's record of suitable tests passed within the previous six months or tests made before the commencement of the work.

The Contractor must submit to the Engineer the names of the welders who will be employed on the work, together with documentary evidence of their competency.

Any welder considered by the Engineer as not having the skill necessary for the work will at once be barred from further welding on the site or in the Contractor's workshop.

The Engineer may instruct the Contractor to cut out typical welded joints for inspection and the Contractor shall include for the removal of such pieces and re-making joints to the satisfaction of the Owner. The Contractor shall include in his Tender for the cost of removing all such pieces for inspection and re-making joints.

Care must be exercised by the Contractor to ensure that the welding flux does not project into the bore of the tube. All welds shall be good, clean metal, free from slag inclusions and porosity, of even thickness and regular contour, well fused with the parent metal and finished smooth.

Where site welding is carried out in proximity to inflammable materials, the Contractor must take special precautions to protect the materials from risks of fire.

23.9.3.1 TESTING OF WELDED JOINTS

The welded joints shall be tested in accordance with procedure laid down in IS: 3600 (Part I). One test specimen taken from at least one field joint out of any 10 shall be subjected to test.

If the results of the tensile test do not conform to the requirements specified, retests of two additional specimens from the same section shall be made, each of which shall conform to the required specifications. In case of failure of one or two, extensive gouging (scooping out) and repairing shall be carried out as directed by the authority.

If internal pressures exceed 1.5 Mpa (15kgf/cm²), special attention should be given to the assembly of the pipe and the first run of weld. Non-destructive testing of the completed weld may be carried out on pipelines by radiographic (see IS: 4853) or ultrasonic method (see IS: 4260) as agreed upon between the Owner and the Contractor.

23.9.4 FLANGED JOINT

Flanges shall be as per the relevant Indian Standard and shall be faced. Rubber or asbestos gasket shall be inserted between the joints.

Flange shall be provided on:

a. Straight runs not exceeding 12-15 m on pipelines 80 mm dia and above or as indicated in the drawing.

b. Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm or larger diameter.

c. For jointing all type of valve, appurtenances, pumps, connection with other type of pipes, to water tanks and other places necessary and required as per good for engineering practice.
23.9.5 VALVES:

23.9.5.1 Gate Valves:

Gate valves shall be provided as required or as shown in the applicable shop drawings conforming to the following specifications:

Gate valves shall conform to I.S:778-1971, Class - I, Flanges to BS 4504-PN6, PN10, PN16 or as required. Valves shall have non-rising spindles unless otherwise specified and shall be suitable for 21 Kg/Sq.cm test pressure.

23.9.5.2 Check valves:

Check valves shall be provided as required or as shown on the drawings and conform to BS EN 558-1. The valves shall comply with following specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Pressure</td>
<td>21 Kg/ cm²</td>
</tr>
<tr>
<td>Body</td>
<td>Ductile Iron, GG40</td>
</tr>
<tr>
<td>Disc</td>
<td>AISI 316/Ductile Iron with Nickel Plate</td>
</tr>
<tr>
<td>Resilient Seat</td>
<td>EPDM</td>
</tr>
<tr>
<td>Hinge pin</td>
<td>AISI 316</td>
</tr>
<tr>
<td>Spring</td>
<td>AISI 304</td>
</tr>
<tr>
<td>Retainer Screw</td>
<td>Carbon steel</td>
</tr>
<tr>
<td>Disc Bearing</td>
<td>Teflon</td>
</tr>
<tr>
<td>Operating Pressure</td>
<td>232 PSI</td>
</tr>
<tr>
<td>Flanges standard</td>
<td>DIN PN10/16</td>
</tr>
</tbody>
</table>

23.9.5.3 Butterfly Valves:

All the isolation valve 50cm and above on the equipment and water lines, where specified or shown on drawings shall be BL-A LUG type butterfly valves. They shall be designed for installation between flanges drilled in accordance with American Standard and with the hand lever operation. The Valve’s liner and Disc are replaceable and available in various materials for media compatibles. The valves shall comply with BS: 5155 or IS:13095.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
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<tr>
<td>Test Pressure</td>
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<td>AISI 316/Ductile Iron with Nickel Plate</td>
</tr>
<tr>
<td>Liner</td>
<td>EPDM</td>
</tr>
<tr>
<td>Hand Lever</td>
<td>American Standard</td>
</tr>
<tr>
<td>Temperature</td>
<td>266 Degree F (max.)</td>
</tr>
<tr>
<td>Operating Pressure</td>
<td>232 PSI</td>
</tr>
<tr>
<td>Flanges standard</td>
<td>ANSI 150 LBS</td>
</tr>
</tbody>
</table>

Installation:

Valve shall be installed in a manner that allows future removal and service of the valve. Packing and gasket shall not contain asbestos. The valve shall be of the same size as the pipe to which they are
installing. Valve above 150mm diameter shall be self locking warm gear type water proof and proctor
lubricated.

23.9.5.4 PRESSURE GAUGES

Pressure gauge shall be not less than 100 mm dia dial and of appropriate range and be complete with
shut off gauge valve etc. duly calibrated before installation.

Pressure gauge shall be provided at the following locations and as indicated on the drawings and Bill of
Quantities. Care shall be taken to protect pressure gauges during pressure testing.

23.9.5.5 LANDING VALVE

Contractor shall provide on each locations as shown on the drawings one double headed gunmetal
landing valve with 63 mm dia outlets and 80mm inlet (BS 5041 Part -1) with individual shut off valves
and cast iron wheels. Landing valves shall have flanged inlet and instantaneous type outlet as shown on
the drawings.

Instantaneous outlets for fire hydrants shall be standard pattern approved and suitable for fire brigade
hoses.

Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia, 15 meter long
rubberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine
wound with GI wire (Hose to BS 5041 Part -1) Multipurpose Nozzle with instantaneous branch pipe with
fire hose reel, gunmetal branch pipe with nozzle.

Each hose box shall be conspicuously painted with the letters “FIRE HOSE”.

23.10 FIRE HOSE REELS

Contractor shall provide standard fire hose reels with 20mm dia, high pressure rubber hose of 36 meters
length with gunmetal nozzle with 5mm bore, and control valve, connected wall mounted on circular hose
reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall conform to BS 5274. The
hose reel shall be connected directly to the pipe riser through an independent connection.

23.10.1 ORIFICE FLANGES

Provide orifice flanges fabricated from 6mm thick stainless steel plate to reduce pressure on individual
hydrants to restrict the operating pressure to 3.5 Kg/m². The design of the orifice flanges shall be given
by the Contractor as per the location and pressure conditions of each hydrants/hose reel and get
approved from Engineer before installation.

23.10.2 FIRE HOSE CABINETS

Provide hose cabinets for all hydrants fabricated from 1.5 mm CRCA MS sheet with single or double
glass front door and locking arrangement with breakable glass key access arrangement, duly painted
fire red with Powered Coated paint fixed to wall or self supported on floor as per site conditions. The
cabinet shall also have a separate chamber to keep the key with breakable glass as per approved
design. Hose cabinets shall be Powder Coated fire red paint with “FIRE HOSE” written on it prominently.
Samples of hose cabinet for internal and external works be got approved from Engineer before
installation at site.

Indoor type Fire hose cabinet suitable to accommodate 1 No. landing valve, 2 Nos. 15 meters long
hoses, 1 No. first aid reel, 2 Nos. branch pipe and 1 Nos. fire extinguishers or as given in BOQ.

Outdoor type Fire hose cabinet suitable to accommodate 2 Nos. 15 meters long hoses and 1 Nos.
branch or as given in BOQ.

23.10.3 AIR RELEASE VALVES

Provide 25mm dia, screwed inlet spring type single acting brass air valve on all high points in the system
or as shown on drawings on top of air cushion tanks. Air release shall conform to BS Standard.
23.10.4 SLUICE VALVES

Sluice valves shall be cast iron double flanged solid wedge, outside screw, non rising stem, yoke type bonnet and two piece gland construction. The valves shall have renewable screwed body seat rings. Flanges shall have raised faces and serrated face finish and shall conform to IS: 909.

Installation:
Valve shall be installed in a manner that allows future removal and service of the valve.

Packing and gasket shall not contain asbestos. The valve shall be of the same size as the pipe to which they are installing. Valve above 150mm diameter shall be self locking warm gear type water proof and proctor lubricated. Provide chain operators w/chain cleats on all valves more than 2.4 meters above floor.

23.11 FIRE BRIGADE CONNECTIONS

The Contractor shall provide gun-metal 4 way Fire Brigade collecting head with 63 mm dia instantaneous type inlets with built in check valves and 150 mm dia flanged outlet connection.

23.11.1 TESTING

All piping shall be tested to hydrostatic test pressure of 15 Kg/Sq.cm or twice the design pressure whichever is higher for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Client’s Representative.

Piping required subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped.

The Engineer shall be notified well in advance by the Contractor of his intention to test a section of piping and all testing shall be witnessed by the Engineer’s Representative.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the system concerned. If proper circulation is not achieved due to air bound connections, the Contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification including the tarring-up and re-finishing of floors, walls etc. as required.

The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test, and shall ensure that the plant room and other areas are cleaned up and spill over water is removed.

The Contractor shall give the pressure test of head for external yard hydrant at ground level

23.11.2 PAINTING

All pipes in exposed locations shall be painted with one coat of approved red oxide primer and two or more coats of approved synthetic enamel paint of approved shade after the Hydrostatic test pressure of the external and internal hydrant piping network.

23.11.3 MEASUREMENT

Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings, welding, jointing and testing.

Butterfly valves with orifice flanges, check valves and full way valves shall be measured by numbers and shall include all items necessary and required for fixing and as given in the Specifications/Bill of Quantities.

Landing valves, hose cabinets, rubberized fabric linen fire hose pipes, First-aid fire hose reels (with gunmetal port way valves) and gunmetal branch pipes shall be measured by numbers and shall include all items necessary and required for fixing as given in the Specifications/Bill of Quantities.

Suction and delivery headers shall be measured per linear meter of finished length and shall include all items as given in the Bill of Quantities.
No additional payment shall be admissible for cutting holes or chases in walls or floors or ceiling, making connections to pumps, equipment and appliances.

23.11.4 RATES AND BASIS OF PAYMENT

The rate shall include the cost of labour and materials involved in all the operations described above.

The completed Works shall be paid at their respective contract unit rate which shall be the full and the final compensation to the Contractor to complete the work as per these Specifications.

23.12 CENTRIFUGAL PUMPS

23.12.1 SCOPE

Contractor shall furnish all labour, materials, equipment for supply, installation testing and commissioning of complete fire hydrant system. In general, the item of works shall include but not limited to the following:

Electrically operated common for hydrant and Jockey pumps, diesel engine driven common standby pump.

Mild Steel heavy pipes for fire protection system including fittings, valves, accessories etc. as given in BOQ.

Internal and external fire hydrants including valve chambers, fire brigade inlet connections, air cushion tanks with air release valves, M.S. hose box for Internal and External fire hydrants as given in BOQ.

23.13 ELECTRIC PUMPS

23.13.1 Main Electrical Pump and Jockey Pump

Contractor shall provide and install electrically operated fire pumps and Jockey pump of capacity and head indicated in the Drawings/Bill of Quantities

Pumping sets shall be single/multi stage horizontal centrifugal or end suction single or multi outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease lubricated bearings mounted on common M.S. base frame mounted on a suitable nos. of cushy foot mounting on foundation.

The coupling joints for the prime mover with the pump shall be provided with a sheet metal guard.

Pumps shall be provided with approved type of mechanical seals.

23.13.2 Motors for Electric Driven Pumps

Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. The motor shall have class ‘H’ insulation.

Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

Motors for fire pumps shall meet all requirements and specifications of the tariff advisory committee.

23.13.3 Construction for Main Electric Pump:

Pumps shall be as per IS: 1520-1660, IS: 9079, IS: 325 and shall be of following construction:

Pump and driver shall be mounted on a single bed-plate and directly driven through flexible coupling in case of horizontal split casing pumps.

The pumps shall be of the type approved by statutory authority and capable of delivering not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head of pump
shall not exceed 120% of the rated head. The drive motor shall be continuous rating type and its rating shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PUMP DESCRIPTION</th>
<th>HORIZONTAL SPLIT CASING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flow(lit/min)</td>
<td>As per BoQ</td>
</tr>
<tr>
<td>2</td>
<td>Head(meter)</td>
<td>As per BoQ</td>
</tr>
<tr>
<td>3</td>
<td>Pump Type</td>
<td>End Suction</td>
</tr>
<tr>
<td>4</td>
<td>Pump Eff(%)</td>
<td>73.5</td>
</tr>
<tr>
<td>5</td>
<td>RPM</td>
<td>As per BoQ</td>
</tr>
<tr>
<td>6</td>
<td>Motor(Kw)</td>
<td>As per BoQ</td>
</tr>
<tr>
<td>7</td>
<td>Electrical Supply</td>
<td>3x400 Volts,50Hz</td>
</tr>
<tr>
<td>8</td>
<td>Suction &amp; delivery</td>
<td>100x65</td>
</tr>
<tr>
<td>9</td>
<td>Control Panel</td>
<td>Included</td>
</tr>
<tr>
<td>10</td>
<td>MOC Casing</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>11</td>
<td>MOC Impeller</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>12</td>
<td>Pressure Tank</td>
<td>Included</td>
</tr>
<tr>
<td>13</td>
<td>MOC Shaft</td>
<td>EN 8</td>
</tr>
<tr>
<td>14</td>
<td>Bearings</td>
<td>Heavy Duty Ball/Roller Bearings</td>
</tr>
<tr>
<td>15</td>
<td>Base Plate</td>
<td>Fabricated M.S./Cast Iron</td>
</tr>
<tr>
<td>16</td>
<td>Flanges</td>
<td>Conforming to IS:1536/1960</td>
</tr>
<tr>
<td>17</td>
<td>Packing</td>
<td>Gland Packing</td>
</tr>
<tr>
<td>18</td>
<td>Starter</td>
<td>Auto start</td>
</tr>
</tbody>
</table>

23.14 DIESEL ENGINE

23.14.1 Engine Rating:

The Diesel Engine shall be of approved make and type having bare engine horse power rating (after correction for altitude and ambient temperature) equivalent to the higher of the following two values:

20% in excess of the maximum brake horse power required to drive the pump at its duty point.

The brake horse power required to drive the pump at 150% of its rated discharge.

The engine shall be complete with cooling mechanism, air-filtration, exhaust system (insulated exhaust pipe will be paid separately), shut down mechanism, fuel tank, starting mechanism, batteries, battery chargers, ancillary equipment, tools kit, spare parts and all other accessories to complete the work.

23.14.2 Engine Cooling:

The following systems are acceptable:

Cooling by water from the discharge of fire pump (taken off prior to the pump discharge valve) direct into the engine cylinder jackets via a pressure reducing device to limit the applied pressure to a safe value as specified by the engine manufacturer. The outlet connection from this system shall terminate at least 150mm above the engine water outlet pipe and be directed into an open tundish so that the discharge water is visible.

A heat exchanger, the cooling water being supplied from the pump discharge (taken prior to the pump discharge valve) via a pressure reducing device, if necessary to limit the applied pressure to a safe value as specified by the engine manufacturer. The water outlet connection from this system shall be so designed that the discharged water can be readily observed.

23.14.3 Fuel Tank:

The fuel tank shall be of welded steel constructed to relevant Indian Standard for M.S. drums. The tank shall be mounted above the engine fuel pump to provide gravity feed. The tank shall be fitted with an indicator showing the level of the fuel in the tank. The capacity of tank shall be sufficient to allow the engine to run on full load for 6 hours.

23.14.4 Diesel Engine Exhaust System:

The Diesel Engine exhaust system shall be provided with 150mm dia insulated pipe.
23.14.5 Air Vessel for Fire Pumps

Provide an air vessel fabricated from 10 mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 25mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. The vessel shall be 450mmx2000mm dia high and tested to 10.0Kg/Sq.cm pressure.

The fire pumps shall operate on drop of 1 Kg/Sq.cm pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

23.14.6 Construction for Diesel Pump

Pumps shall be as per IS: 1520-1660, IS: 9079, IS: 325 and shall be of following construction:

Pump and driver shall be mounted on a single bed-plate and directly driven through flexible coupling in case of horizontal split casing pumps.

The pumps shall be of the type approved by statutory authority and capable of delivering not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head of pump shall not exceed 120% of the rated head. The drive motor shall be continuous rating type and its rating shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge.

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<td>End Suction</td>
</tr>
<tr>
<td>4</td>
<td>Pump Eff (%)</td>
<td>53</td>
</tr>
<tr>
<td>5</td>
<td>RPM</td>
<td>1450</td>
</tr>
<tr>
<td>6</td>
<td>Motor (Kw)</td>
<td>As per BoQ</td>
</tr>
<tr>
<td>7</td>
<td>Electrical Supply</td>
<td>12 Volts</td>
</tr>
<tr>
<td>8</td>
<td>Suction &amp; delivery</td>
<td>125x100</td>
</tr>
<tr>
<td>9</td>
<td>Control Panel</td>
<td>Included</td>
</tr>
<tr>
<td>10</td>
<td>MOC Casing</td>
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<td>18</td>
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<td>Auto start</td>
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</tbody>
</table>

23.15 ACCESSORIES AND FITTINGS

The following accessories shall be provided with each pump among other standard accessories required:

Coupling guard for end suction /horizontal split casing pumps.

Lubrication fittings and seal piping.

Test and /or air vent cocks.

Following fittings shall be provided with each pump among other standard fittings required:

Suction and discharge shut off valves (butterfly type), ‘Y’ strainer on suction and discharge check valves as specified under section “piping”.

Pressure gauge at discharge of size not less than 100 mm dia and of the appropriate rating with gauge valves etc.

25mm GI gland drain.
23.16 CONTROL PANEL

23.16.1 Cubical Panel:

The main switch board cubicle panel shall be of floor mounted type, totally enclosed, dust and vermin proof made from 14 SWG M.S. sheet of suitable size duly painted with one coat of anti-corrosive paint and two coats of synthetic enamel paint of approved make and shade with stove enameled finish. The cubical shall comprise of the followings:

- Incoming main M.C.C.B unit of required capacity.
- Outgoing M.C.C.Bs one for each motor.
- Aluminium busbar of suitable capacity.
- Fully Automatic "D.O.L." starter suitable for the motor H.P. with Push Buttons and ON/OFF indicating light one for each motor.
- Single phasing preventors one for each motor.
- 96 mm² panel type Ampere meters - one for each motor complete with CTs.
- 150 mm² voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.
- Three neon phase indicating lamps.
- Rotary switch for manual/auto operation.

All colour coded internal and inter-connecting wiring from incoming main to busbar, switch board panel and power/control cables from switch board cubicle to motors, engine and batteries etc. complete in all respect.

All switchgears and accessories shall be approved make to relevant IS codes and to the satisfaction of Project Manager/Consultant and rating of all equipment must match the KW of motors included. All electrical work to be carried out as per CPWD rules/specifications.

23.16.2 Earthing:

There shall be two independent earthing stations at least 3 meters away from the pump room. Each earth electrode shall consist of G.I. earth plate 600mmx600mmx6mm thick including accessories and masonry enclosure with cover plate having locking arrangement. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connection of 25mmx5mm G.I. strip. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be riveted and sheathed. The main earthi

Earth plates shall be buried in a pit 1.2 x 1.2m at minimum depth of 3 meters below ground. The connections between main bars shall be made by means of these 10 mm studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G. I pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plates to reach ground level for watering.

Brick masonry manhole 30x30x30cms size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated in this manhole for testing.

Earthing shall be done complete as per CPWD specifications.

23.16.3 Cabling:

All cables from switch board panel to the motors shall be PVC insulated and PVC sheathed armored aluminum conductor power cables of 650/1100 V grade conforming to IS: 1553. The cables of required size shall be suitable for laying on surface of wall or in flooring with suitable clamps. Necessary cable trays shall deemed to be included in this item as per site requirements.

The termination shall be with brass compression glands suitable for PVC sheathed armored aluminum conductor cable of 1.1 KV ‘A’ grade of the required size.
23.17 INSTALLATION

23.17.1 Pump installation

Pump shall be installed as per manufacturer’s recommendations. Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. Concrete floating foundation shall be provided by the Engineer as per approved shop drawings and specifications. The isolation pads, foundation bolts etc. shall be supplied by the Contractor. Contractor shall however ensure that the foundation bolts are correctly embedded.

Pump sets shall preferably be factory aligned, whenever necessary, site alignment shall be done by competent persons. Before the foundation bolts are grouted and the couplings are bolted, the bed plate levels and alignment results shall be submitted to the Engineer.

23.18 TESTING AND COMMISSIONING

Work shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the Contractor under this contract. Testing and commissioning Work shall be executed without any additional cost. 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. Contractor shall get the thread test between the Fire Department Hose and service connections.

23.19 PRE-COMMISSIONING

On completion of the installation of all pumps, piping, valves, pipe connections, electrical wiring, motor control panels and water level controlling devices the Contractor shall proceed as follows:

23.20 TESTING OF M.C.C.

1. Tests to be carried out for motor control centers shall be:

2. Insulation resistance test with 500 volt megger, before and after high voltage test, on all power and control wiring.

3. High voltage test at 3000 Volts A. C. for one minute on all power and control wiring.

4. Low voltage continuity test (6 volts) on power wiring of each feeder, between bus bars and outgoing terminals with switches and contactors in closed position Low voltage continuity test (6 volts) on all control wiring.

5. Operation test for all feeders with only control supply made “ON” to ensure correctness of control wiring, operation of the various equipment used, such as push buttons, protective devices, indicating lamps and relays, etc. All contactors shall be checked for the earth bus provided in the M.C.C.

6. Operation of all instruments and meters provided on the M.C.C.

23.21 MEASUREMENT

Pumping sets, and switch board cubicle shall be measured by number and shall include all item necessary and required and given in the specifications.

Earthing and power/control cabling shall not be measured separately but included in switchgear cubicle and shall include all items necessary and required to complete the work as per specification and relevant IS to the satisfaction of Engineer.

Pressure switches and pressure gauges shall not be measured separately, but included in respective pumping sets and shall include all items necessary and required to complete the work to the satisfaction of Engineer.
23.22 RATES AND BASIS OF PAYMENT

The rate shall include the cost of labour and materials involved in all the operations described above. The completed Works shall be paid at their respective contract unit rate which shall be the full and the final compensation to the Contractor to complete the work as per these Specifications.

23.23 REFERENCE DOCUMENT

The work specified in this section shall be in accordance with the following standards, or approved equal, except as they are modified and supplemented herein:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Reference</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BS</td>
<td>Code of practice for British Standard</td>
</tr>
<tr>
<td>2.</td>
<td>IS</td>
<td>Code of practice for Indian Standard</td>
</tr>
</tbody>
</table>

23.24 RELATED WORK

The Contractor shall become familiar with other Divisions of the specifications affecting work of this trade.

23.25 SAMPLES/SUBMITTALS

Representative samples of all types of Fire Extinguisher shall be submitted to the Engineer and his approval taken before bulk purchase. The samples shall be kept with the Engineer for future reference and comparison. All Fire Extinguisher items supplied shall conform to these approved samples in all respects.

All fire protection items shall have to be approved by the Engineer. Any fire Extinguisher items not up to the specification must be removed from the site immediately at Contractor’s own cost.

23.26 MATERIALS

23.26.1 General Requirements

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Engineers.

Dry Powder Fire Extinguisher shall be fixed truly vertical as required in a neat workmanlike manner and shall be placed as shown in Drawing.

Dry Powder Fire Extinguisher shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in passages etc.

Dry Powder Fire Extinguisher shall be securely fixed to walls by suitable clamps or inside MS cabinet. Only approved type of anchor fasteners shall be used for RCC walls.

23.27 DRY POWDER FIRE EXTINGUISHER SYSTEM

23.27.1 Test Demonstration

At least 1 extinguisher per each type shall be demonstrated at site in simulated fire conditions. Fire extinguishers shall be installed as per BS Code of practice for selection, installation and maintenance of portable first aid appliances. Hand appliances shall be installed in readily accessible locations with the Appliance brackets fixed to wall by suitable anchor fasteners. Each appliance shall be provided with an inspection, testing, change of charge and other relevant data. All appliances shall be fixed in a true workman like manner truly vertical and at current locations.

23.27.2 Dry Powder Fire Extinguisher

Dry Powder Fire Extinguisher conforming to BS 5423:1987 or as given in BOQ. The Dry Powder agents shall be mono-ammonium phosphate and ammonium sulphate base.
Dry Powder Fire Extinguisher shall be as follows:

<table>
<thead>
<tr>
<th>CO₂ - 4.5kg:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>CO₂ - 4.5 2</td>
</tr>
<tr>
<td>Media</td>
<td>CO₂</td>
</tr>
<tr>
<td>Capacity</td>
<td>4.5kgs</td>
</tr>
<tr>
<td>Discharge time</td>
<td>10sec. to 18sec.</td>
</tr>
<tr>
<td>Gas storage pressure</td>
<td>85 kgf/cm²</td>
</tr>
<tr>
<td>Cylinder diameter</td>
<td>140mm</td>
</tr>
<tr>
<td>Overall height</td>
<td>710mm approx.</td>
</tr>
<tr>
<td>Operation method</td>
<td>Upright</td>
</tr>
<tr>
<td>Temp. range</td>
<td>0 ± 5°C</td>
</tr>
<tr>
<td>Charged weight</td>
<td>17 kgs approx.</td>
</tr>
<tr>
<td>Test pressure</td>
<td>250kgf/cm²</td>
</tr>
</tbody>
</table>

Dry Chemical Powder DCP - 6 kg:

<table>
<thead>
<tr>
<th>DP6</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Sq. Grip Nozzle</td>
</tr>
<tr>
<td>Types</td>
<td>Dry Powder (IS:4308)</td>
</tr>
<tr>
<td>Media</td>
<td>6 Kg.</td>
</tr>
<tr>
<td>Capacity</td>
<td>85% min</td>
</tr>
<tr>
<td>Effective discharge</td>
<td>6m min.</td>
</tr>
<tr>
<td>Jet length</td>
<td>23sec. to 30sec.</td>
</tr>
<tr>
<td>Discharge time</td>
<td>30kgf/cm²</td>
</tr>
<tr>
<td>Test pressure</td>
<td>15kgf/cm² max.</td>
</tr>
<tr>
<td>Expansion space pressure</td>
<td>180 gms CO₂</td>
</tr>
<tr>
<td>Gas cartridge</td>
<td>Epoxy polyester powder coating</td>
</tr>
<tr>
<td>Anti-corrosion inhibitor</td>
<td></td>
</tr>
<tr>
<td>Overall width</td>
<td>280mm approx.</td>
</tr>
<tr>
<td>Overall height</td>
<td>560mm approx.</td>
</tr>
<tr>
<td>Shell diameter</td>
<td>180mm</td>
</tr>
<tr>
<td>Charged weight</td>
<td>19kg approx.</td>
</tr>
<tr>
<td>Temp. range</td>
<td>0 ± 5°C</td>
</tr>
<tr>
<td>Operation method</td>
<td>Upright</td>
</tr>
</tbody>
</table>

23.27.3 MEASUREMENT

Fire extinguishers shall be measured by numbers and include installation and all items necessary and required and given in the Bill of Quantities.

23.27.3 RATES AND BASIS OF PAYMENT

The rate shall include the cost of labour and materials involved in all the operations described above.

The completed Works shall be paid at their respective contract unit rate which shall be the full and the final compensation to the Contractor to complete the work as per these Specifications.

LIST OF APPROVED MATERIAL IN ORDER OF PREFERENCE

<table>
<thead>
<tr>
<th>Description</th>
<th>Approved Makes/ Brands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric drive centrifugal Main Fire pump set</td>
<td>Kirloskar/ Mather &amp; Platt</td>
</tr>
<tr>
<td>Electric drive centrifugal Fire pump set</td>
<td>Grundfos/ Kirloskar/ Mather &amp; Platt</td>
</tr>
<tr>
<td>Electric Motor for Fire pump</td>
<td>Siemens/ ABB/ Kirloskar/ NGF/ Bharat Bijli/ Crompton Greaves</td>
</tr>
<tr>
<td>CI Butterfly Valves</td>
<td>Audco/ KSB/ Alfa Laval</td>
</tr>
<tr>
<td>CI Sluice Valves</td>
<td>Kirloskar/ Upadhyay/ H. Sarkar</td>
</tr>
<tr>
<td>CI Non-Return Valves</td>
<td>Kirloskar/ KSB/ Advance</td>
</tr>
<tr>
<td>GM Brass Valve</td>
<td>Zoloto/ Leader</td>
</tr>
<tr>
<td>CI Y-Strainer</td>
<td>Kirloskar/ KSB/ Advance</td>
</tr>
<tr>
<td>CI Flexible Coupling</td>
<td>Kirloskar/ KSB/ Advance/ IVC</td>
</tr>
<tr>
<td>Air Release Valve</td>
<td>Zoloto/ Leader</td>
</tr>
<tr>
<td>Ball Valve</td>
<td>Zoloto/ Leader</td>
</tr>
<tr>
<td>Pressure Switch</td>
<td>System Sensor/ Dunfoss/ Switzer</td>
</tr>
<tr>
<td>Flow Switch</td>
<td>System Sensor/ Dunfoss/ Spray Safe/ Pottar</td>
</tr>
</tbody>
</table>
24. AIR-CONDITIONING & VENTILATION SYSTEM (HVAC)

24.1 GENERAL

Supply, site delivery, installation, testing and commissioning of proposed system including skilled manpower/labors, testing instruments, tools, installation materials, service equipment, consumables and making the entire system ready for continuous operation of the air-conditioning system as per design and drawing, specifications, instruction and site conditions:

- Heat pump type VRF multi split air-conditioning systems with 4 way ceiling cassette type indoor units and remote controllers
- Heat pump type DC Inverter single split air-conditioning systems 4 way ceiling cassette type indoor units and remote controllers
- Floor standing precision type cooling only air-conditioning systems
- Sound insulated rectangular centrifugal exhaust air supply fans
- Inline tubular fresh air supply fans
- Refrigerant quality copper pipe and factory made branch kits covered with closed cell insulation
cPVC drainpipes covered with closed cell insulation
- Power coated aluminium fresh/exhaust air grilles
- Related electrical work
- Related civil work
- Comprehensive 2 year Guarantee with defective part replacement
- Maintenance plan during 2 year guarantee period
- Proposal for AMC contract for 3 year after expiry of guarantee period with Annual Maintenance plan
- Additional works, applicable during installation period.

24.2 BASIS OF DESIGN

**Outdoor Conditions**

<table>
<thead>
<tr>
<th>Description</th>
<th>DBT [°C]</th>
<th>RH [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Summer</td>
<td>33</td>
<td>70</td>
</tr>
<tr>
<td>i) Winter</td>
<td>0</td>
<td>65</td>
</tr>
</tbody>
</table>

**Indoor Conditions**

<table>
<thead>
<tr>
<th>Description</th>
<th>DBT [°C]</th>
<th>RH [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Summer</td>
<td>24</td>
<td>55 %</td>
</tr>
<tr>
<td>ii) Winter</td>
<td>20</td>
<td>55 %</td>
</tr>
</tbody>
</table>

Fresh air Supply : 15 CMH per person

Lighting Load : 10 W/Sq.m.

Occupant Load : 73 W/person (Latent Heat)

Toilet Exhaust : 15 ACH
24.2.1 Operating Tests

After all mechanical work has been completed, tested, adjusted and approved, the system shall be tested for six continuous days, or longer when so directed, to demonstrate that they fulfil all requirements and that they operate satisfactorily in full load in presence of representative of RBB and consultant.

The bidder shall furnish three copies of test data, computations and results in reports in report form to the consultant.

24.2.2 Instruments:

All instruments required for testing and commissioning shall be provided by the contractor at his cost. Cost for those items shall be included in item rate of equipment.

24.2.3 Two Years Comprehensive Guarantee with parts replacement

Testing, trial usage or use of equipment for temporary provision of services shall not shorten or modify the terms of this guarantee. Manufacturers shall provide their standard guarantees for work under this division. However, such guarantees shall be in addition to and not in lieu of all other liabilities, which the manufacturer and bidder may have by law or by other provisions of the contract documents.

All materials, items of equipment and workmanship furnished under this division shall carry the standard warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship which may develop shall be made good, forthwith, by and at the expense of the bidder, including all other damage done to areas, materials and other systems resulting from this failure.

The bidder shall guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated for 2 years with part replacement of defective parts.

The bidder shall guarantee that all components used in installed air-conditioning system are in stock at all the time with them and assures to replace within stipulated time.

Upon receipt of notice from the RBB of failure of any part of the systems or equipment during the guarantee period, the bidder at his own expense shall replace the affected part or parts within 24 hours of written notification.

All mechanical equipment, pipe works, control system and installed accessories shall have a guarantee for a period of one year. Any part that fails or proves defective during this guarantee period except force majeure shall be replaced or repaired without any extra cost. If the defects are not rectified within stipulated time frame the RBB may arrange to do so at the contractor’s risk and cost, without prejudice to any other rights. The contractor failing to fulfill their duty will be black listed and will be automatically disqualified to participated in any future projects of the RBB.

24.2.4 Operation and Maintenance Instructions:

During operating tests, the contractor shall arrange and pay for the services of qualified and authorized representatives of manufacturers of air-conditioning equipment to instruct the RBB’s operating personnel in operating and maintaining the systems and equipment. The period of this instruction shall be one week.

During operating tests, the bidder shall arrange to keep one experienced mechanical engineer on the job for a continuous period of 5 days.

24.2.5 Workmanship:

The entire work provided in this specification shall be constructed and finished in every respect and substantial manner. It is not intended that the drawings shall show every pipe, fitting and appliance, but the bidder shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best trade practice and to the satisfaction of the consultant.
The successful bidder shall obtain detailed information from the manufacturers of apparatus as to the proper method of installing and interconnections.

All pipes shall be thoroughly cleaned and blown out by dry nitrogen to prevent any debris from accumulation of debris in the indoor unit's coil when systems are placed in operation. All temporary connections required for blowing out the network of piping and any other equipment or labour for cleaning shall be provided by the contractor.

24.3 Equipment

24.3.1 Heat pump type VRF multi split air-conditioning units

24.3.2 Four way ceiling cassette type indoor units

a) Cabinet Section: Cabinet of 4 way ceiling cassette type indoor units shall be fabricated of heavy gauge electro-galvanized mild steel with structural rigidity. Supply and return air grill shall be made of high quality plastic. Return air grill shall be located at center, while four way supply air grill with automatic louver shall swing in order to maintain proper air distribution. The flap shall be designed to prevent soiling on false ceiling near supply grills. The flap shall be easily removed if require. Access panel should be constructed as to easy removable. The indoor unit shall be equipped with powerful inbuilt drain pump to avoid the collection of water in drain pans and over flow inside the room. The unit shall equipped with drain pan inspection port for cleaning of drain pan and drain pump easily. The mounting height should be able to adjust through the panel corner cover.

Supply/return grill size of way ceiling cassette type indoor unit shall be 850 mm x 850 mm x 260 mm.

b) Fan: Fan shall be energy efficient turbo axial type for noiseless operation suitable for the electric characteristic of 220 volts 1ph. 50 hz. Thermal & electrical protectors shall protect fan. Fan shaft shall be of stainless steel and supported in self aligning precision for balancing.

c) Coil Section: Refrigerant coil shall be of copper tube mechanically bonded to aluminium fins assembled within heavy gauge aluminium framework.

d) Filter Section: Filter shall be easily accessible and designed for easy withdrawal of filter cells. Filters shall be of dry (cleanable) type having efficiency rating of 90 %. Filters must possess a high flow rate, high dust retention with low differential pressure.

e) Refrigerant: Refrigerant used in the equipment shall be environmental friendly with a zero Ozone Depleting Potential rating R-410A. R-410A has better heat transfer properties than other common refrigerant and higher density which allows reducing pipe sizes in heat exchangers and interring connecting pipes. Thus reduces amount of refrigerant to be charged.

f) Capacity: Nominal cooling and heating capacity of each 4 way ceiling cassette type indoor unit shall be not be less than data given in B.O.Q.

g) Power consumptions: Nominal power consumption of each 4 way ceiling cassette type indoor unit shall be not be more than data given in B.O.Q.

24.3.3 VRF type Outdoor unit

a. Cabinet Section: Cabinet of outdoor units shall be fabricated of heavy gauge electro-galvanized mild steel with structural rigidity.

b. Compressor shall be scroll type DC inverter hermetic with suction and discharge valves, gas cooled motor, vertical crank shaft balanced and mounted on vibration isolators to provide free floating operation. It should have the over load protection. Whereas, condenser fan shall be propeller type made of glass reinforced acryl styrene resin and direct driven with DC motor for improved energy efficiency.

c. The outdoor shall be suitable for 3 phase, 380 V, 50 Hz. Condenser fan and compressor shall be protected by separate thermal & electrical protectors. Further more HPC/LPC switch shall be installed to protect the compressor.
d. Power cables and control cables shall be installed as per equipment manufacturer's requirement.

e. Coil Section: Refrigerant coil shall be of copper tube mechanically bonded to Aluminium blue fins assembled within heavy gauge aluminium framework. Headers shall be in copper coil and header shall be electro-tinned after manufacturers.

f. Refrigerant flow control: The outdoor unit shall have electronic expansion valves to meet exact cooling/heating demand.

g. Accumulator: The outdoor unit shall have over sized accumulator to store unused refrigerant during low demand and optimises the flow of gaseous refrigerant and oil to the compressor.

h. Noise level: The outdoor unit shall have low noise level. While operating at highest speed the noise level of each outdoor unit shall not exceed data given in B.O.Q.

i. Capacity: Nominal cooling and heating capacity of each VRF type outdoor unit shall be not be less than data given in B.O.Q.

j. Power consumption: Nominal power consumption of each VRF type outdoor unit shall be not be more than data given in B.O.Q.

24.3.4 Heat pump type DC Inverter Single Split Air-conditioning Units with 4 way ceiling cassette type indoor units

All outdoor units shall be equipped with DC inverter type compressor capable of adjusting the speed as per cooling/heating load in the occupied zone and temperature setting to achieve the desired comfort. Indoor units shall be 4 way ceiling cassette type. Cooling, heating capacities, power consumptions, noise level, refrigerant etc. shall be as mentioned in BOQ.

24.3.5 four way ceiling cassette type indoor units

a. Cabinet Section: Cabinet of 4 way ceiling cassette type indoor units shall be fabricated of heavy gauge electro-galvanized mild steel with structural rigidity. Supply and return air grill shall be made of high quality plastic. Return air grill shall be located at center, while four way supply air grill with automatic louver shall swing in order to maintain proper air distribution. The flap shall be designed to prevent soiling on false ceiling near supply grills. The flap shall be easily removed if require. Access panel should be constructed as to easy removable. The indoor unit shall be equipped with powerful inbuilt drain pump to avoid the collection of water in drain pans and over flow inside the room. The unit shall equipped with drain pan inspection port for cleaning of drain pan and drain pump easily. The mounting height should be able to adjust through the panel corner cover.

Supply/return grill size of way ceiling cassette type indoor unit shall be 850 mm x 850 mm x 260 mm.

b. Fan: Fan shall be energy efficient turbo axial type for noiseless operation suitable for the electric characteristic of 220 volts 1ph. 50 hz. Thermal & electrical protectors shall protect fan. Fan shaft shall be of stainless steel and supported in self-aligning precision for balancing.

c. Coil Section: Refrigerant coil shall be of copper tube mechanically bonded to aluminium fins assembled within heavy gauge aluminium framework.

d. Filter Section: Filter shall be easily accessible and designed for easy withdrawal of filter cells. Filter. Filters shall be of dry (cleanable) type having efficiency rating of 90 %. Filters must possess a high flow rate, high dust retention with low differential pressure.

e. Refrigerant: Refrigerant used in the equipment shall be environmental friendly with a zero Ozone Depleting Potential rating R-410A. R-410A has better heat transfer properties than other common refrigerant and higher density which allows reducing pipe sizes in heat exchangers and interring connecting pipes. Thus reduces amount of refrigerant to be charged.

f. Capacity: Nominal cooling and heating capacity of each 4 way ceiling cassette type indoor unit shall be not be less than data given in B.O.Q.
g. Power consumptions: Nominal power consumption of each 4 way ceiling cassette type indoor unit shall be no more than data given in B.O.Q.

24.3.6 Inverter type Outdoor unit

a. Cabinet Section: Cabinet of outdoor units shall be fabricated of heavy gauge electro-galvanized mild steel with structural rigidity.

b. Compressor shall be scroll type DC inverter hermetic with suction and discharge valves, gas cooled motor, vertical crank shaft balanced and mounted on vibration isolators to provide free floating operation. It should have the over load protection. Whereas, condenser fan shall be propeller type made of glass reinforced acryl styrene resin and direct driven with DC motor for improved energy efficiency.

c. The outdoor shall be suitable for 1 phase, 220 V, 50 Hz. Condenser fan and compressor shall be protected by separate thermal & electrical protectors. Further more HPC/LPC switch shall be installed to protect the compressor.

d. Power cables and control cables shall be installed as per equipment manufacturer’s requirement.

e. Coil Section: Refrigerant coil shall be of copper tube mechanically bonded to Aluminium blue fins assembled within heavy gauge aluminium framework. Headers shall be in copper coil and header shall be electro-tinned after manufacturers.

f. Refrigerant flow control: The outdoor unit shall have electronic expansion valves to meet exact cooling/heating demand.

g. Accumulator: The outdoor unit shall have over sized accumulator to store unused refrigerant during low demand and optimises the flow of gaseous refrigerant and oil to the compressor.

h. Noise level: The outdoor unit shall have low noise level. While operating at highest speed the noise level of each outdoor unit shall not exceed data given in B.O.Q.

i. Capacity: Nominal cooling and heating capacity of each inverter type outdoor unit shall be not less than data given in B.O.Q.

j. Power consumption: Nominal power consumption of each VRF type outdoor unit shall be not more than data given in B.O.Q.

24.4 FLOOR STANDING PRECISION TYPE COOLING ONLY AIR-CONDITIONING UNITS

24.4.1 Floor Standing Indoor Unit:

a. Cabinet Section: Cabinet of Floor standing indoor units shall be fabricated of heavy gauge electro-galvanized mild steel with structural rigidity with power coated panels. Supply air outlet shall be located at bottom of the indoor unit while return air inlet shall be located at the top of the indoor unit to maintain proper air distribution. Cabinet shall also be cladded with thermal and sound insulation material. It shall also be compact in design for saving space and maintenance friendly with access from front.

b. Fan: Fan shall be turbo axial type with electronically commuted (EC) motor for low energy consumption and noiseless operation suitable for the electric characteristic of 220 volts 1ph. 50 hz. Thermal & electrical protectors shall protect fan. Fan shaft shall be of stainless steel and supported in self aligning precision for balancing.

c. Coil Section: Refrigerant coil shall be of copper tube mechanically bonded to aluminium fins assembled within heavy gauge aluminium framework. Cooling coil shall be designed with high sensible heat factor (SHF) with up to 1 for maintaining high efficiency and suitable for data centre.
d. Filter Section: Filter shall be easily accessible and designed for easy withdrawal of filter cells. Filters shall be of dry (cleanable) type having efficiency rating of 95%. Filters must possess a high flow rate, high dust retention with low differential pressure.

e. Refrigerant: Refrigerant used in the equipment shall be environmental friendly with a zero Ozone Depleting Potential rating R-410A. R-410A has better heat transfer properties than other common refrigerant and higher density which allows reducing pipe sizes in heat exchangers and interring connecting pipes. Thus reduces amount of refrigerant to be charged.

f. Compressor: Compressor shall be scroll type DC inverter hermetic with suction and discharge valves, gas cooled motor, vertical crank shaft balanced and mounted on vibration isolators to provide free floating operation. It should have the over load protection. Furthermore, HPC/LPC switch shall be installed to protect the compressor. The outdoor shall be suitable for 3 phase, 380 V, 50 Hz.

g. Accumulator: The outdoor unit shall have over sized accumulator to store unused refrigerant during low demand and optimises the flow of gaseous refrigerant and oil to the compressor.

h. Control system: Control system shall be equipped with high resolution digital display. It shall also have provision of self-diagnosis system, on/off, programmable temperature and fan modes operation setting.

i. Capacities: Nominal cooling capacity of each Floor standing indoor unit shall be not be less than data given in B.O.Q.

j. Power consumption: Nominal power consumption of each 4 way ceiling cassette type indoor unit shall be not be more than data given in B.O.Q.

24.4.2 Remote Condensing Unit:

a. Cabinet Section: Cabinet of outdoor units shall be fabricated of heavy gauge electro-galvanized mild steel with structural rigidity.

b. Whereas, condenser fan shall be propeller type made of glass reinforced acryl styrene resin and direct driven with DC motor for improved energy efficiency.

c. The outdoor shall be suitable for 1 phase, 220 V, 50 Hz. Condenser fan shall be protected by separate thermal & electrical protectors.

d. Power cables and control cables shall be installed as per equipment manufacturer's requirement.

e. Coil Section: Refrigerant coil shall be of copper tube mechanically bonded to Aluminium blue fins assembled within heavy gauge aluminium framework. Headers shall be in copper coil and header shall be electro-tinned after manufacturers.

f. Refrigerant flow control: The outdoor unit shall have electronic expansion valves to meet exact cooling/heating demand.

g. Noise level: The outdoor unit shall have low noise level. While operating at highest speed the noise level of each out door unit shall not exceed data given in B.O.Q.

h. Capacity: Nominal cooling and heating capacity of each VRF type outdoor unit shall be not less than data given in B.O.Q.

i. Power consumption: Nominal power consumption of each VRF type outdoor unit shall be not more than data given in B.O.Q.
24.5 ACCESSORIES:

24.5.1 Refrigerant Pipe, Drain Pipe and Fresh Air Duct/Pipe:

**Refrigerant pipe:**
Refrigerant pipe interconnecting indoor units and outdoor units shall be of refrigeration quality copper pipe; soft drawn seamless high grade copper pipe. Refrigerant line shall be covered properly to avoid any mechanical injuries. All pipe joints shall be properly braced with oxy-acetylene (if required). For the refrigerant pipes larger than 19mm diameter hard copper pipe should be used with elbows wherever required. For the smaller pipes pipe bender should be used for bending the pipe.

Indoor units shall be connected to main refrigerant pipe with factory made branch kit having facility to joint various sizes of pipes as required in each branch kit. Model number of branch kit shall be mentioned in the bid document. Pipe sizing shall be carried out as per manufacturer's instructions.

All insulated refrigerant pipes exposed to outdoor shall be covered with 24 gauge G.I. ducting and properly secured on walls/floors. The bidder shall include the cost for this purpose in rate of refrigerant pipes and not entitled to claim separately.

The bidder must submit the detail refrigerant piping layout with respective pipe sizes, location of branch kit along the bid document.

**Drain pipe:**
Drain pipe shall be made of cPVC. The bidder shall maintain adequate slope to avoid the collection and leakage of condensate drain.

Fresh air duct shall be made of 0.6 mm thick GI sheet and branches to each 4 way ceiling cassette indoor unit shall be made of uPVC pipe. It is bidder’s responsibility that the refrigerant and drain pipe sizes are as per the manufacturer’s recommendation and are of correct sizes to ensure the optimum operation of entire installed HVAC system.

24.5.2 Testing of Refrigerant Pipe, Drain Pipe & Fresh Air Duct/Pipe:

The contractor shall test the refrigerant piping with nitrogen at a pressure 2 times greater than nominal operating discharge pressure and keep the pressure record every 2 hours during day and every 12 hours during night for 24 hours. All inactive refrigerant piping shall keep pressurized all the time till connection of indoor units and outdoor unit are ready. It is the Contractor's responsibility to ensure that the installed pipes are free of debris and moisture to ensure smooth and trouble free operation of the entire HVAC system.

Testing of drain pipe shall be carried out by filling the drain pan of indoor units by water and allowing to flow the water to drain and make sure that there is no leakage and accumulation of water inside the pipe.

Testing of fresh air duct/pipe shall be carried out with smoke testing to make sure that there is no leakage and proper distribution of fresh air supply to each indoor unit by adjusting balancing dampers.

24.6 REFRIGERANT:

Refrigerant used in the equipment shall be R-410A. Additional R-410A shall be charged into the system if required. The additional amount of refrigerant required shall be calculated based on the length and size of installed liquid refrigerant pipe and manufacturer's data book. The bidder is not entitled to claim for extra refrigerant required. Cost of extra quantity of refrigerant, if required shall be included in unit cost of equipment.

24.7 REMOTE CONTROLLER

Each indoor unit shall have individual wired remote controller with LED display having provision of weekly operation schedule to be registered. It shall also have provision of self-diagnosis system, temperature settings and cooling, heating and fan modes operation setting. It shall have three speed fan controller. It shall have provision of setting upper and lower room temperature to precisely control the room temperature and energy conservation. It shall also have run hours meter to registered cumulative operation hours of the unit since commissioning.
24.8 PIPE INSULATION

All refrigerant pipes shall be insulated with closed cell insulation tubes of respective sizes with at least 19 mm thickness for pipes exposed to outdoor and 13 mm thickness for pipes installed indoor. All piping to be insulated shall be cleaned thoroughly before applying insulation. Care shall be taken to ensure that there are no damages to piping insulation. All joints shall be sealed with adhesive compounds.

Insulation material should be of expanded closed cell electrometric nitrile rubber material having a thermal conductivity of not more than 0.034 w/mK at 24 °C. The density of the material shall not be more than 0.75 g/cu.cm.. Material shall be self-extinguishing and CFC free so as not to emit toxic gases in case of fire.

24.9 SUPPORTS/HANGERS FOR PIPING

Vertical piping: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.

Horizontal piping: Horizontal piping shall be secured at sufficiently close intervals to keep the pipe in alignment and prevent sagging. Pipe support shall be adjustable for height.

All pipe support shall be painted with two coats of red oxide and two coats of enamel paints of approved colour. Spacing of pipe support shall not be more than 3 m. Extra support shall be provided at the bends and tees, if required. Insulated piping shall be supported in such a way so as not to damage the insulation. None of the pipe hanger shall be secured to the support made for false ceiling. The hangers shall be secured with help of at least 6 mm diameter anchor bolt.

Where pipes pass through floors and walls provide PVC pipe sleeves 30 mm larger than outside diameter of the pipe inclusive of insulation. The centre of the pipes shall be at the centre of the sleeves and sleeves shall be flushed with the finished surface. The bidder is not entitled to claim for extra cost for supports/hangers for pipes, cost for these items shall be included in unit cost of pipe.

24.10 SUPPORT FOR INDOOR UNITS AND OUTDOOR UNITS

4 way ceiling cassette type indoor unit shall be hanged on ceiling by 4 numbers of 8 mm diameter threaded rod with expansion bolt having provision of adjustment of height. The units shall be properly levelled so as not to spill the condensate drain.

Supports for each outdoor shall be strong enough to hold the weight of the unit and locally fabricated using MS angles. Such support shall be secured with 4 numbers of 10 mm diameter expansion bolt on floor. The support shall be painted with two layers of red oxide and two layers of enamel paint of specified colour. The outdoor unit shall be installed on vibration isolator as recommended by the manufacturer.

The bidder is not entitled to claim for extra cost for supports/hangers for indoor and outdoor equipment, cost for these items shall be included in unit cost of equipment.

24.11 TESTING OF CONTROL SYSTEM AND PERFORMANCE TESTING OF HEAT PUMP TYPE VRF MULTI SPLIT AC UNITS, DC INVERTER SINGLE SPLIT AC AND FLOOR STANDING PRECISION TYPE AC UNITS

After installation of the entire heat pump type VRF multi split and DC inverter type single split air-conditioning systems and precision type air-conditioning systems, a testing and commissioning must be conducted to check the performance of the AC systems, control system and drain piping system. The test report shall include but not limited to designation of AC units, location, voltage, current, indoor and outdoor temperature, humidity, air flow rate, suction and discharge pressures etc. The contractor shall get prior approval of the format of test report and conduct the test in presence of consultant and RBB. Then the contractor shall submit test report to the consultant for approval. The bidder is not entitled to claim for extra cost for supports/hangers for indoor and outdoor equipment, cost for these items shall be included in unit cost of equipment.

24.12 RELATED ELECTRICAL WORKS:

Electrical power supply for all indoor units and VRF type inverter outdoor units, DC inverter Outdoor unit and outdoor units of precision type AC unit shall be provided by Electrical contractor. The Electrical contractor shall provide control panel with MCB, MCCB, contractors, high/low voltage protector, phase
protectors, earth leakage circuit breaker (ELCB) and indicator lamps. However, it is the HVAC contractor’s responsibility to provide the control (data) cable required between indoor units and outdoor units and control (data) cable for each remote controller shall be also be provided by the HVAC contractor themselves. The control (data) cable shall be shield twisted pair (STP) type. The bidder is not entitled to claim for extra cost for control/data cable, cost for these items shall be included in unit cost of equipment.

24.13 RELATED CIVIL WORKS:

The air-conditioning contractor shall submit the shop drawing showing the locations of the cut out / hole to be made on existing wall/floor/ceiling and get written approval from the consultant prior to make holes / cut the groves. The holes / cut outs shall be made by using drilling machine / cutters, not by chisel and hammer. Utmost care must be taken not to make existing wall/floor/ceiling dirty/damage. All holes made shall be filled with cement plaster / plaster of Paris of same quality as existing by Civil Contractor. Installation of the indoor units shall be carried out in close coordination with false ceiling contractor. The VRF type outdoor units shall be installed on structurally rigid MS frame and secured by at least 4 numbers of diameter 12 anchor bolts with vibration isolators. Repairing of walls, RCC slab, plastering and painting are not scope on the HVAC contractor.