AZAD GOVERNMENT OF THE
STATE OF JAMMU & KASHMIR

General and Technical Specifications for (Buildings, Infrastructure and Irrigation)

(Civil Works, Electrical Works, Public Health Engineering Works & Irrigation and Drainage works)

November, 2020

PLANNING & DEVELOPMENT DEPARTMENT (P&DD)
MUZAFFARABAD, AJ&K

SAMPAK International (Pvt.) Ltd.

FOREWORD

Review and updating of General and Technical Specifications of Government of Azad Jammu and Kashmir (2013) became essential in light of new developments being planned by the government i.e. Construction of High-rise Buildings, Infrastructure and allied important Structures on international standards.

In order to assess the new requirements of General Specifications Sampak interacted with P&D and other Departments of AJK. Opinion of other Consultants working in AJ&K was also taken, besides getting the opinions of major Contractors of AJK. Sampak also widened the field studies to know the availability of construction materials in AJK.

We have carried out amendments in the current General Specifications looking to the causes of disputes and reasons of failure of certain projects constructed in various parts of AJK. Addition of new items has also been made in these specifications to cater for future needs of Building construction and bring this specification at par with international standards. Superfluous or repeated items have been deleted, as the present BOQ contains more than 1200 items and most of these are not in use. Similarly, a lot of codes provided in present General Specifications are obsolete hence, these have been replaced by the International Codes like ASTM, BS or DIN. The user of these Specifications is advised to exercise caution in use of various new items and these may require deeper understanding than what can be covered in specifications. Any other item, not available in this General Specifications may be incorporated by the Designer, under Special Provisions.

Our sincere thanks are due to several agencies, who contributed in compilation of this important document, however special attention of Planning and Development Department under the guidance of Chairman P&D, helped us to complete the assignment successfully. We hope that this document will contribute effectively in improving the workmanship and quality of highway and bridge construction in Azad Jammu and Kashmir.

For SAMPAK International (Pvt.) Ltd.

(S. M. A. Shirazi)

PLANNING AND DEVELOPMENT DEPARTMENT GOVT OF AJK

GENERAL SPECIFICATIONS (Civil and Allied Works)

Table of Contents

PART-1
CIVIL & ALLIED WORKS

PLANNING AND DEVELOPMENT DEPARTMENT GOVT OF AJK

GENERAL SPECIFICATIONS (Civil and Allied Works)

Table of Contents

GENERAL

INTRODUCTION AND SCOPE

G.1 PREAMBLE

These General Specifications have been developed taking into consideration the following types of activities that are to be carried out for the Construction and Rehabilitation of following types of Buildings / Allied Infrastructure.

i. High Rise Buildings RCC Frame Structures

ii. Buildings with Load Bearing walls of Brick and Concrete Block Construction

iii. Outside Infrastructure like PHE, Electrical, Mechanical works.

iv. Other Outside works e.g. Parking, Pathways etc.

The aspects of construction and rehabilitation have been covered in subsequent chapters, providing details of specific work items involved in each of above four categories.

G.2 STANDARDS

The General Specifications describe the requirements and procedures for execution of the various work items to achieve the required workmanship and quality. The materials to be used shall conform to specifications and testing procedures mentioned in the relevant sections as per the American Society for Testing and Material (ASTM), British Standards (BS) European Norm (EN) or Deutsches Institut für Normung (DIN), as indicated in their latest editions. Sampling of materials for laboratory tests and their subsequent approval shall be executed according to these references unless otherwise directed by the Engineer.

G.3 SCOPE

G.3.1 CONTRACT WORKS

Where Works are to be executed by contract, the General Specifications is a document that shall be read in conjunction with the following priority in contract documents.

i. The Contract Agreement.

ii. The Letter of Acceptance.

iii. The Bid and the Appendix to Bid.

iv. Part II – The Conditions of Particular Application.

v. Part I – The General Conditions.

vi. The Special Provisions.

vii. The Drawings.

viii. The Priced Bill of Quantities.

In the event that situations exist which are not satisfactorily covered by the General Specifications or where particular conditions pertaining to a specific contract occur, the relevant clauses of the General Conditions will be modified by the terms of the Special Provisions that will be prepared for each individual contract.

G.3.2 SILENCE OF SPECIFICATIONS

The apparent silence of the Specifications, Drawings or other Contract Documents, as to any detail or the apparent omission from them of a detailed description concerning any point, shall be regarded as meaning that only the best general practice is to be used. All interpretations of the specification will be made by the Engineer on this basis.

G.4 ABBREVIATIONS AND DEFINITIONS

G.4.1 ABBREVIATION

Wherever in these specifications or in other contract documents the following abbreviations and terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

AAMA	American Architectural Manufactures Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Material
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWS	American Welding Society
BS	British Standard Code of Practice
NWWDA	National Wood Window and Door Association
PCA	Portland Cement Association
SWG	Standard Wire Gauge
Wt.	Weight
Lb.	Pound
Gallon	U.S. Gallon
in.	Inch
Ft.	Foot
Yd.	Yard
Ltr.	Litre
Mm	Millimetre
Cm	Centimetre
M	Metre
Km	Kilometre
Sq-m	Square metre
^{0}C	Degree Centigrade
^{0}F	Degree Fahrenheit
Sq-cm	Square Centimetre
Cu-m	Cubic Metre
Kg	Kilogram
Tonne	Metric Ton (1000 Kg)

G.5 WORKFORCE

G.5.1 GENERAL REQUIREMENTS

The Contractor shall provide suitably skilled labour in adequate numbers, who can adequately carry out the works to the quality and with the standard of workmanship in accordance with the requirements of each individual work item.

The Contractor shall make all necessary arrangement for employing and maintaining the workforce required for the execution of the Works in accordance with the Conditions of Contract.

Any person employed by the Contractor who is not capable of performing the required works in a proper and skillful manner or who behaves in an improper manner may be removed from the site in accordance with the requirements of the Conditions of Contract.

G.5.2 MEASUREMENT AND PAYMENT

Small hardware like nuts, bolts, hinges, door hardware shall not be measured for separate payment and cost of all such items shall be deemed, to be included in the item, unless appearing separately in BOQ.

Full compensation for furnishing all labour, Equipment and Materials shall be considered as included in the price paid for the contract item of work involving such labour and no additional compensation will be allowed thereof.

G.6 MATERIALS REQUIREMENTS

G.6.1 SUPPLY, SAMPLES AND QUALITY REQUIREMENTS

All materials to be incorporated in the Works shall meet all quality requirements of the relevant provisions of the Contract. In all cases the materials, manufactured articles and machinery must be approved by the Engineer prior to their inclusion into the Work.

In order to expedite the Work, the Contractor shall, before placing any purchase order for materials, manufactured articles and machinery to be incorporated in the Works, submit for the approval of the Engineer, a complete description of such items, the names of the firms from which it is proposed to obtain such items, together with a list of the items it is proposed for each firm to supply. No such materials, manufactured articles or machinery shall be ordered from any firm without the written approval of the Engineer.

When directed by the Engineer or otherwise specified in the Contract the Contractor shall submit samples for approval.

If it is found after trials that sources of supply for previously approved materials, manufactured articles or machinery do not produce items in accordance with the Specifications, the Contractor shall furnish such items from other sources approved by the Engineer.

G.6.2 LOCAL MATERIAL SOURCES

Material deposits have not been designated on the Drawings or described in the Special Provisions therefore the Contractor shall locate and provide materials acceptable to the Engineer.

The Contractor shall determine for itself the quality and the number/capacity of equipment and labour required to produce a material meeting the requirements of the Specifications.

It shall be understood that it is not feasible to ascertain from the samples the limits for an entire deposit and that variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a deposit and may reject portions of the deposit as unacceptable, for this purpose policy.

The sources of local materials are not designated on the Drawings and / or described in the Special Provisions therefore the Contractor shall be totally responsible for locating and producing materials that conform to the requirements of the Specifications. The exploring, testing of samples and developing of such material sources and the costs thereof are the responsibility of the Contractor.

No material, regardless of its source, shall be incorporated in the Work until representative samples taken by the Contractor in the presence of the Engineer and tested by the Contractor in the presence of the Engineer have been approved and written authority is issued by the Engineer for the use of the materials. Check request system shall be used for this purpose.

G.6.3 QUARRY MATERIALS

Quarry material is rock, sand, gravel, earth or other mineral material, other than local borrow or selected material, obtained from the project. Quarry material does not include materials such as cement, lime, marble powder etc. obtained from established commercial sources.

The furnishing of quarry materials from any source is subject to the provisions of Conditions of Contract regarding Inspection and Testing of materials.

Unless approved in writing by the Engineer, material sources shall not be excavated at locations where the resulting scars will present an unsightly appearance from any road. No payment will be made for material obtained in violation of this provision.

The Contractor shall, at his expense, make any arrangements necessary for hauling over local public and private roads from any source and shall comply in all respects with the relevant provisions of the General Conditions.

G.6.4 STORAGE OF MATERIALS

Articles or materials to be incorporated in the work shall be stored in such a manner, as to ensure the preservation of their quality and fitness for the work and to facilitate their prompt inspection.

Stored materials, even though approved before storage, may again be inspected prior to their incorporation in the Works, if so required.

Materials and articles shall not be stored in the traffic movement areas unless permitted by the Engineer. Stockpiling of aggregate material within the site shall be confined to such authorised areas as may be approved by the Engineer. The site shall be abandoned immediately upon completion of the utilisation of the stockpile material and the natural surface shall be restored as nearly as possible to the original condition by the Contractor at its expense and to the satisfaction of the Engineer.

Any costs for the use of privately owned land for storage and/or for the placing of the Contractor's plant and equipment shall be borne by the Contractor. Private property shall not be used for storage purposes without written permission and release of the owner or lessee, and a copy of the written permission and release shall be submitted to the Engineer prior to any use of the land by the Contractor.

G.6.5 DEFECTIVE MATERIALS

All materials that the Engineer has determined do not conform to the requirements of the drawings and specifications will be rejected whether in place or not. They shall be removed immediately from the site of the work, unless otherwise permitted by the Engineer. No rejected material, the defects of which have been subsequently corrected, shall be used in the work, unless approval in writing has been given by the Engineer.

Upon failure of the Contractor to comply promptly with any order of the Engineer made under the provisions in this clause, the Engineer shall have authority to cause the removal of rejected material and to deduct the cost thereof from any monies due or to become due to the Contractor in accordance with the provisions of Conditions of Contract.

G.6.6 TRADE NAMES AND ALTERNATIVES

Mention of a specific name in BOQ, shall be avoided, However, if such designation is unavailable, then alternate equivalent from other manufactures will be allowed. 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:

i. The burden of proof as to quality and suitability of alternatives shall be upon the Contractor and he shall furnish all information necessary as required by the Engineer.

ii. The Engineer shall be the sole judge as to the quality and suitability of alternative articles or materials and his decision shall be final.

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 request for the substitution is made in writing by the Contractor accompanied by complete data as to the equality of the material or article proposed. Such request shall be made in reasonable time to permit approval without delaying the work.

G.6.7 LOAD RESTRICTIONS

The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the Works.

The Contractor shall use every reasonable means to prevent any of the roads or bridges communicating with or on the routes to the Site from being damaged by any traffic of the Contractor or any of its Subcontractors and in particular shall select routes, choose and use vehicles and restrict and distribute loads so that any such extraordinary traffic as will inevitably arise from the moving of plant and materials from and to the Site shall be limited as far as reasonably possible and so that no unnecessary damage or injury may be caused to such roads and bridges.

The Contractor shall bear all responsibility and liability for damages or injury resulting from its failure to abide by these provisions, in accordance with the Conditions of Contract except when such transport or passage is done by special written permission of the Employer. The Contractor shall be responsible for all damage caused by his material/machinery hauling to the roads/bridges, beyond project limit.

G.7 EQUIPMENT

G.7.1 GENERAL REQUIREMENTS

All equipment, which is proposed to be used on the work, shall be of sufficient size/capacity and in such mechanical condition as to meet the requirements of the Work and to produce a satisfactory quality of the Work.

Equipment used on any portion of the Works shall be such that no damage to the roadway, adjacent property, or other highways or works will result from its use.

The number and types of equipment required for different items of work shall be planned by the Contractor keeping in view the workmanship required by a particular item and the quantity of the finished item required to be carried out in an eight hour shift. Any such planning shall be approved by the Engineer and changes may be proposed for the guidance of the Contractor. However, this procedure shall not relieve the Contractor of his contractual obligations.

G.7.2 ALTERNATIVE EQUIPMENT

While certain of these specifications may provide that equipment of a particular size and type is to be used to perform portions of the work, it is to be understood that the development and use of new or improved equipment is to be encouraged.

The Contractor may request, in writing, permission from the Engineer to use equipment of a different size or type in place of the equipment specified.

The Engineer, before considering or granting such a request, may require the Contractor to furnish, at his expense, evidence satisfactory to the Engineer that the equipment proposed for use by the Contractor is capable of producing work equal to, or better than, that which can be produced by the equipment specified.

If such permission is granted by the Engineer, it shall be understood that such permission is granted for the purpose of testing the quality of work actually produced by such equipment and is subject to continuous alignment of results which, in the opinion of the Engineer, are equal to, or better than, that which can be obtained with the equipment specified. The Engineer shall have the right to withdraw such permission at any time that he determines that the alternative equipment is not producing work that is equal, in all respects, to that which can be produced by the equipment specified. Upon withdrawal of such permission by the Engineer, the Contractor will be required to use the equipment originally specified and shall, in accordance with the directions of the Engineer, remove and dispose of or otherwise remedy, at his expense, any defective or unsatisfactory work produced with the alternative equipment.

Neither the Employer nor the Contractor shall have any claim against each other for either the withholding or the granting of permission to use alternative equipment, or for the withdrawal of such permission.

Permission to use alternative equipment in place of equipment specified will only be granted where such equipment is new or improved and its use is deemed by the Engineer to be in furtherance of the purposes of this clause. The approval for use of particular equipment on any activity or project shall in no way be considered as an approval of the use of such equipment on any other activity or project.

Nothing in this clause shall relieve the Contractor of his responsibility for providing appropriate equipment or producing finished work of the quality specified in these specifications.

G.7.3 REMOVAL OF UNSUITABLE EQUIPMENT

In the event that the equipment specified by the Contractor in his Bid is considered unsuitable for the proper execution of the Works it shall be removed from the site. Further, any equipment approved by the Engineer fails to deliver, shall also be replaced, if so directed by Engineer.

G.7.4 LOAD RESTRICTIONS

The provisions of Clause 1.4.7 of the General Specification will apply for the transport of equipment on public roads beyond the limits of the Works.

Any type of equipment of such weight or so loaded, as to cause damage to drainage structures of any kind, or to any other type of construction, either being constructed or previously constructed, will not be permitted to operate in any location where damage would be caused.

G.8 ALTERNATIVE METHODS OF CONSTRUCTION

G.8.1 RESPONSIBILITIES

The Contractor shall submit to the Engineer, a general description of his proposed arrangements and methods for the execution of the Works, including inter alia temporary offices, buildings, access roads, detours, Constructional Plant and its intended production output, working shift arrangements, labour strength, skilled and unskilled labour and supervision arrangements, power arrangements, supply of materials, stone crushing, aggregate production and storage, cement handling, concrete mixing and handling, methods of excavation, dealing with water, testing methods and facilities.

During the execution of the Works, the Contractor shall also submit to the Engineer full and detailed particulars of any proposed amendments to the arrangements and methods submitted in accordance with the above requirements.

Whenever the plans or specifications provide that more than one specified method of construction or more than one specified type of constructional equipment may be used to perform portions of the Work and leave the selection of the method of construction or the type of equipment to be used to the discretion of the Contractor, it is understood that the Employer does not guarantee that every such method of construction or type of equipment can be used successfully throughout all or any of the Works.

It shall be the Contractor's responsibility to select and use the alternative or alternatives that will satisfactorily perform the work under the conditions encountered. In the event some of the alternatives are not feasible or it is necessary to use more than one of the alternatives on any project, full compensation for any additional cost involved shall be considered as included in the contract price paid for the item of work involved and no additional compensation will be allowed thereof.

G.8.2 ALTERNATIVE METHODS

When the Contract specifies that the construction be performed by the use of certain methods, such methods shall be used unless others are authorized by the Engineer.

If the Contractor desires to use a method other than that specified in the Contract, it may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and an explanation of the reasons for desiring to make the change. If approval is given, it

will be on the condition that the Contractor will be fully responsible for producing Work that conforms to the requirements of the Specifications.

If after trial use of the alternative methods, the Engineer determines that the Work produced does not conform to the Contract requirements, the Contractor shall discontinue the use of the alternative method and shall complete the remaining construction with the specified methods. The Contractor shall remove the deficient Work and replace it with Work of he specified quality or take such other corrective action as the Engineer may direct.

No change will be made in the basis of payment for the construction items involved or in the Contract Time for Completion as a result of approving a change in the method of construction

G.9 LAND REQUIREMENTS

G.9.1 DESCRIPTION

The land within project limits will be made available to the Contractor free of charge, shall be that within the recognized boundaries of the site. It is the responsibility of the Employer to ensure that this land is made available and, in the event of objections being raised by the local population, the Contractor shall immediately report the circumstances to the Engineer.

All necessary negotiations, agreements and payments for additional land for whatever purpose, including that required for the Engineer's facilities, shall be the responsibility of the Contractor.

The Contractor shall indemnify the Employer and the Engineer against any claims or proceedings resulting from the occupancy and use of such areas of additional land in accordance with the requirements of the Conditions of Contract.

G.10 SERVICES AND UTILITIES

G.10.1 DIVERSION OF PUBLIC SERVICES

The diversion of public services is the responsibility of the Employer and it is the intention that all public services shall have been diverted from the site or to locations where they will not interfere unduly with the Works, prior to commencement.

Never the less it will be the responsibility of the Contractor to take all reasonable measures to avoid causing damage to public services whether outside the confines of the Site, or buried under the Site or overhead. It will be the responsibility of the Contractor to familiarize himself and his staff with the known locations of all services passing through or over the Site.

In the event that the Contractor discovers a previously undisclosed service during the course of construction operations he shall take immediate steps to protect the installation and shall inform the Engineer of the discovery. The Engineer shall either arrange for the appropriate authorities to relocate or otherwise reinstate the service or shall instruct the Contractor to carry out the work.

G.10.2 NOTIFICATION OF DAMAGE

In the event of interruption to any service or utility as a result of accidental breakage, or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with the said authority in the restoration of the service or utility.

If an essential public utility service is interrupted, repair work shall be continuous until the service is restored.

G.11 USE OF EXPLOSIVES

G.11.1 DESCRIPTION

This work consists of the provision and use of explosives required to carry out specific activities as required by the Contract in accordance with the provisions of the General Conditions and the following requirements of the General Specifications.

G.11.2 GENERAL REQUIREMENTS

G.11.2.1 CONTROL

The Contractor shall not use explosives without the prior written approval of the Engineer. Such approval shall not relieve the Contractor from any of his liabilities or responsibilities to ensure that blasting operations are carried out in safe manner and in full compliance with all relevant statutory obligations.

The Contractor shall obtain all necessary permits and pay all necessary fees for the acquisition, storage and use of explosives and explosive devices. He shall submit full details to the Engineer and obtain approval in writing for each occasion when he intends to use explosives, such details to include without limitation the date and time of the blast, the size of charge, method of firing, and protective measures to be adopted.

G.11.2.2 STORAGE

The Contractor shall store all explosives and explosive devices in a secure location and in accordance with statutory requirements and to the approval of the Engineer.

The Contractor shall keep a current inventory of all explosives and explosive devices obtained and used and submit a monthly report to the Engineer, detailing the usage of all explosives and explosive devices by date and location.

G.11.2.3 TRANSPORT

The Contractor shall provide a properly equipped secure vehicle, which shall be maintained in good condition, for the transportation of explosives.

G.11.2.4 PERSONNEL

The Contractor shall appoint a responsible person or persons to order and receive explosives and to be responsible for all blasting activities. The name(s) and details of experience of such person or persons shall be submitted to the Engineer for approval.

The Contractor shall only employ properly qualified workmen approved by the Engineer in the handling and firing of all charges.

G.11.2.5 SAFETY PROCEDURES

The Contractor shall provide an approved system of warning the Employer and the public and all site personnel of an impending blast by both audible and visible means and shall ensure that the blasting area at risk to personnel is cleared of all personnel immediately prior to blasting.

The Contractor shall take all necessary measures to protect personnel and property and to prevent any fragments due to blasts from being projected in a dangerous manner.

If blasting is to be carried out in the vicinity of overhead electrical power cables the contractor shall check for stray electric currents at the blasting site prior to commencing charging. If blasting is to be carried out at locations where it is likely to cause damage to structures/properties in the vicinity, controlled blasting measures as approved by Engineer should be adopted.

G.12 PROTECTION OF THE ENVIRONMENT

G.12.1 DESCRIPTION

This work consists of the implementation of the necessary procedures required for the protection of the Environment during the execution of specific work activities as required by the Contract in accordance with the provisions of the General Conditions and the following requirements of the General Specifications.

G.12.2 GENERAL REQUIREMENTS

G.12.2.1 GENERAL

This Section of the Specification sets out limitations on the Contractor's activities specifically intended to protect the environment. The Contractor's attention is however drawn to the fact that other provisions, equally important to the protection of the environment, are included throughout these Specifications.

The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on site or off-site are carried out in conformity with statutory and regulatory environmental requirements including those prescribed elsewhere in this document.

The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated.

The provisions of these clauses are subject to amendment, if so required, for emergency work necessary for the saving of life or property or the safety of the Works.

G.12.2.2 WATER QUALITY

The Contractor shall prevent any interference with the supply to or abstraction from or the pollution of water resources (including underground percolating water) as a result of the execution of the Works.

Areas where water is regularly or repetitively used for dust suppression purposes (including, without limitation, stockpiles for concrete-batching and asphalt plants) shall be laid to fall to specially-constructed settlement tanks to permit sedimentation of particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.

All water and other liquid waste products arising on the Site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause either nuisance or pollution.

The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer and the regulatory authorities concerned.

The Contractor shall at all times ensure that all existing stream courses and drains within and adjacent to the Site are kept safe and free from any debris and any materials arising from the Works.

The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollution, silting, flooding or erosion as a result of the execution of the Works.

The Contractor shall submit details of his temporary drainage work system (including all surface channels, sediment traps, washing basins and discharge pits) to the Engineer for approval prior to commencing work on its construction.

G.12.2.3 AIR QUALITY

The Contractor shall devise and implement methods of working to minimize dust, gaseous or other air-borne emissions and carry out the Works in such a manner as to minimize adverse impacts on air quality.

The Contractor shall use effective water sprays during delivery and handing of materials when dust is likely to be created, and to dampen stored materials during dry and windy weather. Stockpiles of friable materials shall be covered with clean tarpaulins, with application of sprayed water during dry and windy weather. Stockpiles of material or debris shall be dampened prior their movement, except where this is contrary to the Specification.

Any vehicle with an open load-carrying area used for transporting potentially dust-producing material shall have properly fitting side and tailboards. Materials having the potential to produce dust shall not be loaded to a level higher than the side and tail boards, and shall be covered with a clean tarpaulin in good condition. The tarpaulin shall be properly secured and extend at least 300 mm over the edges of the side and tailboards.

In the event that the Contractor is permitted to provide temporary non-bituminous surfaced roads for the use of the public or uses gravel or earth roads for haulage, he shall provide suitable measures for dust palliation, if these are, in the opinion of the Engineer, necessary. Such measures may include spraying the road surface with water at regular intervals.

G.12.2.4 NOISE

The Contractor shall consider noise as an environmental constraint in his planning and execution of the Works.

The Contractor shall take all necessary measures to ensure that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimize the noise emission during construction works.

G.12.2.5 CONTROL OF WASTES

The Contractor shall control the disposal of all forms of waste generated by the construction operations and in all associated activities. No uncontrolled deposition or dumping shall be permitted. Wastes to be so controlled shall include, but shall not be limited to, sewerage, all forms of fuel and engine oils, bitumen, cement, surplus concrete, surplus aggregates, gravels etc. The Contractor shall make specifies provision for the proper disposal of these and any other waste products, conforming to local regulations and acceptable to the Engineer.

In the event of any spoil or debris or silt from the Site being deposited on any adjacent land, the Contractor shall immediately remove all such spoil debris or silt and restore the effected area to its original state to the satisfaction of the Engineer.

G.12.2.6 EMERGENCY RESPONSE

The Contractor shall plan and provide for remedial measures to be implemented in the event of an occurrence of emergencies such as spillages of oil or bitumen or chemicals.

The Contractor shall provide the Engineer with a statement of the measures he intends to implement in the event of such an emergency that shall include a statement of how he intends to provide personnel adequately trained to implement such measures. This statement shall accompany the programme to be submitted by the Contractor in accordance with the provisions of Clause 14 of the General Conditions.

G.13 CONTROL AND QUALITY OF WORKS

G.13.1 FREQUENCY OF TESTS AND TEST DESIGNATIONS

Frequency of tests for major items of construction will be defined in these specifications or in the Special Provisions, however for certain items frequency of tests has been left to the discretion of the Engineer.

While deciding the frequency of tests for major items, each aspect of new construction, may be dealt with differently, keeping in view the quantum of work.

G.13.2 TESTING STANDARDS

Unless otherwise specified, all tests shall be performed in accordance with the methods used by AASHTO/ASTM and shall be made by the Engineer or his designated representative.

Whenever the specifications provide an option between two or more tests, the Engineer will determine the test to be used.

Whenever a reference is made in the specifications to a specification manual, or a test designation either of the American Society For Testing and Materials, the American Association of State Highway and Transportation Officials, British Standard, or any other recognised national organisation, and the number or other identification representing the year of adoption or latest revision is omitted, it shall mean the specification, manual or test designation in effect on the day 28 days prior to the date for submission of bids.

Whenever said specification manual or test designation provides for test reports (such as certified mill test reports) from the manufacturer, copies of such reports, identified as to the lot of material, shall be furnished to the Engineer. When material that cannot be identified with specific test reports is proposed for use, the Engineer may, at his discretion, select random samples from the lot for testing. Test specimens from the random samples, including those required for retest shall be prepared in accordance with the referenced specification and furnished by the Contractor at his expense. The number of such samples and test specimens shall be entirely at the discretion of the Engineer. Unidentified metal products such as sheet plate, hardware, etc., shall be subject to the test requirements prescribed by the Engineer.

When desired by the Engineer and in accordance with the requirements of Clause G.4.1 of these Specifications, the Contractor shall furnish, without charge, samples of all materials placed into the work and no material shall be used prior to approval by the Engineer. Samples of material from local sources shall be taken by or in the presence of the Engineer, otherwise the samples will not be considered for testing.

G.13.3 LINES AND GRADES

Such stakes or marks will be set by the Contractor as the Engineer determines to be necessary to establish the lines and grades required for the completion of the work specified in these specifications, on the plans and in the Special Provisions.

When the Contractor has installed such stakes or marks, he shall notify the Engineer in writing giving a reasonable length of time in advance of starting operations to enable the Engineer to check such stakes or marks. In no event shall a notice of less than 2 working days be considered a reasonable length of time.

The Engineer shall, where necessary, provide in writing the reference lines and levels and the Contractor will use these reference lines and levels for setting out.

Stakes and marks set on the ground shall be carefully preserved by the Contractor. In case such stakes and marks are destroyed or damaged they will be replaced at the Contractor's earliest convenience. The Contractor will be responsible for the cost of necessary replacement or restoration of stakes and marks.

G.13.4 INSPECTION

The Engineer shall, at all times, have safe access to the work during its construction, and shall be furnished with every reasonable facility for ascertaining that the materials and the workmanship are in accordance with the requirements and intentions of these specifications, the Special Provisions, and the plans. All work done and all materials furnished shall be subject to his inspection.

The inspection of the work or materials shall not relieve the Contractor of any of his obligations to fulfil his contract as prescribed. Work and materials not meeting such requirements shall be made good and unsuitable work or materials may be rejected, not withstanding that such work or materials have been previously inspected by the Engineer or that payment thereof has been included in a progress estimate.

G.13.5 CONFORMITY WITH CONTRACT DOCUMENTS AND ALLOWABLE DEVIATIONS

Work and materials shall conform to the lines, grades, cross sections, dimensions and material requirements, including tolerances, shown on the plans or indicated in the specifications. Although measurement, sampling and testing may be considered evidence as to such conformity, the Engineer shall be the sole judge as to whether the work or materials deviate from the plans and specifications, and his decision relating to any allowable deviations there from shall be final.

G.13.6 REMOVAL OF REJECTED UN-AUTHORIZED WORK

All work that has been rejected shall be remedied, or removed and replaced by the Contractor in an acceptable manner and no compensation will be allowed to him for such removal, replacement, or remedial work.

Any work done beyond the lines and grades shown on the plans or established by the Engineer, or any extra work done without written authority will be considered as unauthorised work and will not be paid for.

Upon order of the Engineer unauthorised work shall be remedied, removed or replaced at the Contractor's expenses.

Upon failure of the Contractor to comply promptly with any order of the Engineer made under this Item the Employer may cause rejected or unauthorised work to be remedied, removed, or replaced, and to deduct the costs from any monies due or to become due to the Contractor in accordance with the Conditions of Contract.

G.14 PRIORITY OF ITEM

If there is any disparity between nomenclature of bill of items and text specification than following will be the priority.

a) Specification of the text will get the priority over bill of items (Text).

b) If there is any difference in dimensions than the figures in bill of items shall priority.

G.15 MEASUREMENT AND PAYMENTS

No measurement and payments shall be made for any work carried out under section G-1 to G-13, unless specifically provided in a particular item or BOQ of works.

SECTION 1 CARRIAGE

1.1 CARRIAGE OF EARTHWORKS MATERIALS

1.1.1 SCOPE

The carriage and stacking of earthworks materials shall be done as provided in the Contract Agreement. All tools and plants and means of transport shall be arranged by the Contractor. The carriage of materials includes loading unloading and stacking unless specifically provided otherwise in the Contract Agreement. No extra carriage shall be paid for all manufactured or quarry material used in various items, as same will be deemed to be included in BOQ items.

1.1.2 RESPONSIBILITY FOR LOSS OR DAMAGE

The Contractor undertaking carriage of earthwork material shall be responsible for its safe loading, carriage, unloading and stacking of material at specified site within the specified time. Loading, carriage, unloading and stacking shall be done carefully to avoid loss or damage to the materials. In case of any loss or damage to material issued by the Department, recovery shall be affected from the Contractor at the Departmental issue rates of the materials. If the departmental issue rates of the materials are not available then the recovery shall be affected at the prevailing market rates as determined by the Engineer-in-Charge.

1.1.3 MODE OF CARRIAGE

Depending upon the feasibility and economy, the Contractor shall propose the mode of carriage viz. whether by mechanical, animal transporter manual means and shall be as approved by the Engineer-in-Charge in accordance with corresponding item as provided in Contract Agreement.

1.1.4 LEAD

All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and as approved by Engineer-in-Charge along with reasons in writing. Carriage by animal and mechanical transport shall be reckoned in one km unit. Distances of 0.25 km or more shall be taken as 0.50 km and distance of less than 0.25 km shall be ignored.

1.2 MEASUREMENT AND PAYMENT

The following rates are calculated for each consignment plain areas. If distance covered is in hilly areas then add 25% allowance in these rates. Furthermore, for kacha/fair weather roads additional allowance of 25% above the rates in metaled areas shall be allowed for total distance covered in Kms.

The rates for carriage by boat or streamer shall be the same as by any other mechanical means on land.

The Measurement and payment for the carriage of earthworks materials including loading unloading and stacking shall be made corresponding to items as provided in Contract Agreement and shall constitute full compensation for performance and completion of work in all respects as specified and approved by the Engineer-in-Charge. No additional payment shall be made to Contractor for charges like demurrage, wharf age, toll tax, zila tax etc.

The work of carriage is divided in four modes of transportation which are as under.

a) Truck able distance
b) Jeep/Trolly able distance
c) Animal haulage distance
d) Manual haulage distance

Pay Item No.	Description	Unit of Measurement
1.2 a	Carriage of 440 CFT (12.46 CM) of all materials like stone, aggregate, spawl, kankar, excavated material of all types etc. or 1000 CFT (28.32 CM) of timber or 400 bags of cement or 20 T steel, by truck of 20 tonne capacity(Specs # 1.1)	
	i. Up to 500m	Km
	ii. 500m to 1st km	Km
	iii. 2nd km	Km
	iv. 3rd km	Km
	v. 4th km	Km
	vi. 5th km	Km
	vii. 6th km	Km
	viii. 7th km	Km
	ix. 8th km	Km
	x. 9th km	Km
	xi. 10th km	Km
	xii. 11th km and subsequent kms	Km
1.2 b	Carriage of 220 CFT (6.23 CM) of all materials like stone, aggregate, spawl, kankar, excavated material of all types etc. or 500 CFT (14.16 CM) of timber or 200 bags of cement or 10 T steel, by truck of 10 tonne capacity(Specs # 1.1)	
	i. Up to 500m	Km
	ii. 500m to 1st km	Km
	iii. 2nd km	Km
	iv. 3rd km	Km
	v. 4th km	Km
	vi. 5th km	Km
	vii. 6th km	Km
	viii. 7th km	Km
	ix. 8th km	Km
	x. 9th km	Km
	xi. 10th km	Km
	xii. 11th km and subsequent kms	Km
1.2 c	Carriage of 66 CFT (1.86 CM) of all materials like stone, aggregate, spawl, kankar, excavated material of all types etc. or 150 CFT (4.24 CM) of timber or 60 bags of cement or 3 T steel, by jeep (4x4) or 3 tonne capacity truck (Specs # 1.1)	
	i. Up to 500m	Km
	ii. 500m to 1st km	Km
	iii. 2nd km	Km
	iv. 3rd km	Km
	v. 4th km	Km
	vi. 5th km	Km
	vii. 6th km	Km
	viii. 7th km	Km
	ix. 8th km	Km
	x. 9th km	Km
	xi. 10th km	Km
	xii. 11th km and subsequent kms	Km
1.2 d	Carriage of 5000 Nos. bricks 9”x4.5”x3” or 4000 Nos. tiles 12”x6”x2” by truck of 20 tonne capacity(Specs # 1.1)	
	i. Up to 500m	Km

	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	6th km	Km
	viii.	7th km	Km
	ix.	8th km	Km
	x.	9th km	Km
	xi.	10th km	Km
	xii.	11th km and subsequent kms	Km
1.2 e		Carriage of 2500 Nos. bricks 9"x4.5"x3" or 2000 Nos. tiles 12"x6"x2" by truck of 10 tonne capacity(Specs # 1.1)	
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	6th km	Km
	viii.	7th km	Km
	ix.	8th km	Km
	x.	9th km	Km
	xi.	10th km	Km
	xii.	11th km and subsequent kms	Km
1.2 f		Carriage of 750 Nos. bricks 9"x4.5"x3" or 600 Nos. tiles 12"x6"x2" by jeep (4x4) or 3 tonne capacity truck(Specs # 1.1)	
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	6th km	Km
	viii.	7th km	Km
	ix.	8th km	Km
	x.	9th km	Km
	xi.	10th km	Km
	xii.	11th km and subsequent kms	Km
1.2 g		Carriage of 250 maunds of fuel wood, by means of truck of 10 tonne capacity(Specs # 1.1)	
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	6th km	Km
	viii.	7th km	Km
	ix.	8th km	Km
	x.	9th km	Km
	xi.	10th km	Km
	xii.	11th km and subsequent kms	Km
1.2 h		Carriage of 100Nos. bitumen, tar or other lubricants drums (200kg) by truck of 20 tonne	

capacity(Specs # 1.1)

i.	Up to 500m	Km
ii.	500m to 1st km	Km
iii.	2nd km	Km
iv.	3rd km	Km
v.	4th km	Km
vi.	5th km	Km
vii.	6th km	Km
viii.	7th km	Km
ix.	8th km	Km
x.	9th km	Km
xi.	10th km	Km
xii.	11th km and subsequent kms	Km

1.2 i Carriage of 50Nos. bitumen, tar or other lubricants drums (200kg) by truck of 10 tonne capacity(Specs # 1.1)

i.	Up to 500m	Km
ii.	500m to 1st km	Km
iii.	2nd km	Km
iv.	3rd km	Km
v.	4th km	Km
vi.	5th km	Km
vii.	6th km	Km
viii.	7th km	Km
ix.	8th km	Km
x.	9th km	Km
xi.	10th km	Km
xii.	11th km and subsequent kms	Km

1.2 j Carriage of 15Nos. bitumen, tar or other lubricants drums (200kg) by jeep (4x4) or 3 tonne capacity truck(Specs # 1.1)

i.	Up to 500m	Km
ii.	500m to 1st km	Km
iii.	2nd km	Km
iv.	3rd km	Km
v.	4th km	Km
vi.	5th km	Km
vii.	6th km	Km
viii.	7th km	Km
ix.	8th km	Km
x.	9th km	Km
xi.	10th km	Km
xii.	11th km and subsequent kms	Km

1.2 k Carriage of cement concrete pipe, GI pipe, PVC pipe, HDPE pipe, MS pipe, etc. of all sizes with truck of 20 tonne capacity(Specs # 1.1)

i.	Up to 500m	Km
ii.	500m to 1st km	Km
iii.	2nd km	Km
iv.	3rd km	Km
v.	4th km	Km
vi.	5th km	Km
vii.	6th km	Km
viii.	7th km	Km
ix.	8th km	Km
x.	9th km	Km
xi.	10th km	Km
xii.	11th km and subsequent kms	Km

1.2 l	Carriage of cement concrete pipe, GI pipe, PVC pipe, HDPE pipe, MS pipe, etc. of all sizes with truck of 10 tonne capacity(Specs # 1.1)		
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	6th km	Km
	viii.	7th km	Km
	ix.	8th km	Km
	x.	9th km	Km
	xi.	10th km	Km
	xii.	11th km and subsequent kms	Km
1.2 m	Carriage of cement concrete pipe, GI pipe, PVC pipe, HDPE pipe, MS pipe, etc. of all sizes by jeep (4x4) or 3 tonne capacity truck(Specs # 1.1)		
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	6th km	Km
	viii.	7th km	Km
	ix.	8th km	Km
	x.	9th km	Km
	xi.	10th km	Km
	xii.	11th km and subsequent kms	Km
1.2 n	Labour load (50kg) for distance(Specs # 1.1)		
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	For each km after 1km	Km
1.2 o	Donkey/Mule load (100kg) for distance(Specs # 1.1)		
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	6th km	Km
	viii.	7th km	Km
	ix.	8th km	Km
	x.	9th km	Km
	xi.	10th km	Km
1.2 p	Cart load (500kg) for distance(Specs # 1.1)		
	i.	Up to 500m	Km
	ii.	500m to 1st km	Km
	iii.	2nd km	Km
	iv.	3rd km	Km
	v.	4th km	Km
	vi.	5th km	Km
	vii.	For each km after 5kms	Km

SECTION 2 LOADING, UNLOADING AND STACKING

2.1 SCOPE

Scope of work shall include the loading into trucks from specified sites or stockpiles (or unloading as the case may be) for earth works as provided in the Contract Agreement and approved by the Engineer-in-Charge.

No extra loading / unloading or stacking of all manufactured or quarry material used in various items, as same will be deemed, to be included in BOQ items.

2.2 REQUIREMENTS

a) The Contractor shall furnish, install, operate and maintain all necessary facilities for loading/unloading trucks.

b) The Contractor shall perform all loading/unloading operations in a systematic manner without breakages or segregation as determined by the Engineer-in-Charge and that the cement bags and such other materials do not catch moisture and will not be contaminated with soil or other foreign material. Contractor shall load trucks in which materials are to be transported in such a manner as to avoid loss in transit and shall be responsible for and make good any loss of materials lost in transit due to improper loading of mobile trucks and other handing operations. The materials carted shall be properly stacked as specified or directed by the Engineer-in-Charge.

2.3 STACKING AND STORAGE

For any site, there shall be proper planning of the layout for stacking and storage of different materials, components and equipment, with proper access and proper maneuverability of the vehicles carrying the material. Stacking shall be done in a safe and secure manner and in a manner to avoid any wastage or damage to material. While planning the layout, the requirements of various materials, components and equipment at different stages of construction shall be considered. Storage requirements and Safety and Health requirements shall be implemented as per USA OSHA 1926 and OSHA 2236.

2.4 MEASUREMENT AND PAYMENT

The Employer will not be responsible for possible damage of any material, equipment or system during loading, unloading or transportation of goods to the site of works.

The Contractor shall replace any damage goods at his own expense without additional cost to the Employer.

No measurement and extra payment for loading/unloading into trucks/trolley and stacking shall be made corresponding to item as provided in the Contract Agreement.

No separate cost will be paid under this item and will be deemed to be included under other items of works.

Pay Item No.	Description
2.4 a	Loading or unloading into or from mobile trucks, coarse aggregate, sand, stone, brick ballast, excavated materials of all types, bricks/stone bats and coal etc. lead up to 100ft (30m) (Specs #2.1) i. For 20 tonne capacity truck ii. For 10 tonne capacity truck iii. For jeep (4x4) or 3 tonne capacity truck
2.4b	Loading or unloading Bricks or tiles into or from mobile trucks properly laid and stacked lead up to 100ft (30m)(Specs # 2.1) i. For 20 tonne capacity truck ii. For 10 tonne capacity truck iii. For jeep (4x4) or 3 tonne capacity truck
2.4 c	Loading or unloading into or from mobile trucks cement in bags (inside or outside the godown) and stacking lead up to 100ft (30m)(Specs # 2.1) i. For 20 tonne capacity truck ii. For 10 tonne capacity truck iii. For jeep (4x4) or 3 tonne capacity truck
2.4 d	Loading or unloading into or from mobile truck structural steel, steel reinforcement, RS joist, RCC precast members, PVC pipes, wooden logs, GI pipes, suspension bridge components etc. lead up to 100ft (30m)(Specs # 2.1) i. For 20 tonne capacity truck ii. For 10 tonne capacity truck iii. For jeep (4x4) or 3 tonne capacity truck
2.4 e	Manually loading or unloading of fuel, bitumen, asphalt or tar and other Liquid items in drums (200kg), into or from mobile truck lead up to 100ft (30m)(Specs # 2.1) i. For 20 tonne capacity truck ii. For 10 tonne capacity truck iii. For jeep (4x4) or 3 tonne capacity truck

SECTION 3 EARTHWORK

3.1 SCOPE

Earth work shall include furnishing of all labour, material, tools, plants, equipment, instruments and services for;

i. Excavation and formation of embankment in all types of soils. It also covers lifting and transporting excavated material. Suitable material intended for use as backfill shall be placed in temporary stockpiles. All other excavated material shall be placed in spoil banks. These works shall be performed and executed by the Contractor in accordance with stipulations and requirements set forth herein which shall apply except when they are specifically modified in writing by the Engineer-in-Charge for any particular item. The method of carrying out earthwork shall be subject to approval of the Engineer-in-charge in writing, and no extra payment will be allowed due to change in methodology.

ii. Fill and backfill using selected excavated material or imported material obtained from approved sources or by blending the excavated and imported materials.

iii. Before commencement and during the execution of works, the Contractor shall be responsible for surveys, layout and their maintenance for execution of works according to contract and as approved by the Engineer-in-Charge.

3.2 CLASSIFICATION OF SOILS (FROM CONSTRUCTION POINT OF VIEW)

The earthwork shall be classified under the following categories and measured separately for each category.

CLASSIFICATION OF ROCKS BASED UPON GEOLOGY FOR EARTHWORK

Category	Rock type	Material/Rock Type and Name	U.C.S (Unconfined compressive Strength) MPa	Dry Density t/m^3	Field Propertied of Rocks	Work Type
Soft	I	Coal(Soft)	5-25	1.4	Crumble under blows break with hammer and hand	Pick Work/Jumper work
		Gypsum	20-25	2.2	Dent by finger nail white in color	Jumper work
		Salt	5-20	2.1	Show cubical cleavage ductile deformation in stress	Jumper work
		Clay	1-4	1.8	Mold by finger, break by hammer if compacted	Pick Work
		Mudstone(soft)	10-25	2.3		
		Shale (soft)	05-25	2.3		
		Chalk (soft)	05-25	1.8		
		Slate (Soft)	20-25	2.7		

Medium	II	Gypsum (medium)	25-100	2.2	Break by hammer crumble under pick blows. Break by hand.	
		Mudstone	25-50	2.3		Pick Work/Jumper work
	III	Weathered Sandstone	25-40	1.9	Moderately strong rock , break by hammer	Jumper work/blasting work
		Dolomite (medium)	50-100	2.5		
		Gneiss (medium)	50-100	2.7		
		Schist (medium)	20-100	2.7		
		Marble (medium)	60-100			
		Conglomerate	variable	variable	Moderately medium	Brake by hammer
		Slate (Medium)	25-100	2.7		
		Weathered limestone (medium)	50-100	2.6		
		Granite (medium)	50-100	2.7		
Hard	IV	Dolomite	100-150	2.5	Moderately strong rock, break by hammer	
		Gneiss	100-200	2.7	Strong break by hammer	
		Marble	100-200	2.6	Moderately strong rock, break by hammer	
	V	Sandstone (Greywacke)	100-200	2.6	Blasting generally required	Jumper work/chiseling
		Conglomerate	variable	variable	Ripping & blasting required if cemented conglomerate and limestone hard bed.	Jumper work/chiseling
		limestone	100-150	2.6		Jumper work/chiseling
	VI	Granite	100-350	2.7	Blasting, chiseling and ripping required to break, very strong rocks. Mostly rocks are igneous and metamorphic.	Jumper work/chiseling
		Basalt	100-350	2.9		
		Quartzite	100-350	2.9		Blasting work
		Dolerite	100-350	2.9	Blasting, chiseling and ripping required to break, very strong rocks. Mostly rocks are igneous and metamorphic.	Blasting work

Note: The above rock classification is based on the following strength criteria. Any rock from the above table, or not shown in the table will be classified accordingly.

Soft Rock: < 25 MPa

Medium Rock: 25 – 100 MPa

Hard Rock: > 100 MPa

3.2.1 SOFT SOIL

It comprises sand, silt and those soils that offer no resistance to excavation and sometimes requires shoring when foundations of exact dimensions are required to be excavated. Ordinary kassi, shovels or spade can be used for excavation in such type of soils.

3.2.2 ORDINARY SOIL

It comprises earth and sandy loam, spoil or rubbish of every description and any other formation into which a kassi, shovel or spade can penetrate for excavation.

3.2.3 HARD SOIL

It comprises stiff and hard clay soil (having SPT value of 17 and above) and at times has small percentage say up to 15%of kankar or boulders mixed up, repeated blows of kassi, or with pick or shovel can excavate it.

3.2.4 SHINGLE OR GRAVEL

It comprises gravel formation, soft varieties of limestone, sandstone, fissured stone or any other formation which can be excavated by the use of pick, shovel, jumpers, wedges, hammers etc.

3.2.5 ORDINARY / SOFT ROCK

Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation. If required, light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as 'Hard Rock'.

3.2.6 HARD ROCK

Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, consolidated sand stone, massive bedded lime stone, laterite, marble, schist, Mandrasite, dolerite, pegmatite and reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

3.2.7 HARD ROCK (BLASTING PROHIBITED)

Hard rock requiring blasting as described in sub-section 3.2.6but where the blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging, use of rock hammers and cutters or any other agreed method.

3.3 ANTIQUITIES AND USEFUL MATERIALS

Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government. Any material obtained from the excavation which in the opinion of the Engineer-in-Charge is useful shall be stacked separately in regular stacks as directed by the Engineer-in-Charge and shall be the property of the Government.

In case of archaeological monuments are found within or adjacent to the area, the contractor shall provide necessary fencing all around such monuments as per the directions of the Engineer-in-Charge and protect the same properly during execution of works. Payment for providing fencing shall be made separately.

3.4 PROTECTIONS

Excavation where directed by the Engineer-in-Charge shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by Engineer in charge during the night to avoid accident. The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that the services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time by the Contractor with approval of Engineer-in-Charge.

Excavation shall not be carried out below the foundation level of the adjacent buildings until underpinning, shoring etc. is done as per the directions of the Engineer-in-Charge any damages done by the contractor to any existing work shall be made good by him at his own cost. Existing drains, pipes, culverts, overhead wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the tools and/ or equipment used during the excavation. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

3.5 SITE PREPARATION

Before the earthwork is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees saplings and removed up to a distance of 30 meters outside the periphery of the area under clearance or up to the area as directed by Engineer-in-Charge. The roots of trees and saplings shall be removed to a depth of60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and levelled.

3.5 a DRESSING OF BERMS WITHOUT THE USE OF EXTRA MATERIAL

In case the berms show undulation of more than 5 cm in level from the desired finished level, the berms shall be scarified to a depth of 15 cm and material will be watered, mixed and compacted with appropriate equipment approved by the Engineer to achieve the desired finished level.

3.6 EXCAVATION IN ALL KINDS OF SOILS

3.6.1 EXCAVATION OPERATIONS

All excavation operations manually or by mechanical means shall include excavation and disposal of the excavated material for canals, drains foundations, trenches, basements, water tanks sewers and manholes; including excavation in hard soils and under water etc. The work shall include of depositing the excavated materials as specified. The disposal of the excavated material beyond free lead shall be either stated as a separate item or included with the items of excavation stating lead. During the excavation, the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

Before commencement of excavation, all existing levels of the Site and related outside levels shall be recorded by the Contractor at a suitable grid not exceeding 3m apart in both directions and shall be submitted to the Engineer for his check and approval.

In Hard Rock, the sides of the excavations shall be kept vertical up to a depth of 6 meters from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 60 cms on either side after every 6 metres from the bottom.

In Stiff soil, the sides of the excavations shall be kept vertical up to a depth of 1.5 meters from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 60 cms on either side after every 1.5 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:2 (1 horz. 2 vert.).

Where the soil is soft, loose or slushy, unsupported vertical cut shall not be allowed and side's slope of the soil shall be kept 1.5:1 (1.5 horz. 1 vert.). If vertical cut is to be provided then soil shall be shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to prepare proposals for the sloping or shoring as required for excavation for various depths. The work shall be executed only after the proposal is approved by the Engineer-in-Charge.

The excavation shall be done true to levels, slope, shape and pattern as per drawings and directed by the Engineer-in-Charge. Only the excavation shown on the drawings or as approved by the Engineer-in-Charge shall be measured for payment. No separate measurement and payment shall be made for excavation, centring, shuttering and for contractor's convenience.

For excavation in foundation in trenches and other like areas, the bed of excavations shall be to the correct level or slope and consolidated by watering and ramming and other means when necessary. If the excavation is done to a depth greater than that shown in the drawings unless it is required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own risk and cost with the concrete of the mix used for levelling bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.

In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed. In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, additional filling wherever required on that account shall be done by the contractor at his own risk and cost.

The excavation shall be done manually or by mechanical means as proposed by the contractor and approved by Engineer-in-Charge considering feasibility, urgency of work, availability of labour/mechanical equipment, construction completion programme and other factors involved. Contractor shall ensure the safety measures for the workers fully complying with recognised procedures and state laws.

3.6.2 DISPOSAL OF EXCAVATED MATERIALS

The free lead for disposal of excavated materials where stated in the "Schedule of Quantities" against various items is the average lead for the disposal of excavated earth within the site of work. The subsequent disposal of the excavated material where required shall be either stated as a separate item or included with the item of excavation stating lead. The actual lead for the disposal of earth beyond free lead shall be measured for payment appropriately. The excavated earth shall be disposed-off at the locations proposed by the Contactor and approved by the Engineer-in-Charge. All required permissions and cost of disposal shall be responsibility of the contractor. The contractor has to take written permission about place of disposal of earth before the earth is dispose-off, from Engineer-in-Charge.

3.7 EXCAVATION IN ORDINARY / HARD ROCK

3.7.1 GENERAL

All excavation operations shall include excavation and disposal of the excavated material as shown on drawings and approved by the Engineer-in-Charge. In case of excavation for trenches, basements, water tanks etc. the excavation shall include disposal of the excavated materials within free lead as specified. The disposal of the excavated material beyond free lead shall be stated as a separate item unless it is included with the item of excavation. During excavation, the natural drainage of the area shall be maintained; Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.

3.7.2 ORDINARY / SOFT ROCK

The ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be generally adopted. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Engineer-in-Charge in writing but nothing extra shall be paid for this blasting. Blasting shall be done as specified hereof.

If the required excavation is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own risk and cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/defective spots at the bed of foundations shall be dug out and filled with concrete or coarse sand (to be paid separately) as directed by the Engineer-in-Charge.

In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, filling wherever required on this account shall be done by the contractor at his own risk and cost. Only the excavation shown on the drawings or as required by the Engineer-in-Charge shall be measured and recorded for payment except in case of hard rock, where blasting operations have been resorted to, excavation shall be measured of the actual levels, provided the Engineer-in-Charge is satisfied that the contractor has not gone deeper than what was unavoidable.

3.7.3 HARD ROCK

I. General

Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-In-charge in writing along with all other necessary approvals, for resorting to the blasting operations. Blasting operations shall be done as specified and chiselling and/or drilling holes shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer-In-charge, and nothing extra shall be payable for chiselling.

The Contractor shall submit in advance a complete plan of the area requiring blasting, estimated quantity of rock to be blasted, nature of rock, blasting charge required with complete calculations, sequence of blasting for overall area and for daily operations, safety measures and qualification and experience of contractor's staff deputed for the work.

The Contractor shall be fully responsible for all operations and ensure safety of the works, personnel and adjoining structures/ public property.

Any approval of the Engineer-in-Charge shall not relieve the Contractor of his responsibilities mentioned herein.

ii. <u>Blasting</u>

Blasting operations shall be carried out under the supervision of a responsible licensed blasting authorized agent of the contractor (referred to as agent), during specified hours as approved in writing by the Engineer-in-Charge. The agent shall be conversant with the rules of blasting notified by Government from time to time. All blasting operations shall be carried out with due regard to safety regulations as per USA OSHA 1926 (U) and other regulations in force.

For blasting with dynamite or any other high explosives, the position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the contractor's agent. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the agent shall inspect the holes to ensure that drilling has been done only at the marked locations and no extra hole has been drilled. The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridges shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular notch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the notch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

The maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited.

Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations has been done by the agent for the misfired boreholes.

The contractor's agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator. After this a fresh detonator, primer and fuse shall be

placed in the misfired holes and fired, or the holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm. Away and parallel to it. This holes hall be charged and fired. The misfired holes shall also explode along with the new one.

Before leaving the site of work, the agent of one shift shall inform the other agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent. The Engineer-in-Charge shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

iii. General Precautions

For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200metersfromtheblasting site. Audio warning by blowing whistle shall be given before igniting the fuse.

Blasting work shall be done under careful supervision and trained personnel employed by the Contractor. Blasting shall not be done within 200 metres of an existing structure, unless specifically permitted by the Engineer-in-Charge in writing.

All procedures and safety precautions for the use of explosives, drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the contractor in accordance with safety code (OSHA 1926 U) for blasting and related drilling operation.

iv. Precautions against misfire

The safety fuse shall be cut in an oblique direction with a knife. All saw dust shall be cleared from inside of the detonator. This can be done by blowing down the detonator and tapping the open end. No tools shall be inserted into the detonator for this purpose.

If there is water present or if the bore hole is damp, the junction of the fuse and detonator shall be made water tight by means of tough grease or any other suitable material.

The detonator shall be inserted into the cartridge so that about one third of the copper tube is left exposed outside the explosive. The safety fuse just above the detonator shall be securely tied in position in the cartridge. Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.

If a misfire has been found to be due to defective of use, detonator or dynamite, the entire consignment from which the fuse detonator or dynamite was taken shall be got inspected by the Engineer-in-Charge or his authorized representative before resuming the blasting, or returning the consignment.

3.8 EXCAVATION UNDER WATER OR IN LIQUID MUD

3.8.1 GENERAL

Excavation, where water is encountered shall fall in this category. Steady water level in the trial pits before the commencement of bailing or pumping operations shall be the sub-soil water level in that area. Planking and strutting or any other protection work done with the approval of the Engineer-in-Charge to keep the trenches dry and/or to save the foundations against damage by corrosion or rise in water levels shall be measured and paid for separately. Bailing or pumping out water, accumulated in excavation, due to rains is included under respective items of earthwork and is not to be paid separately. In case item for dewatering is listed in the bid schedule, it will be paid as lump-sum item and will constitute full compensation for all labour, equipment, tools and all other items necessary and incidental to the completion of the work.

3.8.2 CARE OF WATER/ DEWATERING

All water that may accumulate in excavations during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed by the contractor. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. As may be required. Pumping shall be done directly from the foundations or from a sump outside the excavation or any other appropriate method proposed by Contractor in advance of undertaking the work and approved by the Engineer-in-Charge in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. During laying of concrete or masonry and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means.

Capacity and number of pumps, location at which the pumps are to be installed, pumping hours and adjustments from time to time etc. shall be proposed by the contractor and approved by the Engineer-in-Charge.

Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby. To prevent slipping of sides, planking and strutting may also be done with the approval of the Engineer-in-Charge.

The approval by the Engineer-in-Charge of the Method Statement for pumping shall not relieve the contractor of his responsibility. The applicable extra unit rate for wet and underwater excavation of earthwork includes full compensation for performance of the work and no separate payment shall be allowed, in case item for dewatering in not listed in the bid separately.

3.9 FILLING

3.9.1 GENERAL

i. For fillings and embankment construction, suitable earth from excavation as far as practicable shall be directly used for filling and no payment for double handling of earth shall be admissible. All costs shall be deemed to be included in the unit rate for excavation.

ii. The earth used for filling and embankment construction shall be free from all roots, grass, shrubs, rank vegetation, brushwood/Tress, sapling and rubbish. Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in thickness unless otherwise specified or approved by the Engineer-in-Charge. All lumps exceeding 8 cm in any direction shall be broken.

iii. Each layer shall be watered and consolidated with mechanical means to a minimum compaction of 90% of Maximum Dry Density (MDD) achieved by modified Proctor Test (ASTM D1557 / AASHTO T180). The top 1.0m layer

shall be compacted to 95% MDD. The contractor shall adopt suitable compaction method using either plate compactor, hand guided roller or static or vibratory power rollers as per requirements of site and as approved by the Engineer in-Charge. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.

a) For small areas - jumping vibrators

b) For trenches – Plate compactors or Hand guided roller

c) For large areas - Static or Vibratory roller of suitable weight

3.9.2 LARGE SCALE LEVELLING WORK

a) In case of large scale levelling work involving both cutting and filling, an accurate site plan shall be prepared before the work is commenced by contractor for approval of the Engineer-in-Charge. The portions requiring cutting and filling shall then be divided into squares and corresponding squares in filling, which are complementary to the squares in cutting, shall be given the same number.

b) A table may be provided in the plan showing leads involved between the various complementary squares. This would form a lead chart for the work to be done.

c) Before the work of levelling is commenced, the lead chart shall be checked in the presence of the contractor or his authorized representative, and his signatures shall be obtained on the same. This should form an integral part of the contract and should be duly signed by both the integral parties before commencement of the work.

d) The payment for lead shall be based on lead chart prepared in the aforesaid manner.

3.9.3 BORROW SOIL

Materials required for fill and embankment construction not available from excavations be imported from pre-determined borrow areas approved by the Engineer-in-Charge before the start of the work. Wherever feasible, the average lead should be worked out and stipulated in the tender.

The borrow area shall be stripped carefully of topsoil, sod and other matter unsuitable for fill. Surface of borrow areas shall be left after completion in a reasonable smooth and even condition approved by Engineer-in-Charge.

The initial limits and levels of the area to be filled should be recorded and approved by Engineer-in-Charge. The levels should be properly checked during the progress of work and on completion.

Borrow material for normal soil shall meet AASHTO classification of A-4, A-5 or A-6 material, or as approved by the Engineer.

Granular borrow material shall meet AASHTO classification of A-1, A-2 or A-3 material, or as approved by the Engineer.

3.9.4 EXCAVATION IN TRENCHES FOR PIPES, CABLES ETC. AND REFILLING

i. General

This shall comprise excavation to any depth in trenches for pipes, cables etc. and returning the suitable excavated material to fill the trenches after

pipes, cables etc. are laid and their joints tested and passed, and disposal of surplus excavated material.

ii. Refilling

Filling in trenches shall be commenced soon after the joints of pipes, cables and conduits etc. have been tested and passed. The space all around the pipes, cables conduits etc. shall be cleared of all debris, brick bats etc. Where the trenches are excavated in hard/ soft soil, the filling shall be done with earth on the side and top of pipes unless otherwise approved, in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the excavated earth is used for filling. In case of excavation trenches in ordinary/ hard rock, the filling up to a depth of 30cm above the crown of pipe, cable, conduits etc. shall be done with fine material like earth, moorum or pulverized/ decomposed rock according to the availability at site. The remaining filling shall be done with boulders of size not exceeding 15cm mixed with fine material like decomposed rock, moorum or earth as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30cm. Excavated material containing deleterious material, saltpetre earth etc. shall not be used for filling. Ramming shall be done with plate compactors or iron rammers where feasible and with blunt ends of crow bars where rammers cannot be used. Compaction within 1xdia.of pipe above the crown shall be done by manual means or by using plate compactor. For fill above this, rollers can be used. Special care shall be taken to ensure that no damage is caused to the pipes, Cables, Conduits etc. laid in the trenches.

iii. Planking and Strutting – General

When the depth of trench in soft/loose soil exceeds 1.5 metres, stepping, sloping and/or planking and strutting of sides shall be done. In case of loose and slushy soils, the depths at which these precautions are to be taken shall be as approved by the Engineer-in-Charge according to the nature of soil. Planking and strutting shall be 'close' or 'open' depending on the nature of soil and the depth of trench. The type of planking and strutting shall be as proposed by Contractor and approved by the Engineer-in-Charge. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches from collapse.

iv. Close Planking and Strutting

Close planking and strutting shall be done by completely covering the sides of the trench generally with short upright, members called 'poling boards'. These shall be 250x38 mm in section or as approved by the Engineer-in-Charge.

The boards shall generally be placed in position vertically in pairs, one board on either side of cutting. These shall be kept apart by horizontal wallings of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies, or as directed by Engineer-in-Charge. The length and diameter of the ballies strut shall depend upon the width of the trench.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical 'wallings' which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be embedded in the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed. The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and preceded systematically to the other end. Concrete or masonry shall not be damaged while removing the

planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried, unless required by the Engineer-in-Charge to be left permanently in position.

v. Open Planking and Strutting

In case of open planking and strutting, the entire surface of the side of the trench is not required to be covered. The vertical boards 250 mm wide & 38 mm thick shall be spaced sufficiently apart to leave unsupported strips of 50cm average width. The detailed arrangement, sizes of the timber and the distanceapartshallbesubjecttotheapprovaloftheEngineer-in-Charge.In all other respect, specifications for close planking and strutting shall apply to open planking and strutting.

3.9.5 FILLING IN PLINTH, UNDER FLOOR ETC.

i. Earth filling

Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank, vegetation, grass, brushwood, stone shingle and boulders (larger than 75mm in any direction), organic or any other foreign matter. Earth containing deleterious materials, saltpetre earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the earth is used for filling.

The space around the foundations and drains shall be cleared of all debris, brick bats etc. The filling unless otherwise specified shall be done in layers not exceeding20cmin depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with plate compactors or iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains and masonry or concrete in the trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

ii. Sand Filling in Plinth

Sand shall be clean and free from dust, organic and foreign matter. Sand filling shall be done in a manner similar to earth filling in plinth specified above except that consolidation shall be done by flooding with water. Sand filling of medium to coarse sand (passing less than 4% through BS sieve No.200) or fine sand (passing 4 to 10% through BS sieve No.200) shall be done in layers not more than 9” (225 mm) thick and shall be rammed after flooding with water to such an extent that 9" layer is reduced to about 6" (150 mm) after compaction. The Density Index shall not be less than 100% as per ASTM D-4254 for top 1meter depth and 94% for depth below 1meter.The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the Engineer-in-Charge has inspected and approved the sand filling.

3.10 SITE CLEARANCE

The surface area of the ground to be occupied by building shall be cleared of all roots, grass, shrubs, brush, trees, fences and such other works as may either cause hindrance with the execution of works or may decay and form dangerous pockets. The clearance may be classified with following categories.

3.10.1 SURFACE DRESSING

Surface dressing before placement of fill shall include cutting and filling up to a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30 cm measured at a height of one metre above the

ground level and removal of rubbish and other excavated material up to a distance of 50 metres outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows and depressions filled up to the required level with the excavated earth so as to give an even, neat and tidy look.

3.10.2 JUNGLE CLEARANCE

Jungle clearance shall comprise uprooting of rank vegetation, grass, brushwood, shrubs, stumps, trees and saplings of girth upto75 cm. measured at a height of one metre above the ground level.

3.10.3 UPROOTING OF VEGETATION

The roots of trees and saplings shall be removed to a depth of 60 cm below ground level. All holes or hollows formed due to removal of roots shall be filled up with earth rammed and levelled. Trees, shrubs, poles, fences, signs, monuments, pipelines, cable etc., with in or adjacent to the area which are not required to be disturbed during jungle clearance shall be properly protected by the contractor at his own cost and nothing extra shall be payable.

3.10.4 CLEARANCE OF GRASS

Clearing and grubbing operation involving only the clearance of grass including removal of rubbish up to a distance of 50 m outside the periphery of the area under clearance shall not be measured and paid for separately. Its costs shall be deemed to be included in the unit rate for earthwork.

3.10.5 FELLING TREES

While clearing jungle growth, trees above30cm girth (measured at height of one metre above ground level) to be cut, shall be approved by the Engineer-in-Charge and then marked at site. Felling of trees shall include taking out roots up to 60 cm below ground level. All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 20cm layers and compacted thoroughly so that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut into suitable pieces as directed by the Engineer-in-Charge.

3.10.6 STACKING AND DISPOSAL

All useful materials obtained from clearing and grubbing operation shall be stacked in the manner as directed by the Engineer-in-Charge. Trunks and branches of trees shall be cleared of limbs and tops and stacked neatly at places indicated by the Engineer-in-Charge. The materials shall be the property of the Government. All unserviceable materials which in the opinion of the Engineer-in-Charge cannot be used or auctioned shall be removed up to a distance of 50m.Outsidethe periphery of the area under clearance. It shall be ensured by the contractor that unserviceable materials are disposed off in such a manner that there is no likelihood of getting mixed up with the materials meant for construction.

3.10.7 OTHER PHYSICAL OBSTRUCTIONS

Other physical obstructions like structures, fencing appearing on ground shall be cleared and accounted as approved by the Engineer-in-Charge.

3.11 ANTI-TERMITE TREATMENT

Sub-terrain an termites are responsible form of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber

buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, and stationeryetc.Isconsiderable.Anti-termitetreatmentcanbeeitherduringthetimeof construction i.e. pre-constructional chemical treatment or after the building has been constructed i.e. treatment for existing building.

Prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable termiticide.

3.11.1 MATERIALS

Chemicals: Termiticide made from any one of the following chemicals as per manufacturer's recommendations shall be used:

a) Bifenthrin (Repellent)

b) Imidacloprid (Non-Repellent)

c) Fipronil (Non Repellent)

Anti-termite treatment chemical is available in the market from approved manufacturers. Termiticide shall not be prepared by the contractor by buying concentrated chemicals and diluting it with water rather already prepared chemicals shall be acquired from the approved manufacturers along with the guarantee certificate for protection against termite attack.

Engineer-in-Charge shall approve procurement of chemical in sealed original containers directly from the reputed and authorized manufacturers. Chemical shall be kept in the custody of the Engineer- in-Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

3.11.2 SAFETY PRECAUTIONS

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with the chemicals. After handling the chemicals, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

3.12 ANTI-TERMITE TREATMENT -CONSTRUCTIONAL MEASURES

The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding the building.

Earth free from roots, dead leaves, or other organic matter shall be placed and compacted in successive horizontal layers of loose material not more than 200 mm thick. Dry brick shall be inserted at last 50mmin brick masonry for providing apron floor around the periphery.

3.13 TREATMENT FOR EXISTING BUILDING (POST CONSTRUCTION TREATMENT)

3.13.1 CHEMICALS

Termiticide made from any one of the following chemicals manufactured by approved manufacturer shall be used for soil treatment in order to protect a building from termite attack.

a) Imidacloprid (Non-Repellent)

b) Fipronil (Non Repellent)

Anti-termite treatment chemical is available in the market from approved manufacturers. Termiticide shall not be prepared by the contractor by buying concentrated chemicals and diluting it with water rather already prepared chemicals shall be acquired from the approved manufacturers along with the guarantee certificate for protection against termite attack.

Engineer-in-Charge shall approve procurement of chemical in sealed original containers directly from the reputed and authorized manufacturers. Chemical shall be kept in the custody of the Engineer- in-Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

3.13.2 SAFETY PRECAUTIONS

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with the chemicals. After handling the chemicals, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

3.13.3 TREATMENT

Once the termites have ingress into the building, they keep on multiplying and destroy the wooden and cellulosic materials, and as such it becomes essential to take measures for protection against termites. Anti-termite measures described below are necessary for the eradication and control of termites in existing building. To facilitate proper penetrations of chemical into the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemicals used for the required area during the operation. Chemical treatment for the eradication and control of sub-terrain an termites in existing building shall be done. Treatment shall be got done only from the approved specialized agencies using the chemical procured directly by the Engineer-in-Charge from reputed and authorized manufacturers.

i. Treatment along outside of foundations

The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5litres per square metre of vertical surface of the sub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 litres per running metre of the channel. Roding with 12 mm. diameter mild steel rods at 150 mm apart shall be done in the channel if necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 litres per running metre shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linear metre. In soils which do not allow percolation of chemicals to desired depth, the uniform disposal of the chemical to a depth of 300 mm shall be obtained by suitably modifying the mode of treatment depending on site condition.

In case of RCC foundations the soil (backfill) in contact with the column sides and plinth beams along with external perimeter of the building shall be treated with chemical emulsion at the rate of7.5 litres/sq.m. of the vertical surface of the structure. To facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams up to a depth of 300 mm or up to the bottom of the plinth beams, if this level is less than 300 mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned in to the trench directing the spray against the concrete surface of the beam or column as the case may be.

ii. Treatment of Soil under Floors

The points where the termites are likely to seek entry through the floor are the cracks at the following locations:

a. At the junction of the floor and walls as result of shrinkage of the concrete;

b. On the floor surface owing to construction defects;

c. At construction joints in a concrete floor, cracks in sections; and

d. Expansion joints in the floor.

Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever such cracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted in to these holes using a hand operated pressure pump to soak the soil below until refusal or up to a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing

floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-charge.

iii. Treatment of Voids in Masonry

The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at300mmintervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

iv. Treatment at Points of Contact of Wood Work

The wood work which has already been damaged beyond repairs by termites shall be replaced. The new timber shall be dipped or liberally brushed at least twice with chemical in oil or kerosene. All existing woodworking the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts with the adjoining masonry with the chemical emulsion by drilling 6 mm holes at a downward angle of about 45 degree at junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a litre per hole. The treated holes shall then be sealed.

Infested wood work in chowkats, shelves, joints, purlins etc., in contact with the floor or the walls shall be provided with protective treatment by drilling holes of about 3mm diameter with a downward slant to the core of the wood work on the inconspicuous surface of the frame. These holes should be at least 150mm centre to centre and should cover entire frame work. Chemicals shall be liberally infused in these holes. If the wood is not protected by painter varnish two coats of the chemicals shall be given on all the surfaces and crevices adjoining the masonry.

3.14 DRESSING AND COMPACTION OF BERMS/BANKS

3.14.1 DESCRIPTION

This work shall consist of scarification of berms/banks, which are undulated, or out of level. The existing material shall be scarified, watered, mixed and properly leveled and compacted according to specification described here under or as directed by the Engineer. This item will be applicable to Dowel of canal bank, Marginal bunds, Flood protection bunds and slopes.

3.14.2 MATERIAL REQUIRMENT

In this item no fresh material is required, however, if fresh material is used it shall be measured and paid under other relative items of works.

3.14.3 CONSTRUCTION REQUIRMENT

3.14.3.1 Dressing of berm/banks without the use of extra material

In case the berms/banks show undulation of more than 10 cm in level from the reconstructed pavement structure, the berm/banks shall be scarified to a depth of 15 cm and material will be watered, mixed and compact with appropriate equipment approved by the Engineer

3.14.3.2 Dressing of berm/banks with the use of extra material

In case the difference of elevation of existing berm with respect to reconstructed bund/bank structure is less then 15 cm then additional material (to be measured under other items of work) shall be added to bring the level of berms in conformity with the lines and grades of the existing bund/bank. Existing and fresh material shall be properly mixed, watered and compacted as directed by the Engineer.

3.14.3.3 Compaction requirement

Compaction requirement of the fresh and existing material shall be as under:-

Depth in cm	Compaction requirement as per AASHTO-180 (D).
0 -15 (Top layer)	95% for common earth material.

3.14.3.4 Compaction of slopes

While reinstating/dressing of berms/banks, it shall be ensured that compaction requirements are observed on slopes of the berms/banks. The degree of compaction shall be as per direction of the Engineer.

3.14.4 MEASUREMENT AND APYMENT OF BERMS/BANKS

3.14.4.1 Measurement of Berms/Banks

Measurement under this item shall be made in square meter of berms/banks dressed and compacted in accordance with theoretical lines, or sections shown on the drawings, or as per existing edge of berm/bank.

In case partial fresh material is used to compensate for shortage of material in the top layer the quantity of such material shall be measured by survey levels of existing ground and designed lines, grades or sections shown on the drawing.

The quantity of material thus measured shall be paid under other items of works of back fill from borrow (item 3.15 g).

3.14.4.2 Payment of Berms/Banks

The payment of this item shall be made for at the contract unit price per square meter of dressed and compacted berm/banks measured as above, for scarification watering, mixing, rolling, labour, equipment, tools and incidentals necessary to complete this item.

3.15 MEASUREMENT AND PAYMENT

Measurement for earth work shall be made as under

a) For general excavation or backfill, by use of x-section showing original and formation level.

b) For structural excavation, contractors shall submit shop drawings giving the top level of soil with lowest level of excavation including length and width with tolerance of 30 cm all round

Pay Item No.	Description	Unit of Measurement
3.15 a	General excavation in open cut/ borrow pit up to any depth as directed by the Engineer for	
	i. Soft soil/ Ordinary soil	CM
	ii. Hard soil/ Shingle/Gravel	CM
	iii. Soft rock (compressive strength up to 25 MPa, type I)	CM
	iv. Medium rock (compressive strength 25 MPa to 100 MPa, type II & III)	CM
	v. Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting allowed	CM
	vi. Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting prohibited	CM
3.15 b	Structural excavation for foundation, drains, irrigation channels, bed clearance, trenches for pipe lines, septic tank, underground water tank, circular soakage pit and manhole etc. including disposal of excavated material outside work site and a depth up to 1.5m	
	i. Soft soil/ Ordinary soil	CM
	ii. Hard soil/ Shingle/Gravel	CM
	iii. Soft rock (compressive strength up to 25 MPa, type I)	CM
	iv. Medium rock (compressive strength 25 MPa to 100 MPa, type II & III)	CM
	v. Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting allowed	CM
	vi. Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting prohibited	CM
3.15 c	Structural excavation for foundation, drains, irrigation channels, bed clearance, trenches for pipe lines, septic tank, underground water tank, circular soakage pit and manhole etc. including disposal of excavated material outside work site and a depth1.5m to 3.0m for	
	i. Soft soil/ Ordinary soil	CM
	ii. Hard soil/ Shingle/Gravel	CM
	iii. Soft rock (compressive strength up to 25 MPa, type I)	CM
	iv. Medium rock (compressive strength 25 MPa to 100 MPa, type II & III)	CM
	v. Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting allowed	CM
	vi. Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting prohibited	CM
3.15 d	Structural excavation for foundation, drains, irrigation channels, bed clearance, trenches for pipe lines, septic tank, underground water tank, circular soakage pit and manhole etc. including disposal of excavated material outside work site and a depth 3.0m to 6.0m for	

	i.	Soft soil/ Ordinary soil	CM
	ii.	Hard soil/ Shingle/Gravel	CM
	iii.	Soft rock (compressive strength up to 25 MPa, type I)	CM
	iv.	Medium rock (compressive strength 25 MPa to 100 MPa, type II & III)	CM
	v.	Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting allowed	CM
	vi.	Hard rock (compressive strength more than 100 MPa, type IV,V&VI) with blasting prohibited	CM
3.15e	Dewatering in trenches/ pits of any kind (open) any depth with pump (2HP)		Hrs.
3.15f	Backfill for foundations and trenches etc. from excavation (any type) available at site		CM
3.15g	Backfill for foundations and trenches etc. from borrow (Normal soil)		CM
3.15h	Tree removal along with its roots including sand backfilling for		
	i.	Girth 150mm – 300mm	NO
	ii.	Girth 301mm – 600mm	NO
	iii.	Girth over 600mm	NO
3.15i	Anti–Termite treatment in foundation and floors		SM
3.15j	Compaction of natural ground (any classification)		SM
3.15k	Dressing of berm/banks without extra material		SM
3.15l	Clearing & grubbing (removal) of roots including scarifying natural ground up to 12" (30cm) depth and disposal of roots		SM
3.15 m	Filling and compacting soil, earth and boulders behind retaining and breast walls lead up to 50ft (15m)		CM

3.16 GLOSSARY

I. Lead

All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by Engineer-in-charge along with reasons in writing.

II. Lead distance

It shall mean the shortest possible horizontal route between the centre of gravity of the material excavated and centre of gravity of the material finally placed

III. Lift

The vertical distance for removal with reference to the ground level

IV. Safety Rules

Safety rules as laid down by the statutory authority shall be followed.

SECTION 4 DISMANTLING (Demolition)

4.1 GENERAL

The term “Dismantling” means to carefully take apart one or more parts of a building or structure without damaging the other parts. The term ‘Demolition’ on the other hand implies breaking up. The work may comprise dismantling/demolishing whole or part of work including all relevant items consisting of but not limited to stone work, brick work, concrete, floorings, roofing and iron work as specified and or shown on the drawings.

Dismantling and Demolition work shall comply with BS 6187 Code.

4.2 PRECAUTIONS

a) All materials retrieved from dismantling or demolition shall be properly stored/ stacked and shall be the property of the Employer unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer-in-Charge/ Authorized Representative.

b) Before commencement of dismantling/demolition, the Contractor shall prepare and submit his proposals and program for proceeding with the work for approval of the Engineer-in-Charge. Generally, the Contractor will be permitted to demolish the structures only through approved means, Blasting can be permitted provided the necessary precautions are taken to protect the Works, public and private property and all persons in the vicinity of the Works, except if there be pumps, motors, hand rails, structural steel, bricks and other usable materials, the Contractor shall salvage and immediately handover to the Employer at the site of salvaging all such equipment and materials prior to demolishing or removing the structure.

c) The work should generally be performed in reverse order of the one in which the structure was constructed. Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Temporary enclosures or partitions and necessary scaffolding wherever specified shall also be provided, as directed by the Engineer-in-Charge.

d) Necessary steps/ precautions should be taken to keep noise and dust nuisance to a minimum. If specified or directed by the Engineer-in-Charge, the Contractor shall provide, erect and remove screens of canvas or other suitable material to minimize the nuisance from dust and shall provide for watering as the work of demolition proceeds. Helmets, goggles, safety belts etc. should be used whenever required and as directed by the Engineer-in-Charge. All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. Chisels and cutters may be used carefully as directed. The dismantled articles should be removed manually or lowered to the ground and then properly stacked as directed by the Engineer-in-Charge.

e) Dismantling shall be done by taking out the fixtures with proper tools and not by tearing or ripping off. Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-in-Charge. All unserviceable materials, rubbish etc. shall be disposed off as directed by the Engineer-in-Charge.

f) The contractor shall maintain/ disconnect existing services, whether temporary or permanent. No demolition work should be carried out at night especially when the building or structure to be demolished is in an inhabited area. Screens shall be placed where necessary to prevent injuries due to falling pieces. Water may be used to reduce dust while tearing down plaster from brick work. Safety belts shall be used by labourers while working at higher level to prevent falling from the structure. First-aid equipment shall be got available at all demolition works of any magnitude.

g) Fall protection measures shall be implemented at site as per OSHA 1926 and other regulations in force.

4.3 MEASURES TO BE ADOPTED FOR DEMOLITION OF CERTAIN ELEMENT OF STRUCTURES

4.3.1 ROOF TRUSSES

In case of a pitched roof, the roof structure should be removed to wall plate level manually. Sufficient purloins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively. Temporary bracing should be introduced, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, should be independently and securely guyed in both directions before commencement of work. The bottom tie of roof trusses should not be cut until the principal rafters are prevented from making outward movement.

4.3.2 HEAVY FLOOR BEAMS

Heavy bulks of timber and steel beams should be supported before cutting at the farthest point and should then be lowered to a safe working place.

4.3.3 JACK ARCHES

Where tie rods are present between main supporting beams, these should not be cut until the arch or series of arches in the floor have been removed. Due care should be exercised and full examination of this type of structure undertaken before demolition is commenced. The floor should be demolished in strips parallel to the span of the arch rings (at right angles to the main floor beams).

4.3.4 BRICK ARCHES

Full time supervision should be given by experienced persons fully conversant in the type of work to ensure that the structure is stable at all times. Dead loads as much as possible may be removed provided it does not interfere with the stability of the main arch rings but it should be noted that the load-carrying capacity of many old arches relies on the filling between the spandrels. The restraining influence of the abutments should not be removed before the dead load of the spandrel fill and the arch rings has been removed.

Special temporary support shall be provided in the case of skew bridges. A single span arch can be demolished by hand by cutting narrow segments progressively from each springing parallel to the span of the arch until the width of the arch has been reduced to a minimum which can then be collapsed. Where it is impossible to allow debris to fall to the ground below, centering designed to carry the load should be erected and the arch demolished progressively. The design of the centering should make appropriate allowance for impact.

Where deliberate collapse is feasible the crown may be broken by the demolition ball method working progressively from edges to the centre. Collapse of the structure can be affected in one action by the use of explosives. Charges should be

inserted into boreholes drilled in both arch and abutments. This method is the most effective for demolition of tall viaducts.

In multi-span arches before individual spans are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for a single span, care being taken to demolish the spandrels down to the springing line as the work proceeds. Where explosives are used it is preferable to ensure the collapse of the whole structure in one operation to prevent the chance of leaving unstable portions standing.

4.3.5 CANTILEVERS (NOT PART OF A FRAMED STRUCTURE)

A cantilever type of construction depends on the super imposed structure for its stability. Canopies, cornices, staircases and balconies should be demolished or supported before the tailing down load is removed.

4.3.6 IN-SITU REINFORCED CONCRETE

Demolition of RCC shall comply with ACI 555R-01 Standard.

Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained. Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability. Demolitions should be commenced by removing partitions and external non-load bearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability. Where hard demolition methods are to be used, the following procedures should be used.

a) Reinforced Concrete Beams

For beams, a supporting rope should be attached to the beam. The concrete should than be removed from both ends by pneumatic drill and the reinforcement expose. The reinforcement should then be cut in such a manner so as to allow the beam to be lowered under control to the floor.

b) Reinforced Concrete Columns

In case of columns, the reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a manner so as to allow the column to be pulled down to the floor under control.

c) Reinforced Concrete Walls

Reinforced concrete walls should be cut into strips and demolished.

d) Reinforced Concrete Slabs

Reinforced concrete slabs should be demolished in the following manner:

i. Safety gear comprising of hard hat, goggles, face mask, gloves and hard shoes should be worn by workers.

ii. Slab which is to be demolished should be clear of any utility line e.g. electric, gas or water lines etc.

iii. The method to break up large slabs is to break it up into smaller sections. Breaking of slab should start at the farthest end and proceed slowly towards the near end, always making sure that solid flat concrete footing is available for the workers.

iv. Breaking of slab should be carried out by jack hammer, sledge hammer or other suitable tools.

v. Concrete should be broken down into smaller pieces which can be disposed of easily by workers.

vi. Reinforcement can be cut into smaller pieces and disposed of after concrete has been removed.

4.3.7 ELECTRICAL ITEMS

Electrical Cables shall be identified and tagged for removal by the contractor. The same shall be verified by the Engineer prior to removal. It shall be ensured that no other cable is disturbed/damaged in the process of removal of tagged cables.

Electrical points and fixtures shall be removed carefully in such a way that their components are not damaged.

4.3.8 METHODS OF DISMANTLING

Dismantling of various Structures and Elements of Structures can be carried out by adopting Manual or Mechanized method. The following procedure shall be adopted for Dismantling.

a) Manual Method

The Engineer and the Contractor will jointly agree to the Quantum of work to be dismantled like Doors, Windows, Bathroom fittings, Tiles of various kinds, Trusses and Electrical items and there by agree to the types of Manpower, No. of Manpower and their hours of deployment. In case the Contractor does not agree the Engineer shall have the authority to take the final decision in this regard. In case if the Contractor does not agree then the Engineer shall have the authority to carry out the work by other source at the risk and cost of the Contractor which Payment shall be deducted from the invoices of the Contractor.

The rates of Manpower shall be applicable as appearing in day work order of the clause of the contract or the rates of Manpower appearing in Rate analysis of CSR.

b) Mechanized Method

The Engineer shall determine the Measurement/Quantum of work pertaining to Concrete and Brick/Stone masonry to be dismantled. The equipment to be used for dismantling shall be approved by the Engineer prior to start of work. The rates quoted by the Contractor in the BOQ shall be applicable to the item, in case if there is no item in BOQ than CSR rate of latest version shall be applicable.

4.4 MEASUREMENT AND PAYMENT

The measurement and payment for the item of the work of dismantling hereof shall be made corresponding to the applicable items, as provided in contract agreement.

Pay Item No.	Description	Unit of Measurement
4.4 a	Dismantling/ Demolition of following work and disposal within 30m	
	i. Stone work (All types)	CM
	ii. Brick work (All types)/ block masonry (solid and hollow)	CM
	iii. Concrete (All types)	CM
	iv. Cement plaster	SM
	v. Tile, marble, granite and PCC floor	SM
	vi. Wooden roof truss	CM
	vii. Wooden doors, windows, kitchen cabinets and cupboard	SM
	viii. Steel structure, steel Trusses, CGI sheets, GI gabion and MS mesh wire creates	KG
4.4b	Separating reinforcement from concrete, cleaning and straightening the same	KG
4.4 c	Disjoining of RCC pipe in the trench and stacking outside the trench	
	i. 6” to 12” dia.	LM
	ii. 12” to 24” dia.	LM
	iii. 24” to 36” dia.	LM
4.4 d	Scraping of white and colour wash from walls and ceiling/soffit of staircase etc. as directed by the Engineer in charge.	SM
4.4 e	Dismantling (Safely or Replacing) of electric points, cables, fixtures etc. of any capacity and size as directed by the Engineer in charge.	NO

SECTION5 PLAIN AND REINFORCED CONCRETE

5.1 SCOPE

The work shall include furnishing of all labour, materials, plant, equipment, accessories and services as required to complete the concrete items as shown on the drawings, specified herein and/or as directed by the Engineer-in-Charge. The materials herein specified shall be proportioned, mixed, formed and placed in accordance with the herein stated requirements. The stipulations and requirements herein set forth shall apply except when such stipulations and requirements are specifically modified by the Engineer-in-Charge for any particular item of work.

Concrete work shall conform to all requirements of ACI 301 (Latest Revision), Specifications for Structural Concrete for Buildings or other Structures, except as modified by supplemental requirements below. The Contractor shall submit, for approval before commencement of any work, his Method Statement which would provide complete details of the procedures and equipment to be used for the satisfactory execution of the work.

5.2 PLAIN & REINFORCED CEMENT CONCRETE

5.2.1 MATERIALS

5.2.1.1 CEMENT

a) General

Cement shall be fresh, furnished in sacks or in bulk form as approved by the Engineer-in-Charge. Unless otherwise permitted, cement from not more than two plants shall be used and in general, the product of only one plant shall be used in any particular section of the work. Cement recovered through cleaning of sacks shall not be used.

b) Portland and Blended Cement

Portland cement shall be of Pakistan origin and manufacture, unless otherwise approved by the Engineer-in-Charge. Portland cement shall conform to Pakistan Standard 232 or to British Standard 12 or to ASTM C 150 type 1. Portland cement conforming to ASTM C 150, rapid hardening Type III or Sulphate Resistant Type-V or conforming to BS4027 may also be used in certain parts of the Works as specified or directed by the Engineer-in-Charge. Where specified Low Heat Cement complying with BS 1370 or ASTM C 150 Type IV shall be used. The Contractor shall use Pozzolanic materials (blast-furnace slag or flyash or calcined clay) by blending the materials with Ordinary Portland Cement/Sulphate Resisting Cement (whichever is specified in the Contract when alkaline reactive aggregates are used) by replacing up to maximum of 40% of cement. The slag cement thus formed shall conform to BS 146 or ASTM C 595. Raw or Calcined natural pozzolan shall conform to ASTM C618 Class N or Class F. The granulated iron blast-furnace slag shall be finely ground and shall conform to ASTM C989 Grade80, 100 or 120.The final proportions of OPC/SRC and Pozzolanic materials shall be determined by the Contractor and approved by the Engineer-in-Charge before each mix. The mix will normally be designed by the Contractor to have:

i. A mortar bar reduction not less than 75% at 14 days when tested in accordance with ASTM C441, and

ii. A heat of hydration of less than 70 calories per gram of Pozzolanic materials (blast-furnace slag or flyash or calcined clay) at 7 days when tested in accordance with ASTM C186.

c) Transportation of Cement

Transportation of the cement from the factory to the Site stores and to the point of use shall be accomplished in such a manner that the cement is completely protected from exposure to moisture. Cement which has been adversely affected by moisture, as determined by the Engineer-in-Charge, shall be rejected. Cement in sacks shall be delivered in strong, well-made sacks, each plainly marked with the manufacturer's name, brand and type of cement and the weight of cement contained therein. Packages varying from the standard weight marked thereon may be rejected and if the average weight of packages in any consignment as shown by weighing fifty packages taken at random is less than that marked on the packages, the entire consignment may be rejected. Packages received in broken or damaged condition shall be rejected or may be accepted only as fractional packages as determined by the Engineer-in-Charge.

d) Storage of Cement

Cement shall be stored at Site in dry, weather tight and properly ventilated stores. All storage facilities shall be subject to approval and shall be such as to permit easy access for inspection and identification of each consignment. Adequate storage capacity shall be furnished to provide sufficient cement to meet the peak needs of the project. The following special precautions shall be observed for storage of cement:

1. Reduce the time of storage as much as possible.

2. The sack should be stacked closely on damp proof or timber raised a foot or so from the ground with the air space below.

3. To avoid bursting of bags and setting under pressure the height of stack should be limited to eight (8) bags.

The best method of storage is that adopted by the cement manufacturers viz; in bulk; and bins of loose cement 6′ (six feet) or more in depth. In bulk storage, cement can remain intact for longer than one year.

Contractor shall use cement in the approximate chronological order in which it is received at the Site.

Cement storage facilities shall be emptied and cleaned by the Contractor when so directed. However, the interval between required cleaning normally will not be less than four months. Suitable, accurate scales shall be provided by the Contractor to weigh the cement in stores and elsewhere on the Site, if required, and he shall also furnish all necessary test weights.

5.2.1.2 AGGREGATES

a) Requirements

Aggregates (Fine and Course) for normal concrete shall conform to the AASHTO Designation M-6 and M-80 and shall be tested in accordance with AASHTO T-11 & T-27. The nominal maximum size of the aggregates shall not be larger than one fifth of the narrowest dimension of the finished wall or slab, or larger than three fourth of the minimum clear spacing between the reinforcing steel and embedment. These limitations may be waived if, in the judgement of the Engineer-in-Charge, workability and method of consolidation be such that the concrete can be placed without honey-combs or voids.

Aggregate shall be stored at the Site in such a manner as to prevent its contamination with dust or other material. Aggregates which have deteriorated or which have been contaminated shall not be used for concrete. All methods employed by the Contractor for loading, unloading, handling and stockpiling aggregates shall be subject to the approval of the Engineer-in-Charge. Sufficient quantities of aggregate shall be maintained at the Site at all times to assure continuous placement and completion of any lift of concrete started.

b) Composition

The use of natural sand or a combination of natural and manufactured sand may be permitted, provided that the fine aggregate meets the applicable requirements of the Specifications for the particular use intended. Coarse aggregate shall consist of gravel, crushed stone or a combination thereof.

The aggregates shall be non-alkaline reactive in accordance with the provisions of ASTM C-227 & C-289.

c) Source

The Contractor shall obtain concrete aggregate from deposits of natural sand and gravel or shall procure crushed aggregate from approved quarries (refer to construction material source study) which produce aggregates meeting with the Specifications contained herein.

d) Processed Aggregates

The Contractor in procuring the processed aggregates or in planning his aggregate processing operations shall ensure that the aggregates, as delivered to the mixer, consist of clean, hard and uncoated particles; light weight elements (chalk, clay, coal) are separated by segregation under water by vibration where required and the fines are removed from the coarse aggregate by adequate washing. The coarse aggregate shall be re-screened just prior to delivery to the concrete mixer bins. The moisture content of coarse and fine aggregates shall be as directed by the Engineer-in-Charge. Compliance with the aggregate grading and uniformity requirements shall be determined before the material is delivered at the mixer. All aggregates shall be sieved and washed with clean water. The aggregates shall conform to the specific requirements given hereinafter.

5.2.1.3 FINE AGGREGATE (SAND)

a) General

Fine aggregates are defined as aggregates passing 3/8 inch standard square mesh sieve size. Fine aggregates shall be of such quality that mortar specimens, prepared with standard Portland cement and tested in accordance with AASHTO Designation T-71, shall develop a compressive strength at 7 days of not less than 90 percent of the strength developed by a mortar prepared in the same manner with the same cement and graded sand having a fineness modulus of 2.3 to 3.1. Natural aggregates if required shall be thoroughly and uniformly washed before use. Sand equivalent (T-176) shall be 75 min.

For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples submitted by the Contractor from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus of greater than 0.20 either way from the fineness modulus of mix design samples submitted by the Contractor may be rejected till new trial mixes are prepared and tested by the contractor.

b) Quality

i. The sand particles of finished sand shall be hard, dense, durable, unquoted inorganic rock fragments fire resistant and all sand shall be washed free from injurious amounts of clay lumps, soft or flaky particles, shale, alkali, organic matter, loam, mica and other deleterious substances. The maximum percentage of individual deleterious substances in the sand shall not exceed the following values:

Description	Percent by weight
Material Passing No. 200 screen (ASTM Designation: C117)	3
Lightweight material(ASTM Designation: C142)	2
Clay lumps(ASTM Designation: C143)	1
Total of other deleterious substances (i.e. Alkali, Mica Coated Grains, Soft Flaky Particles & Loam)	2

ii. The sum of the percentages of all deleterious substances shall not exceed five percent, by weight. Sand producing a colour darker than the standard in the colorimetric test for organic impurities (ASTM Designation: C-40) may be rejected. When required by the Engineer-in-Charge, the sand shall be subjected to a soundness test and may be rejected if the portion retained on a No. 50 screen when subjected to five cycles of the sodium-sulphate test for soundness (ASTM Designation C-88) shows a weighted average loss of more than 8% by weight.

c) Grading

The grading of fine aggregate as delivered to the mixers shall conform to the requirements given in Table 5.3(a).

Table 5.2(a)

Grading of Fine Aggregates

Sieve size Standard square mesh	Percentage passing (by weight)
9.50 mm (⅜ inch)	100
4.75 mm (No. 4)	95 to 100
2.36 mm (No. 8)	80 to 100
1.18 mm (No. 16)	50 to 85
600.00 µm (No. 30)	25 to 60
300.00 µm (No. 50)	10 to30
150.00 µm (No.100)	2 to 10
75.00 µm (No.200)	0 to 3

The Fineness Modulus shall range between 2.31 and 2.51.

5.2.1.4 SAND FOR MORTAR

All sand for mortar used in the construction of brick paving, brick lining and brick masonry shall be natural sand and when tested by means of standard screens (ASTM Designation: E11) shall conform to the following limits:

Screen No.	Percentage by weight, passing screen
8	100
100	15 (Maximum)

Within the above range, the sand shall be well-graded and as coarse as practicable for the production of workable mortar.

5.2.1.5 COARSE AGGREGATES (AGGREGATES)

1. General

The term "Aggregates" is used to designate aggregates which are reasonably well graded between 3/16 to 4 inches.

2. Quality

a) The aggregate shall consist of well-shaped, hard, dense, durable unquoted rock fragments and all aggregates shall be free from injurious amounts of deleterious substances adherent coatings and fire resistant. The percentages of individual deleterious substances in any size aggregates shall not exceed the following values:-

Description	Percent, by weight
Material passing No. 200 screen(ASTM Designation: C117)	1
Lightweight material(ASTM Designation: C123)	2
Clay lumps(ASTM Designation: C142)	½
Other deleterious substances	1

b) The sum of the percentages of all deleterious substances in any size shall not exceed three percent, by weight. Aggregates may be rejected if they fail to meet the following test requirements:-

i. Los Angeles abrasion test (ASTM Designation: C131). If the loss exceeds ten percent by weight, at 100 revolutions, or 40 percent by weight at 500 revolutions.

ii. Sodium sulphate test for soundness (ASTM Designation: C88). If the weighted average loss after five cycles is more than ten percent by weight.

iii. Specific gravity (ASTM Designation: C 127). If the specific gravity (saturated surface – dry basis) is less than 2.60.

Natural aggregates shall be thoroughly washed before use. Testing of coarse aggregate is specified under relevant Item of these Specifications.

The aggregate shall be non-alkali/silica reactive where the concrete is to be poured under water or exposed to humid conditions. In case the Contractor proposes to use the aggregate having the alkaline/siliceous characteristics with the intention to use it with Blast Furnace Slag Cement, he will undertake to carry out the job without any extra cost and shall arrange to conduct the necessary tests as directed by the Engineer.

The coarse and fine aggregate shall be combined in the proportions according to the approved trial mixes for each class of concrete.

If the Contractor prefers to use blended crushed stone and natural gravel, the uniformity of proportions of crushed gravel to natural gravel in any size group of coarse aggregate shall be maintained relatively constant and in no event exceed a variation of 5 percent plus or minus in either component of a combination of crushed and natural gravel in any 24 hours period of mixing operation, except No. 4 to 3/4" group, for which a variation larger than plus or minus 5 percent will be permitted. The limit of the larger variation will be determined after the gradation of fine aggregate has been approved and after the first month of operation of the Contractor's aggregates processing arrangements.

3. Grading

The grading of coarse aggregate as delivered to the mixers shall conform to the requirements given in Table 5.3(b).

4. Particle Shape

The particles of coarse aggregate shall be well shaped and the quantity of flat and elongated particles in the separated size groups of coarse aggregate, as defined and determined according to BS 812, shall not exceed 15 per cent by weight in any size group. A flat particle is one having a ratio of width to thickness greater than three. An elongated particle is one having a ratio of length to width greater than three.

5. Soft Particles

The Contractor in procuring processed aggregates shall make whatever provisions are necessary, as regards methods and equipment, to ensure effective elimination of soft particles from all aggregates to the degree that the percentage of soft particles present in the processed coarse aggregate does not exceed 3 per cent by weight when determined in accordance with the applicable requirements of ASTM C 851.

6. Moisture Control

All fine aggregate and smallest size group of the coarse aggregate shall remain in free draining storage at the site for at least 72 hours immediately prior to use. The free moisture content of the fine aggregate and of the smallest size group of coarse aggregate, as delivered to the mixer, shall be controlled so as not to exceed 4.0 and 1.0 respectively, expressed at percent by weight of the saturated surface dry aggregates unless higher limits are allowed. The moisture content of the other size of the coarse aggregates are delivered to the mixers with the least amount of free moisture and the least variation in free moisture practicable under the job conditions in addition to the limits on the maximum amounts of free moisture in aggregate, the moisture content shall be controlled so that for each size the variation in the percent of free moisture will not be more than 0.5 percent during any one hour of mixing plant operation. Under no conditions shall the aggregate be delivered to the mixed plant being dripping wet.

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The Contractor shall carry out such tests as deemed necessary to determine the free moisture content of aggregate.

7. Tests & Approval

All aggregates shall be subject to testing by the Engineer-in-Charge in accordance with the designated test methods to determine whether the aggregates meet the requirements of these Specifications. Aggregates not meeting the requirements of these Specifications as determined by tests or inspection may be rejected.

TABLE 5.2 (b)
Grading Requirements for Coarse Aggregate (ASTM C-33-03)

Sr. No.	Nominal Size (Sieves with Square Openings)	Amounts Finer than Each Laboratory Sieve (Square openings) Weight Percentage												
		4"	3½"	3"	2½"	2"	1½"	1"	¾"	½"	3/8"	No.4	No.8	No.100
1.	3½" to 1½"	100	90 to100	_	25 to 60	_	0 to 15	_	0 to 5	_	_	_	_	_
2.	2½" to 1½"	–	–	100	90 to 100	35 to 70	0 to 15	_	0 to 5	_	_	–	_	–
3.	2" to 1"	_	_	_	100	90 to 100	35 to 70	0 to 15	_	0 to 5	_	_	_	_
4.	2" to No. 4	_	_	_	100	95 to 100	_	35 to 70	_	10 to 30	_	0 to 5	_	_
5.	1½" to ¾"	–	–	_	–	100	90 to 100	20 to 55	0 to 15	_	0 to 5	_	_	–
6.	1½" to ¾"	–	–	_	–	100	95 to 100	_	35 to 70	_	10 to 30	0 to 5	_	–
7.	1" to ½"	_	_	_	_	_	100	90 to 100	20 to 55	0 to 10	0 to 5	_	_	_
8.	1" to ¾"	_	_	_	_	_	100	90 to 100	40 to 85	10 to 40	0 to 15	0 to 5	_	_
9.	1" to No.4	–	–	_	–	_	100	95 to 100	_	25 to 60	_	0 to 10	0 to 5	–
10.	¾" to ⅜"	–	–	_	–	_	_	100	90 to 100	20 to 55	0 to 15	0 to 5	_	–
11.	¾" to No.4	–	–	_	–	_	_	100	90 to 100	_	20 to 55	0 to 10	0 to 5	–
12.	½" to No.4	–	–	_	–	_	_	_	100	90 to 100	40 to 70	0 to 15	0 to 5	–
13	⅜" to No.8	–	–	–	–	–	–	–	–	100	85 to 100	0 to 30	0 to 10	0 to 5

5.2.1.6 WATER

Water for washing aggregates and for mixing and curing concrete shall be fresh, clean and free from injurious amounts of oil, acid, alkali, salt, organic matter, or other deleterious substances as determined by ASTM D-596 and BS-3148 or equivalent.

It shall meet the following chemical requirements:

Chlorides such as sodium chloride	max. 250 ppm
Sulfates such as sodium sulfate	max. 350 ppm
Alkali carbonate or bi-carbonate	max. 500 ppm
Turbidity	max. 2000 ppm

In no case shall the water contain an amount of impurities that will cause a change in the setting time of Portland cement of more than twenty five (25) percent nor a reduction in the compressive strength of mortar at fourteen (14) days of more than five (5) percent when compared to the result obtained with distilled water.

The water for mixing and curing concrete should have a pH value between 7 to 9 and shall not contain impurities which cause discoloration of concrete. Generally the water fit for drinking is fit for concreting.

Water shall be stored in water tight tanks either of masonry or G.I or M.S sheets so as to be protected from contamination with dust and other foreign matter.

5.2.1.7 ADMIXTURES

a) Approval Required

Admixtures, including air-entraining admixtures, foaming chemicals and water-reducing admixtures, shall not be used, except with the prior approval of the Engineer-in-Charge.

Before using admixtures in concreting process, trial mixes shall be made to determine the mix design by laboratory testing.

b) Air-Entraining Admixtures

The source and brand of air-entraining admixtures, if required, shall be proposed by the Contractor and approved by the Engineer-in-Charge. The air-entraining admixture will be an approved substance or compound conforming to the requirements of ASTM C 260, which will produce entrained air in the concrete as hereinafter specified. The air-entraining admixture shall be added to the batch in solution in a portion of the mixing water. This solution shall be matched by means of a mechanical batcher capable of accurate measurement and in such a manner as to ensure uniform distribution of the admixture throughout the batch during the specified mixing period.

c) Water-Reducing Admixtures

The source, brand, types of suitable water reducing cement dispersing admixtures, if required, shall be proposed by the Contractor and approved by the Engineer-in-Charge. The water-reducing admixture will be compatible with the air-entraining admixture specified above and shall be batched and added to the concrete in the manner specified for the adding of air-entraining admixture but separate from the portion of the mixing water containing the air-entraining admixture. The quantities of water-reducing, cement dispersing admixture to be used shall be in accordance with the instructions of the manufacturers and mix design as approved by the Engineer-in-Charge. Water reducing admixture shall conform to the requirements of ASTM C-494.

d) Foaming Chemicals

The source, brand and types of suitable foaming chemicals, if required, shall be as approved by the Engineer-in-Charge. The foaming agent shall conform to ASTMC-869.

e) Anti freezing Compounds

i. Uses

Anti freezing compound may be used in freezing weather to avoid making ice in mixture of concrete. The shuttering must be cleaned properly, so that ice formation within shuttering is avoided.

ii. Mixing the Anti freeze Agent

Anti freezing liquid or solid (Powder) form, may be used as under

a) Liquid form may be used by mixing in water.

b) Powder form may be used by mixing in the dry mixed aggregate.

iii. Other Parameters and Precautions

a) No ice or water allowed in shuttering or on steel reinforcement. Preferably heat than to at least 0degree centigrade temperature.

b) Concrete temperature after pouring should not fall below 5 degree centigrade.

c) Anti freezing in powder form must be stored in dry environment.

d) Avoid to get in touch with skin and especially on face or eyes.

e) Must be used within 12 months of manufacturer.

iv. Dozes

As recommended by manufacturers or around one (1.0) percent by weight of cement.

5.2.1.8 WATERSTOPS

a) PVC Water-stops

PVC (polyvinylchloride) water-stops shall comply with USACECRD C 572-74 standard and shall be extruded from an elastomeric plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain such additional resins, plasticizers, stabilizers or other materials needed to ensure that when the material is compounded and extruded to the shapes and dimensions shown and tested it shall have the physical characteristics as shown in Table 5.3(c).

Table 5.2 (c)
Physical Characteristics of PVC Water stop

Physical Characteristics	Test Method	Typical Values
Ultimate Elongation	ASTM D 638 (CRD C 573)	350 % min
Tensile Strength	ASTM D 638 (CRD C 573)	1750 psi (12.07 Mpa) min
Low Temperature Brittleness	ASTM D 746 (CRD C 570)	No Failure @ - 35 F (-37 C)
Stiffness in Flexure	ASTM D 747 (CRD C 571)	400 psi (2.76Mpa) min
Specific gravity	ASTM D 792	1.37 max
Hardness, Shore A	ASTM D 2240	70 - 80

Sample of Water Stop shall be approved by the Engineer prior to installation at site.

b) Metal Water-stops

COPPER:

Copper water-stops shall conform to the requirements of ASTM B-370 and shall have the weight as shown in the Drawings.

STAINLESS STEEL:

Stainless steel water and grout stops shall conform to the requirement of ASTM A-167, Type 302 or 304.

STEEL:

Sheet steel for steel water-stops shall conform to the requirements of ASTM A-1008 or ASTM A-569 where no welding is required and to ASTM A-4256 where welding is required.

ALUMINIUM:

Aluminium sheet for water-stops shall conform to the requirements of ASTM B-209.

COPPER:

Copper sheet water-stops shall conform to the requirements of ASTM B-152-97(a).

5.2.1.9 JOINT SEALING COMPOUND

Sealing compound shall be either of the cold application type conforming to ASTM D-1850 or of the single or multiple component type or of the hot poured type conforming to the requirements of ASTM D-6690 or their equivalents.

5.2.1.10 EXPANSION JOINT FILLER

Expansion Joint filler material shall be pre-moulded asphalt impregnated fibre board, to be applied over the full joint-width, except as otherwise indicated on the Drawings, and shall conform to ASTM D-1751 where non-extruding and resilient bituminous type is indicated but where non-extruding and resilient non-bituminous is required the expansion joint filler shall consist of sponge rubber, self-expanding cork or any other material and type as directed by the Engineer-in-Charge, meeting the requirements of ASTM D-1752.

5.2.1.11 NON-SHRINK GROUT

Non-shrink grout of a thickness less than 25mm shall consist of onepart cement, one part clean sharp sand and 1:22000 to 1:15000 part of grained aluminium powder containing non-polishing agent. Non-shrink grout 25mm or more in thickness shall be proportioned as above except that 1.5 parts of 9mm to 6mm (pea-size) gravel shall be added to the mix. The above composition may be varied if so required by the Engineer-in-Charge. In each case, however, the Contractor shall, at his own cost, prepare optimum mix design and conduct testing of the grout composition for strength and non-shrink performance. Pre-mix non-shrink grout from approved manufacturers may also be used.

5.2.2 CLASSES/TYPES& MIXING OF CONCRETE

5.2.2.1 CLASSES OF CONCRETE

Classes of concrete in this specification shall be designated A, B, C, D1, D2, D3 and lean concrete. The class of concrete to be used shall be as per drawings and BOQ or as directed by the Engineer-in-charge. Following requirements shall govern unless otherwise shown on drawings.

Class A_1	Normal plain or reinforced structural concrete including shuttering/scaffolding etc.
Class A_2	Underwater concrete or similar; slump max. 10cms
Class A_3	For piling work, with 10 to 15cm slump
Class B	Mass concrete where directed
Class C	For cribbing, Retaining/Brest walls etc.
Class D_{1-3}	For reinforced of pre stressed/post tension concrete elements with strength of 350,425and 500 kg/sq.cm
Lean concrete	underneath foundation or Floors, Paves etc.

TABLE 5.2 (d)
Portland cement Concrete Requirements

Class of Concrete	Cement Kg/Cubic Meter	Max. Size of Coarse Aggregate (mm)	28 days Cylinder Compressive Strength (Min) (Kg/Sq. cm.) psi	Consistency (Range in Slump) Vibrated (mm)	Maximum Permissible Water – Cement Ratio
A_1	300	20	(210) 3000	25-75	0.58
A_2	350	25	(245) 3500	100-150	0.58
A_3	400	38	(280) 4000	100-150	0.58
B	250	51	(175) 2500	25-75	0.65
C	275	38	(210) 3000	25-75	0.58
D_1	450	25	(350) 5000	50-100	0.40
D_2	500	25	(420) 6000	50-100	0.40
D_3	550	25	(490) 7000	50-100	0.40
Lean Concrete	175	51	(105) 1500	–	–

5.2.2.2 TYPES OF CONCRETE

a. Under Ground

Concrete poured below natural surface level with or without shuttering and shoring e.g. Piles, Pile caps etc.

b. On Ground

Concrete poured by erecting formwork with necessary bracings on ground e.g. Piers, Columns, Slabs on grade, NJ Barriers, Retaining walls ($H \leq 3.0$m) etc.

c. Elevated

Concrete poured by erecting props, Bracing and towers to support the formwork at higher levels e.g. Deck slabs, Retaining wall ($H \geq 3.0$m), Transoms and Diaphragms etc.

5.2.2.3 MIXING

The mode of mixing (i.e. manual mixing or machine mixing) shall be as specified and determined by the Engineer-in-Charge keeping in view the size of work. Manual mixing shall be avoided and only machine mixing will be preferred. However, following broad principal are to be adopted.

5.2.2.4 MANUAL MIXING

Manually mixed concrete shall not be used for preparation of structural concrete (reinforced concrete and concrete for which strength requirement is specified); however, it may be allowed to be mixed in manual mixers approved by the Engineer in-Charge for very small quantity or in case of emergency.

Manual mixers or hand mixing techniques may be employed for non-structural concrete (non-reinforced concrete and concrete for which no strength requirement is specified). Hand mixing of non-structural concrete shall proceed on the following lines:

a. Manual mixing

Lean concrete, concrete in foundation of less than 5CM at places, where transportation of mechanical mixer is not practicable, non-structural concrete like under floor

b. Single bag mixer

For single storey building with covered area of not more than 2000sq.ft, other concrete structures of overall volumes less than 10CM

c. One Cubic yard mixer including other required equipment for pouring

Up to three storey building with frame structures, other concrete structures of overall volumes less than 70CM

d. Concrete batching plant (30CM/Hrs) including other required equipment for transport and pouring

All types of construction and buildings up to 15 storeys high.

e. Concrete batching plant (50CM/Hrs) with all required equipment for transport and pouring

All types of construction and buildings with no limits.

Batching will be allowed by weight for all materials for concrete batching plants, where as volumetric measurement may be allowed for manual or mixer machines. However, concrete mix design shall only be carried out to determine the mix for a specific strength of concrete.

5.2.2.5 MACHINE MIXING

a) Type and Capacity

All concrete shall be produced in a batching and mixing plant or by means of a mechanical mixer (min. 1 bag capacity).

The capacity of the plant shall be such that the proposed arrangement will produce adequate quantity of concrete to meet with all the other requirements of these Specifications and the construction schedule. The batched materials shall be thoroughly combined into a uniform mixture before the addition of water and admixtures. The water shall be added gradually and the mixer operated for specified duration of time so as to obtain a thoroughly mixed concrete of uniform colour and quality.

b) Mixers

The mixers provided by the Contractor shall be capable of combining the materials into a uniform mixture and of discharging without segregation. Mixers shall not be charged in excess of the capacity recommended by the manufacturer and shall not be recharged before completely discharging the previous batches. Over mixing requiring addition of water will not be permitted. The mixers shall be operated at a drum speed designated by the manufacturer. The mixers shall be cleaned frequently and maintained in satisfactory

operating condition, and mixer drums shall be replaced when worn down more than 10 per cent of their length and or thickness.

The concrete shall be mixed only in the quantity required for immediate use. Concrete that has developed an initial set shall be rejected.

Concrete shall be thoroughly mixed in a mixer of an approved size and type that will ensure a uniform distribution of the materials throughout the mass.

All concrete shall be mixed in mechanically operated mixers. Mixing plant and equipment for transporting and placing concrete should be arranged with an ample auxiliary installation to provide a minimum supply of concrete in case of breakdown of machinery or in case the normal supply of concrete should be disrupted. The auxiliary supply of concrete shall be sufficient to complete the casting of a section up to a construction joint.

Equipment having components made of aluminium or magnesium alloys, which would have contacted with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

Concrete mixers shall be equipped with adequate water storage and a device for accurately measuring and automatically controlling the quantity of water used.

Materials shall be measured by weighing, except as otherwise specified or where other methods are specifically authorized by the Engineer. The apparatus provided for weighing the aggregates and cement shall ensure accurate measurement of each ingredient.

The accuracy of all weighing devices except that for water shall be such that successive quantities can be measured to within one (1) percent of the desired value. Cement in standard packages (bags) approved by the Engineer need not be weighed.

The water measuring device shall be accurate to plus or minus half percent± 0.50%. All measuring devices shall be subject to the approval of the Engineer. Scales and measuring devices shall be tested at the expense of the Contractor as frequently as the Engineer may deem necessary to ensure their accuracy.

Weighing equipment shall be isolated so that vibration or movement of other operating equipment do not affect the accuracy of reading. When the entire plant is running, the scale reading at cut-off shall not vary from the weight designated by the Engineer more than one (1) percent for cement, one and half (1-1/2) percent for any size of aggregate, or one (1) percent for the total aggregates in any batch.

Where volumetric measurements are authorized by the Engineer, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowances shall be made for variations in the moisture condition of the aggregates, including the bulking effect in the fine aggregates. Boxes or similar containers of the exact volume required shall be filled and struck off. Measurement by wheelbarrow volumes will not be permitted.

When bulk cement is used and volume of the batch is one cubic meter or more, the scale and weigh hopper for Portland cement shall be separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of bulk cement weigh hopper shall be interlocked against opening before the full amount of cement is in the hopper. The discharging mechanism shall also be interlocked against opening when the amount of cement in the hopper is underweight by more than one percent or overweight by more than three (3) percent of the amount specified.

When the aggregates contain more water than the quantity necessary to produce a saturated surface-dry condition, representative samples shall be taken and the moisture content determined for each kind of aggregate.

The temperature of mixed concrete, immediately before placing, shall be not more than thirty two (32) degree C. Aggregates and water shall be cooled as necessary to produce concrete within this temperatures limit. If ice is used to cool the concrete, discharge of the mixer will not be permitted until all ice is melted.

The batch shall be so charged into the mixer that some water will enter in advance of cement and aggregates. All water shall be in the drum by the end of the first quarter of the specified mixing time.

Cement shall be batched and charged into the mixer by means that will not result in loss due to the effect of wind, or in accumulation of cement on surfaces of conveyors or hoppers, or in other conditions, which reduce or vary the required quantity of cement in the concrete mixture.

The entire contents of a batch mixer shall be removed from the drum before materials for a succeeding batch are placed therein. The materials composing a batch except water shall be deposited simultaneously into the mixer.

During the period of mixing, the mixer shall operate at the speed for which it has been designed.

Mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanism shall be so interlocked that during normal operation no part of the batch will be discharged until the specified mixing time has elapsed. In case of failure of the timing device, the Contractor will be permitted to operate while it is being repaired, provided he furnishes an approved timepiece equipped with minute and second hands. If the timing device is not repaired within twenty four (24) hours, further use of the mixer will be prohibited until repairs are made.

The first batch of concrete material placed in the mixer shall contain cement, sand, and water in excess to the requirement of mix, to ensure that the drum does not extract mortar from the mix changing its design characteristics. When mixing is to stop for a period of one hour or more, the mixer shall be thoroughly cleaned.

c) <u>Water Batcher</u>

A suitable water measuring device shall be provided by the Contractor which shall be capable of measuring water within the specified requirements for each batch. The mechanism for delivering water to the mixer shall be such that no leakage will occur when the valves are closed.

d) Locations

The concrete plant/mixer shall be installed at the Site at locations selected by the Contractor and approved by the Engineer-in-Charge.

c) Arrangement

(i) Separate bins and compartments shall be provided for each size or type of aggregate and Portland cement. The compartments shall be of adequate size and so constructed that the materials will be maintained separated under all conditions. Batching equipment/arrangement shall be capable of delivering concrete within the following limits of accuracy as shown in Table 5.3(e).

Table 5.2 (e)

Tolerances for Weights of Concrete Batching Ingredients

Material	Percent by weight
Cement	±1%
Water	±1%
Admixture	±3%
Aggregate smaller than 19 mm (3/4 inches)	±2%
Aggregate larger than 19 mm (3/4 inches)	±3%

ii) For volume batching suitable measuring boxes shall be used. The batching should preferably be for one full bag of cement (50Kgs.) corresponding to a volume of 1¼ Cu.ft. (0.035 Cu.M.) Or such other amount as may be determined by the Engineer-in-Charge as a result of tests of bulking effect of aggregates being be take into consideration.

d) Cooling

Adequate cooling facilities shall be provided to ensure that the temperature of concrete when discharged from the mixers is sufficiently low to meet the temperature requirements as specified in sub-section 5.3.4(c). Cool mixing water, ice, pre-cooled aggregate, shading the stockpiles with roofing or any other arrangements may be used to ensure the pre-cooling of the concrete, subject to the written approval of the Engineer-in-Charge, but approval shall not in any way relieve the Contractor of his responsibility of placing concrete at temperatures at or below the specified limits. The Engineer-in-Charge if required shall order the following to meet the temperature requirements.

1. Avoiding the placement of concrete during the hottest part of day.

2. Placement only at night.

e) Scales

Adequate weight and volume batching facilities, as approved by the Engineer-in-Charge, shall be provided by the Contractor for the accurate measurement and. control of each of the materials entering each batch of concrete. The accuracy of the weighing equipment shall conform to the requirements of applicable standards. The weighing equipment shall be arranged so that the concrete plant operator and Engineer-in-Charge can observe the dials or indicators. Volumetric measurements, if approved by the Engineer-in-Charge, shall be made by means of accurate measuring boxes.

f) Mixing Time

The mixing periods specified in Table 5.3(f) are based on proper control of the speed of rotation of the mixer in accordance with Plant Manufacturer's recommendation and of the proper introduction of the materials into the mixer. The mixing time will be increased when such increase is necessary to secure the required uniformity, workability and consistency of the concrete. The mixing time for each batch after solid materials are in the mixer drum, provided that all the mixing water is introduced before one fourth of the mixing time has elapsed, shall be as follows:

Table 5.2 (f)

Mixing Periods for Concrete

Capacity	Mixer Mixing Time (Minutes)
Up to 1.5 cubic metres (2 cu.yds)	2.0
from 1.5 to 2.5 cubic metres (2.0 to 3.25 cu.yds)	2.5

The time for higher capacity mixing shall be according to plant manufacture's recommendation.

g) Testing Facility

The Contractor shall provide a set of standard sieves and other relevant control testing equipment and a working space for the inspector and a space suitable for use in the plastic testing of concrete and moulding of concrete tests specimens. The Contractor may at his discretion install a concrete compression test machine at site. In this case certain percentage of cylinders to be fixed from time to time shall be got tested from an approved laboratory for counter check at the Contractor's expenses.

h) Trial Batches for Mix Proportions

The placing of concrete shall not begin until trial batches of the mix design to be used have been produced by the Contractor and tested and approved by the Engineer. The trial mix proportions shall be such that the average strength of five (5) consecutive test cylinders shall be 20% higher than the specified twenty eight (28) days strength and no individual test cylinder shall be below the specified strength.

When concrete compressive strength is specified as a prerequisite to applying loads or stresses to a concrete structure or member, test cylinders will be cured under conditions similar to those at the casting site. The compressive strength of concrete determined for such purposes will be evaluated on the basis of individual tests.

5.2.3 CONVEYING

Concrete shall be conveyed from mixer to the place of final deposit as rapidly as practicable, by methods which will prevent segregation or loss of ingredients and in accordance with ACI-304. Any wet batch hopper through which the concrete passes shall be conical in shape. There shall be no vertical drop greater than 6 feet (1.8 meters) except where the use of such equipment is approved in writing by the Engineer-in-Charge, in advance of any use. Each type or class of concrete shall be visually identified by placing a coloured tag or marker on the bucket as it leaves the mixing plant so that the concrete may be positively identified and placed in the structure forms in the desired position.

5.2.4 PLACING

(a) General

Concrete placing shall follow the Recommended Practice for Measuring, Mixing, Transporting and placing Concrete, ACI 304. No concrete is to be placed until all the preparatory works have been satisfactorily completed and the reinforcement and embedded items have been checked and approved by the Engineer-in-Charge. No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms and preparation of surfaces involved in the placing and the method of placement have been approved by the Engineer-in-Charge. Approval of the method of placement proposed will not relieve the Contractor of his responsibility for its adequacy and Contractor shall remain solely responsible for the satisfactory construction of all work under the Contract. Before concrete is placed, all surface upon or against which concrete is to be placed shall be free from standing water, mud, debris or loose material. All surfaces of forms and embedded material that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that the moisture will not be drawn from the freshly placed concrete.

Concrete shall be worked into the corners and angles of the forms and around all reinforcement and embedded items without permitting the material to segregate. Concrete shall be deposited as close as possible to its final position in the forms. The depositing of concrete shall be regulated so that the concrete may be effectively compacted with a minimum of lateral movement into horizontal layers generally 6 inches to 12 inches for reinforced concrete and 15 inches to 18 inches for mass concrete or as approved by the Engineer-in-Charge. No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the structure, nor shall re-tampered concrete be used unless approved by the Engineer-in-Charge.

The surfaces of construction joints shall be kept continuously wet for at least eighteen hours during the twenty-four hour period prior to placing concrete except as otherwise directed by the Engineer-in-Charge. All free water shall be removed and the construction joint shall be completely surface dry prior to placement of concrete. All concrete placing equipment and methods shall be subject to approval of the Engineer-in-Charge. Concrete placement will not be permitted, if in the opinion of the Engineer-in-Charge, weather conditions prevent proper placement and consolidation. It is advisable during wet weather to maintain a large slope on any large area of fresh concrete, sufficient to result in drainage of water.

b) Time Interval Between Mixing and Placing

Concrete mixed in stationary mixers and transported by non-agitating equipment shall be placed within thirty minutes after it has been mixed, unless otherwise authorized. When a truck mixer or an agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within 1.5 hours after introduction of the cement to the aggregates. The concrete shall be placed within 30 minutes after it has been discharged. In all cases, concrete shall be placed and compacted well within the initial setting time.

Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured and charged into the drum at the proportioning plant. The truck mixer shall be equipped with a device by which the quantity of water added can be readily verified. The mixing water may be added directly to the batch, in case the concrete batch is poured within twenty five (25) minutes of adding water.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer, and stamped in metal on the mixer. Truck mixing shall be continued for not less than fifty (50) revolutions after all ingredients, including water, are in the drum. The mixing speed shall not be less than six (6) rpm, nor more than ten (10) rpm.

Mixing shall begin within thirty (30) minutes after the cement has been added either to the water or aggregate, but when cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above thirty two (32) degree C, this limit shall be reduced to fifteen (15) minutes. The limitation in time between the introduction of the cement to the aggregate and the beginning of the mixing may be waived when, in the judgment of the Engineer, the aggregate is sufficiently free from moisture, so that there will be no harmful effects on the cement.

c) Placing Temperature

Placing temperature unless otherwise approved by the Engineer-in-Charge shall conform to the requirements herein specified for thin, moderate and mass sections. The Engineer-in-Charge's determination as to the type of section and applicable placing temperatures shall govern. Concrete shall be placed at ambient temperatures as follows:

	Thick Sec.	Thin Sec.
Max. Temperature	32°C	38°C
Min. Temperature	05°C	05°C

THIN SECTIONS:

Concrete for thin sections shall be delivered to the forms at the coolest temperature which is practicable to produce under current conditions but in no case at a temperature in excess of 32°C. Except as otherwise determined by the Engineer-in-Charge, sections to which this provision shall apply shall be less than 20 inches (50 cm) in thickness.

MODERATE SECTIONS:

Concrete for moderate sections shall have a temperature of not more than 26°C when placed. A moderate section will be one that is greater than 20 inches (50cm) but less than 36 inches (0.9 m) in thickness.

MASS CONCRETE SECTIONS:

Concrete having a measure of 36 inches (0.9 m) or more in thickness shall have a temperature not exceeding 21°C.Concrete having cement content of more than 400 Kg/m^3or where Type-III cement or accelerator is used may also need to be treated as Mass Concrete. Special measure shall be taken as per instructions of the Engineer to limit temperature gradient in concrete, within allowable range.

d) <u>Concreting in Hot Weather</u>

Hot weather is any one of following conditions that tend to impair the quality of concrete by accelerating the rate of moisture loss and rate of hydration:

a. High ambient temperature (> 38°C)

b. High concrete temperature (> 32°C)

c. Low relative humidity (< 50%)

d. High wind velocity (> 4.5m/s)

e. Direct solar radiation

Concreting shall be avoided in extremely hot weather and shall be done only in better part of the day. It should be particularly avoided in dry hot and windy weather. If wind velocity rises above 4.5 m/s, windshields shall be used. For concreting in such weather ACI 305 shall be complied and as specified, aggregate shall be carefully stored under shelter and shall be sprinkled with cold water from time to time to check high temperature. Water to be used for concreting shall be carefully stored, and if necessary, crushed ice shall be added to bring the temperature of concrete within the specified limits for thin or thick sections.

All the ice must melt prior to ending of mixing operation. Excess of water shall not be added and the approved water cement ratio shall be maintained. Use of retarders or other admixtures & additives to improve consistency shall be subject to approval of the Engineer. Curing shall be carefully watched & no part of concrete shall be exposed to direct atmosphere. After pouring, concrete shall be protected from direct sunlight. All arrangements for hot weather concreting shall be made well in advance of commencement or work and no extra cost shall be paid to the Contractor for the same.

e) Concreting in Cold Weather

Cold Weather is defined as the period when for more than 3 consecutive days, the following conditions exist:

1. The average daily air temperature is less than 40 ^{0}F (5 ^{0}C)

2. Air temperature is not greater than 50 ^{0}F (10 ^{0}C) for more than one half of any 24-hr period.

If concreting is necessary to be continued in cold weather for the progress & safety of structure as determined by the Engineer, take all the additional measures as instructed by the Engineer. Cold weather concreting shall comply with ACI 306. All the additional expenses to meet the requirements of cold weather concreting shall be deemed to be included in the rates quoted by the contractor in the BOQ.

f) Preparation before concreting

Remove all snow, ice, and frost from the surfaces, including reinforcement, against which the concrete is to be placed. Concrete shall not be placed against frozen sub-grade / soil. Before beginning concrete placement, thaw the sub-grade to the depth specified by the Engineer. If necessary, the thawed material should be re-compacted.

Do not place concrete around massive embedments unless such embedments are at a temperature above freezing. Formwork / Shuttering should be free from frost and ice prior to placement of concrete.

Aggregates to be used in concreting shall be thawed by approved method so that they become free from frost, ice and frozen lumps prior to starting concreting The mixing water and/or aggregates shall be heated to not less than average 70 ^{o}F (21 ^{o}C) nor more than average 150 ^{o}F (65 ^{o}C), prior to being placed in the mixer, by an approved type of heating device so that the temperature of the concrete shall not be less than as mentioned in Table 5.3 (g), at the time of placing. Overheating of aggregates should be avoided so that spot temperatures do not exceed 212 ^{o}F (100 ^{o}C). If admixtures are used for accelerated curing, they shall be approved by the Engineer prior to use at site.

Following Water Cement Ratios shall not be exceeded for concreting in cold weather:

Sections having minimum dimension less than or equal to 12 in
0.45

Sections having minimum dimension more than 12in
0.50

g) Concrete temperature

Placement temperature - The minimum temperature of concrete immediately after placement shall be as specified in Column 2 of Table 5.2(g). The temperature of concrete as placed shall not exceed the values shown in Column 2 of Table 5.2(g) by more than 20°F (11 °C).

Table 5.2 (g) - Concrete temperature

(1)	(2)
Least dimension of section, in.	Minimum temperature of concrete as placed and maintained during the protection period, °F
Less than 12	55 (13 °C)
12 to less than 36	50 (10 °C)
36 to 72	45 (7 °C)
Greater than 72	40 (5 °C)

Protection temperature - Unless otherwise specified, the minimum of concrete during the protection period shall be as shown in Column 2 of Table 5.2(g). Temperatures specified to be maintained during the protection period shall be those measured at the concrete surface, whether the surface is in contact with formwork, insulation, or air. Measure the temperature with a surface temperature measuring device having an accuracy of ±2 °F (±1 °C). Measure the temperature of concrete in each placement at regular time intervals of 12 hours.

h) Curing of concrete

Prevent concrete from drying during the required curing period using approved curing compounds. Water curing may be used if allowed by the Engineer. If water curing is used, terminate use at least 24 hr before any anticipated exposure of the concrete to freezing temperatures.

i) Protection of concrete

Combustion heaters - Vent flue gases from combustion heating units to the outside of the enclosure

Overheating and drying - Place and direct heaters and ducts to avoid areas of overheating or drying of the concrete surface

Maximum air temperature - During the protection period, do not expose the concrete surface to air having a temperature more than 20 °F (11 °C) above the values shown in Column 2 of Table 5.3(g), unless higher values are required by an accepted curing method.

Protection against freezing - Cure and protect concrete against damage from freezing for a minimum period of 3 days, unless otherwise specified. Maintain the surface temperature of the concrete during that period in accordance with Column 2 of Table 5.3(g), unless otherwise specified. The protection period may be reduced to 2 days if use of one or more of the following to alter the concrete mixture is accepted:

- Type III Portland cement meeting the requirements of ASTM C-150

- A strength accelerating admixture meeting the requirements of ASTM C-494

- 100 lb/yd^3 (60 kg / m^3) of additional cement

During periods not defined as cold weather, but when freezing temperatures may occur, protect concrete surfaces against freezing for the first 24 hr after placing.

Following insulating materials may be used to maintain concrete at the required temperature, after approval of the Engineer.

- Polystyrene foam sheets

- Urethane Foam

- Foamed Vinyl blankets

- Mineral Wool or Cellulose Fibber

- Blankets (to be protected from rain/moisture)

- Straw (to be protected from rain/moisture and wind)

Protection for structural safety - If the concrete strength is required for structural safety, extend the duration of the protection period to ensure the necessary strength development. The strength required for formwork removal, for reshoring, or for continued construction shall be as specified in the Contract Documents for each type of structural member. Verify whether the required strength has been attained by using one or more of the following methods:

- ASTM C 31 (use procedures in section titled “Curing for Determining Form Removal Time or When a Structure May be Put into Service”)

- ASTM C 803 (Probe Penetration Method)

- ASTM C 873(Compressive Strength of Concrete Cylinders)

- ASTM C 900 (Pull out Test Method)

A correlation with cylinder strength, using the specific concrete intended for construction, is required for ASTM test methods C 803 and C 900.

Protection deficiency - If the temperature requirements during the specified protection period are not met but the concrete was prevented from freezing, continue protection until twice the deficiency of protection in degree-hours is made up. Deficient degree hours may be determined by multiplying the average deficiency in temperature by the number of hours the temperature was below the values shown in Column 2 of Table 5.3(g).

j) Blinding Concrete

Where concrete is to be placed on a flat excavated surface or on an excavated surface inclined at not more than 1 V: 1.75 H, a 3 inches (75 mm) layer of blinding concrete (1:4:8), if not otherwise shown on the Drawings, shall be placed immediately after completion of excavation and cleaning. The upper surface of the blinding concrete shall not be higher than the required cover below the lowest layer of the reinforcing steel. The final excavated level shall be calculated to allow for the 75 mm thickness of the blinding layer.

k) Lifts in Concrete

Concrete shall be placed in lifts or depths as shown on the Drawings. The placement of concrete shall be carried on at such a rate and in such a manner that formation of cold joints is prevented. Slabs shall be placed in one lift, unless otherwise authorized or directed. In walls, lifts shall terminate at such levels as shall conform to structural details. Where slabs and beams are placed continuously with walls and columns, the concrete in walls and columns shall have been in place for at least two hours, or for a longer period when directed by the Engineer-in-Charge, before placing concrete in the slabs and beams. The top surface of vertically formed lifts shall be generally levelled. The concrete in columns shall be placed in one continuous operation, unless otherwise authorized. In general, the construction joints in beams and slabs shall be located as shown on the Drawings and concrete shall be placed in the sequence indicated on the Drawings or as authorized by the Engineer-in-Charge. The maximum differential in height between the various pours of the structure shall be as shown on the Drawings or as directed by the Engineer-in-Charge.

l) Elapsed Time between Placement of lifts

Except as otherwise approved on the basis of lift drawings submitted by the Contractor, a minimum of 72 hours shall elapse between the placing of successive lifts of walls and thin sections and 120 hours shall elapse between placing lifts of moderate and mass sections. Thin, moderate and mass sections are defined in sub-section 5.3.4(c).

m) Time between Adjacent Pours

The time between adjacent pours shall be defined as the time elapsing from the end of the striking off of one pour to the start of placing the next pour. The minimum time elapsing between adjacent pours shall be five days for thin and moderate sections and fourteen days for mass section.

n) Concrete above and Around Openings

If concrete is placed monolithically around openings having vertical dimensions greater than 0.6 metres, or if concrete in floor slabs or other similar parts of structures is placed monolithically with supporting concrete, the following instructions shall be strictly observed:

- Placing of concrete shall be delayed from one to three hours at the top of openings and at the bottom of bevels under floor slabs, or other similar parts of structure when bevels are specified and at the bottom of such structural members when bevels are not specified; but in no case shall the placing be delayed so long that the vibrating unit will not readily penetrate on its own weight in the concrete placed before the delay. When consolidating concrete is placed after the delay, the vibrating unit shall penetrate and re-vibrate the concrete placed before the delay.

- The last 0.6 metres or more concrete placed immediately before the delay shall be placed with as low a slump as practicable and special care shall be exercised to effect thorough consolidation of the concrete.

- The surface of concrete where delays are made shall be clean and free from loose and foreign material, when concrete placing is started after. The delay.

- Concrete placed over openings and in slabs and other similar part of structures shall be placed with as low a slump as practicable and special care shall be exercised to effect thorough consolidation of the concrete.

o) <u>Concrete for Second Stage and Block-outs</u>

Block-outs for equipment and fittings and for such other work as indicated or directed shall be provided as indicated on the Drawings. After the said equipment and fitting have been installed and adjusted in their final location, the block out recesses shall be filled with concrete. Before installing the components to be embedded in block out concrete and before depositing any block out concrete, the concrete surfaces of the block out shall be cleaned in the manner specified for cleaning construction joints.

Second stage concrete for filling the openings left for the installation of equipment and fittings shall be anchored to the first stage concrete. The size and spacing of the concrete fixing sockets, if any, to be embedded in the first stage concrete shall be subject to the approval of the Engineer-in-Charge. Different components of structures to be built from second stage concrete like partition walls, slabs, beams and other parts of structure indicated on Drawings as second stage shall be connected to the first stage concrete through dowels. Dowels not shown in first stage concrete Drawings shall be placed and fixed in position by drilling holes in concrete as approved by the Engineer-in-Charge.

p) <u>Placing Concrete through Reinforcement</u>

In placing concrete through reinforcement, care shall be taken that no segregation of the coarse aggregate occurs.

In certain cases, like the bottom of beams and slabs, the congestion of steel near the forms may make placing difficult. In such cases, as decided by the Engineer-in-Charge, a layer of mortar of a composition compatible with the required concrete strength shall be first deposited to cover the surface to a depth of 15mm.

q) Vibration of Concrete

Recommended Practice given in ACI 309 shall be followed for concrete consolidation. Concrete shall be compacted with mechanical or electrical vibrating equipment supplemented by hand spading and tamping. In no case shall vibrators be used to transport concrete inside the forms. The vibrating equipment shall be of internal type and shall at all times be adequate in number of units and power of each unit to properly consolidate all the concrete. Form or surface vibrators shall not be used unless specifically approved. The intensity (amplitude) of vibration shall be sufficient (frequency not less than 8,000 impulses per minute in concrete) to produce satisfactory consolidation. The duration of vibrations shall be limited to that necessary to produce satisfactory consolidation. Excessive surface working will not be permitted.

Concrete, during and immediately after placing shall be thoroughly compacted, except lean concrete under footings and concrete deposited under water. Concrete in walls, beams, columns, etc. shall be placed in horizontal layers not more than thirty (30) centimetres thick except as hereinafter provided.

When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding layer has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the layers. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer, which has not taken an initial set.

The compaction shall be done by mechanical vibration. The concrete shall be vibrated internally unless special authorization of other methods is given by the Engineer or is provided herein. Vibrators shall be of a type, design, and frequency approved by the Engineer. The intensity of vibration shall be such as visibly to affect a mass of concrete with a 3 cm slump over a radius of at least half a meter. The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it are placed in the forms. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms and shall be applied at the point of placing and in the area of freshly placed concrete. The vibrators shall be inserted into and withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to compact the concrete thoroughly but shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. Vibration shall not be applied directly to the reinforcement or to sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation and vibrators shall not be used to transport concrete neither in the forms nor in troughs or chutes.

Vibration shall be supplemented by such external vibrator as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the normal vibrators. Formwork shall be strong enough to prevent distortion and tight enough to prevent leakage of grout.

5.2.5 EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS

a) Expansion and Contraction Joints

Expansion and contraction joints shall be provided at the locations indicated and according to the details shown on the Drawings. In no case shall any fixed metal, embedded in concrete, be continuous through an expansion or contraction joint.

Where indicated on the Drawings, expansion joint, filler joint sealing compound, GI, Aluminium & Copper sheets shall be installed using materials of the type and quality indicated.

b) Construction Joints

GENERAL:

Construction joints shall be as few as possible; and shall be made on horizontal & vertical planes only unless otherwise shown on the drawings or approved by the Engineer. As soon as a lift is completed, the top surface of concrete and reinforcing dowels shall be immediately and carefully protected from any condition that may damage the concrete surface and the dowels.

CLEANING:

Horizontal construction joints on lifts with relatively open and accessible surfaces shall be prepared for receiving the next lift by cleaning with either wet sandblasting or by air-water cutting. Approved wet sandblasting equipment shall be provided. If the surface of a lift is congested with reinforcing steel and is relatively inaccessible or if for any other reason it is considered undesirable to disturb the surface of a lift before it has hardened, surface cutting by means of air-water jets will not be permitted and the use of wet sandblasting will be required.

AIR WATER CUTTING:

Air-water cutting of a. construction joint shall be performed when approved by the Engineer-in-Charge. The surface shall be cut with a high-pressure air-water jet to remove all laitance and to expose clean, sound aggregate, but not so as to undercut the edges of the larger particles of the aggregate. The air pressure used in the jet shall be 0.7 MPa plus or minus 10% (100 psi± 10%) and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. The surface shall again be washed with an air-water jet while the concrete is still green, say well within 6 hours of concreting, (depending upon the atmospheric conditions of humidity and temperature) prior to placing the succeeding lift. Where necessary to remove accumulated laitance, coatings, stains, debris and other foreign material, wet sandblasting will be required immediately before placing the next lift to supplement air-water cutting. When approved by the Engineer-in-Charge, a retarder may be applied to the surface of the lift in order to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish technical data and samples of the retarder to be used and shall demonstrate the method to be used in its application.

WET SANDBLASTING:

When employed in the preparation of construction joints, wet sandblasting shall be performed immediately before placing the following lift. The operation shall be continued until all laitance, coating, stains, debris and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose material.

JOINTS:

Vertical construction joints shall be prepared similar to the horizontal construction joints. Where allowed by the Engineer-in-Charge, the inner surface of the formwork may be coated with an approved set-retarder to facilitate the preparation of the vertical construction joint. When concreting against a hardened surface is resumed, well roughen, wet, clean the surface and apply cement sand slurry of same ratio as the mortar used in the concrete. Alternatively, special chemical may be applied which facilitates binding of old and new concrete.

WATER DISPOSAL:

The method used in disposing of water employed in cutting, washing and rinsing of concrete surfaces shall be such that the waste water does not stain, discolour, or effect exposed surfaces of the structure. Methods of disposal shall be subject to approval by the Engineer-in-Charge.

5.2.6 INSTALLATION OF WATER STOPS

a) General

Except as otherwise shown on the Drawings, water-stops shall be installed with an approximately equal width of material embedded in concrete on each side of the joint. Water stops shall be sealed to other cut off systems as shown on the Drawings or as directed by the Engineer-in-Charge. All water-stops shall be installed and carefully positioned so as to form a continuous water tight diaphragm in each joint. All splices shall be neat with the ends of the joined materials in true alignment.

Concrete shall be carefully placed and vibrated around water stops to ensure maximum concrete imperviousness and density, the complete filling of the forms in the vicinity of the water stop and complete contact between the concrete and all surfaces of water stop.

b) Metal Water-stops

Copper, stainless steel, steel and aluminium water-stops shall be installed in joint sat the locations shown on the Drawings. The thickness, shape, dimensions and splicing of metal water-stops shall be as shown on the Drawings or as approved by the Engineer-in-Charge.

c) PVC Water-stops

The expansion joints wherever indicated on drawings shall have centre bulb water stops or its equivalent as indicated on drawings to be cast integrally with the in-situ-concrete of retaining walls, beams, columns, slabs or at any locations marked on the drawings incorporating junction places or as straight lengths with separate intersection pieces to be jointed at Site as per Manufacturer's recommendations and Specifications. Water stops shall be placed in U shaped assembly made by bending #3 bar (Grade 40) placed at 9 inch c/c so that the water stops are installed in them securely and so that they are held securely in their correct position during the placement of concrete. The concrete shall be fully and properly compacted around the water stops to ensure that no voids or porous areas remain. Where reinforcement is present adequate clearance shall be left between water stops and the reinforcement to permit proper compaction of concrete. No holes shall be made through any water stops. Hot or cold vulcanizing for jointing places of water stops at site shall be done with the prior approval in accordance with the Manufacturer's recommendations and specifications.

Splices in the continuity or at the intersections of runs of PVC water stops shall be performed by applying approved adhesive/heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations or as directed. A thermostatically controlled electric source of heat shall be used to make all splices. The correct temperature at which splices should be made will differ with the material used but shall be sufficient to melt but not char the plastic. After splicing, a remoulding iron with ribs and corrugations to match the pattern of the water stop shall be used to reform the ribs at the splice. The continuity of the characteristic components of the cross-section of the waters top design (ribs, tabular centre axis, protrusions, and the like) shall be maintained across the splice. Splices shall not be less than 3 inch length in any case.

5.2.7 CURING

a) General

All concrete including concrete repair work shall be cured by an approved method or combination of methods in accordance with ACI 308. The Contractor shall have all equipment and materials needed for adequate curing and protection of the concrete on hand and ready to use before actual concrete placement begins. Means shall be provided for the protection of concrete from the sun, drying winds and traffic until the specified curing has been completed.

The curing medium shall be applied so as to prevent loss of moisture from the concrete. Concrete shall be protected from heavy rains for 24 hours. All concrete shall be adequately protected from damage. No fire or excessive heat, including the heat resulting from welding, shall be permitted near or in direct contact with the concrete at any time. All galleries, conduits and other formed openings through the concrete shall be closed during the curing period.

If during the specified minimum period of curing, the surface temperature of the concrete falls below 10^{o}C, the period of curing shall be extended to allow the concrete to reach sufficient maturity. The period of extension shall be as approved by the Engineer-in-Charge.

b) Moist Curing

Concrete shall be moist-cured maintaining all surfaces continuously (not periodically) wet for 14 days immediately following the placing or until covered with fresh concrete. Precast elements shall also be water-cured for 14 days. Curing water shall be removed without allowing stagnant pools of water to form on the exposed lift surface. Water for curing shall comply with the applicable requirements of Sub-section 5.3.1.6 - Water. Where forms of tongue-and groove or shiplap sheeting are used and are left in place during curing, the sheathing shall be kept wet at all times. When in contact with concrete, steel forms shall be kept wet. Horizontal construction joints and finished horizontal surfaces cured with sand shall be covered with a minimum uniform thickness of 5 cm of sand and kept continuously saturated with water.

c) Liquid Curing Membrane

Surfaces exposed to the air may be cured by the application of an impervious membrane if approved by the Engineer, and if water / cement ratio of concrete is not less than 0.5.Concrete with w/c ratio less than 0.5 shall be moist cured for a period of at least 3 days before application of curing compound.

An approved curing compound conforming to ASTM C-309 shall be applied in accordance with the manufacturer's recommendations immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond or unless positive measures are taken to remove it completely from such areas.

The compound may preferably contain fugitive bright colour dye to identify the areas not properly sprayed. The use of any membrane-forming compound that will alter the natural colour of the concrete or impart a slippery surface to any wearing surface shall be prohibited. The compound shall be applied with a pressure spray in such a manner as to cover the entire concrete surface with a uniform film, and shall be of such character that it will harden within 30 minutes after application. The amount of compound applied shall be ample to seal the surface of the concrete thoroughly. Power operated spraying equipment shall be equipped with an operational pressure gauge and means of controlling the pressure.

The curing compound shall be applied to the concrete following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay in the application of curing compound, which results in any drying or cracking of the surface, application of water with an atomizing nozzle as specified under "Water Method", shall be started immediately and shall be continued until application of the compound which shall not be applied over any free standing water surface. Should the film of compound be damaged from any cause before the expiration of seven (7) days after the concrete is placed in the case of structures, the damaged portion shall be repaired immediately with additional compound.

Curing compounds shall not hard settle in storage. They shall not be diluted or altered in any manner after manufacture. At the time of use, the compound shall be in a thoroughly mixed condition. If the compound has not been used within one hundred twenty (120) days after the date of manufacture, the Engineer may require additional testing before use to determine compliance to requirements.

An anti-settling agent or combination of anti-settling agents shall be incorporated in the curing compound to prevent caking.

The curing compound shall be packaged in clean barrels or steel containers or shall be supplied from a suitable storage tank located at the job-site. On-site storage tanks shall have a permanent system designed to completely re-disperse any settled material without introducing air or any other foreign substance. Containers shall be well sealed with ring seals and lug type crimp lids. The linings of the containers shall be of a character that will resist the solvent of the curing compound. Each container shall be labelled with the manufacturer's name, specification number, batch number, number of gallons, and date of manufacture, and shall have a label warning concerning flammability.

The label shall also warn that the curing compound shall be well stirred before use. When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall accompany each load. The invoice shall contain the same information as that required herein for container labels.

Curing compound may be sampled by the Engineer at the source of supply and at the job-site.

5.2.8 REPAIR OF CONCRETE

a) General

Concrete that is damaged from any cause; concrete that is honeycombed, fractured, or otherwise defective; and concrete which, because of excessive surface depressions, must be excavated and built up to bring the surface to the prescribed lines; shall be removed and replaced with dry pack mortar, or concrete, as hereinafter specified. The excavation to firm surface shall be carried carefully by hand or by using mechanical means without damaging the firm surface on which material is to be placed. Repair of concrete shall be performed only by skilled workmen and within 24 hours of removal of forms. The Contractor shall keep the Engineer-in-Charge advised as to when repair of concrete will be performed. Unless an inspection is waived in each specific case, repair of concrete shall be performed only in the presence of the Engineer-in-Charge. Repairs shall be made in accordance with the procedures approved by the Engineer-in-Charge or his representative.

b) Material

All materials used in the repair of concrete specified hereunder shall conform to the applicable requirements of the Specifications for Section 5 – Plain & Reinforced Concrete.

c) Protrusions

Where bulges and abrupt irregularities protrude outside the specified limits on formed surfaces not to be concealed permanently, the protrusions shall be reduced by bush-hammering and grinding so that the surface irregularities are within the specified limits in accordance with the provisions of Sub-Section 5.3.9.

d) Depressions

GENERAL:

All fillings for depressions shall be bonded tightly to the surfaces of holes and shall be sound and free from shrinkage cracks and drum my areas after the fillings have been cured and have dried. All fillings in surfaces of structures prominently exposed to public view shall contain sufficient white Portland cement to produce the same colour as that of the adjoining concrete. Repairs shall be made with non-shrink grout, guniting or dry pack filling except where repairs with epoxy concrete and/or epoxy mortar are directed to be made by the Engineer-in-Charge. Concrete, mortar, grouting, guniting or dry pack mortar filling as the case may be shall each be mixed in proportions approved by the Engineer-in-Charge to produce a repair at least equivalent in strength density and durability to the concrete in which the repair is required and shall match with the adjacent surfaces in texture, colour and shade.

CONCRETE FILLING:

Concrete filling shall be used for holes extending entirely through concrete sections; for holes in which no reinforcement is encountered and which are greater in area than 10 square inches (0.1 square metre) and deeper than 4 inches (10 cm); and for holes in reinforced concrete which are greater than 5 square inches (0.05 square metre) in area and which extend beyond the reinforcement.

MORTAR FILLING:

Mortar filling (1 cement and 1 sand), placed under impact by use of a mortar gun, may be used for repairing defects on surfaces, not exposed to public view where the defects are too wide for dry pack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest to the surface.

DRYPACK MORTAR FILLING:

Dry pack mortar contains (by dry volume or weight) one part cement, 2-1/2 parts sand, and enough water to produce a mortar that will just stick together while being moulded into a ball with the hands. The ball should neither slump when placed on a flat surface, nor crumble due to lack of moisture. Dry pack mortar fillings shall be used for filling holes having a depth nearly equal to, or greater than, the least surface dimension; for narrow slots cut for repair of cracks; for grout pipes recesses; and for tie rod fastener recesses as specified. Dry pack mortar shall not be used for filling behind reinforcement or for filling holes that extend completely through a concrete section. If removal of the ends of form ties results in recesses, the recesses shall be filled with dry pack mortar provided that filling of recesses in surfaces upon or against which fill material or concrete is to be

placed will be required only where the recesses are deeper than 25 mm in walls less than 300 mm thick.

SURFACE FINISHES OF REPAIRED AREAS:

The Contractor shall correct all imperfections on the concrete surface as necessary to produce surfaces that conform to the requirements specified for the adjacent area. Fins and encrustations shall be neatly removed from the surfaces.

5.2.9 FINISHES AND FINISHING

a) General

Allowable deviations from plumb or level and from the alignment profile grades and dimensions shall be as shown on the drawings or as specified in Clause 5.3.10 for Concrete Construction, are defined as tolerances and are to be distinguished from irregularities in finishes as described herein. The classes of finish and the requirements for finishing of concrete surfaces shall generally be as specified herein or as indicated on the Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skilled concrete finishers.

The Contractor shall keep the Engineer-in-Charge informed as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer-in-Charge. Concrete surfaces will be tested by the Engineer-in-Charge where necessary to determine whether surface irregularities are within the limits hereinafter specified. Surface irregularities are classified as abrupt or gradual. Offsets caused by displaced or misplaced form sheathing or lining or form sections or otherwise defective form lumber will be considered as abrupt irregularities, and wilt be tested by direct measurements. All other irregularities will be considered as gradual irregularities and will be tested by the use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 5 ft. (1.5 metres).

The classes of finish for concrete surfaces shall be as shown on the Drawings or as directed by the Engineer-in-Charge. No grinding will be required on formed surfaces other than that necessary for repair of surface imperfections as specified herein.

b) Ordinary Finish (OF)

Ordinary finish (OF) applies to surfaces upon or against which fill material or concrete is to be placed. If unformed, the finishing operation shall consist of sufficient levelling and screening to produce even uniform surfaces. When formed, the surfaces require no treatment after form removal except for repair of defective concrete and filling of holes left by the removal of fasteners from the end of the tie rods as required under Sub-section 5.3.8 -Repair of Concrete. Correction of surface irregularities shall be required for depressions only and only for those which exceed 25 mm when measured as described in Sub-section 5.3.9(a) above.

c) Rough Concrete Finish (RC)

Rough concrete finish (RC) applies to surfaces which are intended to receive tiles, metallic lining or other applications as indicted on the Drawings. After consolidation and levelling of the concrete to the specified tolerances, the surface shall be roughened with stiff brushes or rakes before final set. Where rough concrete finish is specified for wall surfaces, the same shall be obtained by use of formwork suitable to produce the required finish. Surface irregularities measured as described in Sub-section 5.3.9(a) General, shall not exceed 6mm for floors and 3mm for walls.

d) Ordinary Slab Finish (OS)

Ordinary slab finish (OS) applies to floor surfaces which are not intended to receive any floor coverings. After the concrete has been placed, consolidated, struck-off and levelled, and its surface has stiffened sufficiently, floating shall be performed by use of hand or power driven equipment, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Floating shall be continued until a small amount of mortar without excess water is brought to the surface so as to permit effective trowelling. Steel trowelling shall be started when the surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface. Steel trowelling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense uniform surface, free from blemishes and trowel marks. Surface irregularities measured as described in Sub-section 5.3.9(a) General, shall not exceed 6mm for abrupt irregularities and 12mm for gradual irregularities and 12mm for gradual irregularities.

e) Fair Faced Finish (FF)

Fair Finish (FF) shall be applied to all exposed surfaces of walls and ceilings which are not to be covered by any other finish. Surface irregularities shall not exceed 3mm for abrupt irregularities and 6mm for gradual irregularities, when measured as described in Sub-section 5.3.9(a). All abrupt irregularities and all gradual irregularities in excess of 6mm shall be reduced by grinding to conform to the specified limit for gradual irregularities.

5.2.10 TOLERANCES IN CONCRETE CONSTRUCTION

Permissible surface irregularities for the various classes of concrete surface finish as specified in Clause 5.3.9 "Finishes and Finishing", are defined as finishes, and are to be distinguished from tolerances as described herein. Unless otherwise specified, concrete shall be placed within the tolerances as specified in ACI 117 “Specifications for Tolerance for Concrete Construction and Materials”. In general, the permissible construction tolerances for reinforced concrete shall conform to the requirements of the following section, as applicable.

Notations on the drawings, if indicated, of specific maximum or minimum tolerances in connection with any dimension shall be considered as supplemental to the tolerances specified herein and shall control. The Contractor shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limit so as to ensure that the completed work will be within the tolerances specified herein. Concrete work that exceeds the tolerance limits specified herein shall be remedied or removed and replaced by, and at the expense of the Contractor.

1. Variation from Plumb:

A. In the lines and surfaces of columns, piers, walls, and in arises:

In any 10 feet of length 3/8 in

For heights 100ft or less 1 in

For heights greater than 100ft 1/1000 x height (but not more than 6 in)

B. For exposed corner columns, control-joint grooves, and other conspicuous lines:

In any 10 feet 1/4 in

For heights 100ft or less 1/2 in

For heights greater than 100ft 1/2000 x height (but not more than 3 in)

2. Variation from the level or from the grades specified:

A. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores:

In any 10 feet of length 3/8 in

Maximum for the entire length 3/4 in

B. In exposed lintels, sills, parapets horizontal grooves and other conspicuous lines:

In any bay or in 10 feet of Length 1/4 in

Maximum for the entire length 1/2 in

3. Variation of the linear building lines from established position

A In plan and related position of columns, walls and partitions:

In any 10 feet length 3/8 in

Maximum for the entire length 1 in

B In slabs and locations of openings and sleeves:

Maximum for the entire length 1/2 in

Saw cuts, joints etc. in slabs 3/4 in

4. Variation in the sizes of sleeves, floor openings, and wall openings + 1/4".

5. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls:

12 in dimension or less

Minus 1/4 in

Plus 3/8 in

Over 12 in to 3ft

Minus 3/8 in

Plus 1/2 in

Over 3ft

Minus 3/4 in

Plus 1 in

6. Footings:

A. Variations in dimensions in plan:

Minus 1/2 in

Plus 1/2 in

B. Misplacement of eccentricity:

2 Percent of the footing width in the direction of misplacement but not more than 2"

C. Thickness:

Decrease in specified thickness = 5 percent (%)

D. Relative Alignment:

Variation in footing top and side surfaces – in any 10 ft 1 in

7. Variation in steps:

A. In a flight of stairs:

Riser 1/8"

Tread 1/4"

B. In consecutive steps:

Riser 1/16"

Tread 1/8"

8. Grooves

Specified width less than 2 in 1/8 in

Width 2 in to 12 in 1/4 in

5.3 CONCRETE FORM WORK

5.3.1 GENERAL

The work shall include design, erecting, supporting, bracing and maintaining form work so that it will safely and rigidly support all vertical and lateral loads encountered during construction. The extent of formwork is indicated by the concrete work shown on the Drawings.

Unless otherwise specified, no separate measurement or payment shall be made for “Providing Erection and Removal of Formwork” as specified herein, as all cost thereof shall be considered to be included in the Contract unit prices for the various concrete items requiring formwork.

5.3.2 RELATED WORK

Section 5.3 - Plain and Reinforced Concrete

Section 5.4 - Concrete Reinforcement

5.3.3 SUBMITTALS

The Contractor shall submit the following to the Engineer-in-Charge for his information/review:

a) Manufacturer's Data

Two copies of manufacturer's data and installation instructions for proprietary materials including form coatings, manufactured form systems, ties and accessories.

b) Shop Drawings

Shop Drawings for fabrication and erection of architectural finished concrete surfaces as shown on the Drawings or specified.

General construction for forms including jointing of special formed joints or reveals, location and pattern of form tie placement and other items which affect the exposed concrete visually shall be shown on these Shop Drawings. However, the Engineer-in-Charge's review will be for general architectural and engineering applications and features only. Design of formwork for structural stability and sufficiency is the Contractor's responsibility.

5.3.4 FORM MATERIALS

a) Form liners for Plain Concrete Finish

TIMBER/PLYWOOD:

New Plywood 19 mm or timber planks 25 mm thick with continuous support for edges parallel to framing shall be provided. Timber form shall be will seasoned and free of loose knots.

OTHER MATERIALS:

Approved type forms made of steel, plastic, or other suitable materials may be used in lieu of timber planks/plywood, provided the

formed surfaces obtained conform to the requirements of finishes specified for the concrete surfaces.

RE-USE OF WOOD FORMS:

Projecting nails shall be withdrawn, concrete cleaned off, re-oiling done and Engineer-in-Charge's approval obtained before re-using the wood forms.

The steel formwork surface in contact with concrete shall be free of rust.

b) Form Ties

Form ties shall be snap ties. Sample for Engineer's approval shall be submitted before ordering. Spacing of ties and the rate of placement of concrete shall be consistent with the strength of ties.TheContractor must obtain approval prior to use of any special ties for metal forms.

c) Form Coatings

Commercial formulation form-coating compounds shall be provided that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond, painting or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

5.3.5 INSTALLATION

a) General

Forms shall be so constructed that the tolerances specified in ACI 347.203.1 are met. Openings, offsets, chamfers, blocking and other features as required on the work shall be provided. Easy removal of forms without damage to concrete surfaces shall be provided for. Formwork shall be kept clear of wood chips, clogs, and other deleterious material. All concrete surfaces shall be formed. Earth cuts shall not be used as forms for vertical surfaces of concrete work unless approved by the Engineer-in-Charge.

b) Forms

The formwork shall conform to the shape, lines and dimensions as shown on the Drawings and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete, and shall be sufficiently tight to prevent loss of liquid from the concrete. Unless otherwise specified, chamfer strips shall be placed in the corners of forms to produce bevelled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of the formed joints will not require bevelling unless required on the Drawings. Back joints with extra studs or grits shall be provided to maintain true, square intersections. Extra studs, washers and bracing shall be used as required to prevent bowing of forms between studs.

Reusable steel forms of approved design may be used for cast-in-place concrete.

c) Form Ties

Form ties shall be provided at exposed surfaces. Ties shall be set in straight rows and evenly spaced. Prior approval shall be obtained if any special ties for metal forms are to be used.

d) Form Release Agents

Form release agents shall be applied in accordance with manufacturer's instructions with special attention to rate and method of application.

5.3.6 REMOVAL OF FORMS

Forms for various parts of the structure shall not be removed before the specified time has elapsed after placing the concrete. Consideration shall be given to the weather and other conditions influencing the setting of concrete, curing, and materials in the mix. The exact time shall be determined by the Engineer-in-Charge and will be dependent on curing conditions and the prevalent temperature.

In general, the approximate elapsed time before removal of forms shall be as stated below:

Minimum Periods for Formwork Removal

Position of Formwork	Minimum Period for Temp. Over 10 ^{0}C	Minimum Strength to be Attained
Vertical or near Vertical faces of mass concrete	24 hours	0.2 C
Vertical or near vertical faces of reinforced walls, beams and columns	48 hours	0.3 C
Undersides of arches, beams and slabs (formwork only)	14 days	0.8 C
Supports to underside of arches, beams and slab (up to 15 foot span)	14 days	0.8 C
Supports to underside of arches beams and slabs larger than 15 foot span	21 days	0.9 C

Notes:

1. “C” is the nominal strength for the grade of concrete used.

2. At ambient temperature below 10 ^{o}C or if cements other than Ordinary Portland (Type I) are used the Engineer may instruct longer periods.

3. Personnel and concrete work shall be protected by re-shoring, if required.

5.3.7 COORDINATION

Formwork shall be coordinated with the work of other trades as required for installation of inserts, conduit pipe sleeves, drains, hangers, supports, anchors and similar items. Embedments shall be secured in position before concrete is poured. Sufficient time shall be allowed between erection of forms and placing of the concrete to allow various trades to install their work properly.

5.3.8 RE-USE OF FORMS

The forms that will provide surfaces of same quality as original shall only be reused.

5.4 PRECAST CEMENT CONCRETE

5.4.1 GENERAL

Unless otherwise specified, or directed by the Engineer-in-Charge, precast units shall be prepared as shown on the approved Drawings according to the following specification:

5.4.2 PRECASTING FLOOR

In laying out the work yards the Contractor shall provide a pre-casting floor of 3 to 1 concrete-in-mass at least 155 cms thick to be laid over the entire floor area where pre-casting is to be done. The surface of the floor shall be finished perfectly true and level with a steel trowelled finish. Precautions shall be taken to prevent settlement of the floor. Should settlement take place the floor shall be re-laid or other means adopted to reinstate the level surface before it 'is used again. During the time the floor is in use it shall be kept true, level, clean and dry. Drains shall be provided to drain away the surplus water quickly, and sufficient space shall be provided between the various moulds to allow working room for handling them and cleaning debris between the various moulds to allow working.

5.4.3 MOULDS

Unless otherwise specified, the moulds in which the concrete is precast shall consist of mild steel and shall not be less than 5 mm thick for small items and 6 mm thick for large items, and suitable arrangements shall be made to prevent them from bulging. In all cases suitable precautions shall be taken to maintain the mould vertical, rectangular and with true faces during the time concrete is being filled in and packed. Core pieces of the required shapes to form chamfers, radii, joggle recesses, cavities, tongues, grooves, and other recesses or chassis shall be provided and firmly attached to the inside faces of the moulds. Wooden moulds may be used for small non-repetitive items.

5.4.4 DESIGN OF MOULDS AND LIFTING APPARATUS TO BE APPROVED

The general arrangements of the floor with its mixing machines, methods supplying materials to the machines and transporting concrete from them and the detail designs of the moulds shall be duly approved by the Engineer-in-Charge. Methods of lifting precast concrete shall also be approved by the Engineer-in-Charge.

5.4.5 SETTING UP MOULDS

The floor shall be thoroughly cleaned and dried and cleared of all cement, scum and debris before setting up the moulds. The inside faces of the moulds shall be thoroughly cleaned and, if necessary, scraped. The mould shall be set absolutely square and vertical. Their inside faces and the floor shall be coated with the vegetable oil or other parting agent duly approved so that concrete does not stick to them. The moulds shall be replaced when required, and the various parts shall be checked from time to time to see that no distortion or alteration in size has occurred.

5.4.6 DEPOSITING CONCRETE IN MOULDS

Concrete shall be transported from the mixing machine to the moulds as quickly as possible and shall be deposited and spread in them in layers. Each batch of concrete shall be well worked in and thoroughly packed against the faces of the moulds. On the completion of each block, its top surface shall be well beaten down and struck off true and level by means of long straight edge and finally floated off with supply of concrete shall be continue and the item shall be finished off complete in one operation. All precast concrete shall be kept continuously watered for a period of at least 28 days after casting.

5.4.7 REMOVAL OF MOULDS

When the concrete has set sufficiently, the sides and ends of a mould shall be slackened off and eased away from the face of the green concrete to allow the circulation of air but this shall not be done till twenty-four hours have elapsed since concreting was completed, except when items have hollow faces.

5.4.8 PRECAST CONCRETE NOT SQUARE OR HONEY COMBED.

If the sides or ends of any precast concrete are not true, as a result of the bulging of the mould or faulty setting, all such rounding or inequalities shall be dressed of neatly and accurately by masons so as to produce true and even faces when it is set in position. If honey comb exits in a slight degree only it shall be stopped neatly, carefully with 2 to 1 cement mortar rubbed in with dry sand by mean of a hand float fair with the general face of the block. Precast concrete that is irreparably out of square or badly honey combed shall not be accepted for use in the permanent work.

5.4.9 BROKEN OR DAMAGED PRECAST CONCRETE.

Broken or damaged precast concrete shall not be allowed to be set anywhere in the permanent work unless approved in writing by the Engineer-in-Charge and provided that the Concrete shall be good and sound. If any reducing collar or ordinary collar of Hume pipe is damaged, it shall be replaced or repaired to its original position by the Contractor as per Approved Drawings or as directed by the Engineer-in-Charge.

5.4.10 LIFTING AND DATING PRECAST CONCRETE.

No precast concrete shall be lifted off the floor till at least seven days have elapsed after pre-casting it. Its date of manufacture shall be legibly written on the top directly after it has been floated off and finished.

5.4.11 STACKING PRECAST CONCRETE.

The precast concrete after being cured shall be placed in stacks to mature and air space shall be left around each one of them.

5.4.12 DATE OF USING

No precast concrete shall be set in the permanent work unless four weeks have elapsed since its date of manufacture.

5.4.13 OTHER RESPECT

In all other respect, precast concrete shall conform to Specifications for Plain & Reinforced Concrete.

5.5 FOAM CONCRETE

The structural lightweight concrete shall be of specified grade but for thermal insulation the concrete shall be low strength foam concrete and density as specified. Cement sand mortar in 1:2 ratio and admixture of foaming chemicals as approved by the Engineer-in-Charge shall be used. The amount of different ingredients needed to develop a certain density shall be according to the recommendations of the manufacturer for foaming agent and shall be determined by trial mixes under instructions of the Engineer-in-Charge. All materials and the producing, forming, placing, curing and repairing of the foam concrete shall be in accordance with the applicable requirements of this Plain and Reinforced Concrete Section.

5.6 PLUM/RUBBLE OR CYCLOPEAN CONCRETE

Rubble or cyclopean concrete shall consist of tough, sound, and durable rock embedded in Mass Concrete of Class B. Stone shall be of approved quality, sound and durable, and free from segregation, cracks, or imperfections tending to destroy its resistance to the weather. It shall be sharp angled, non-flaky, cubical, free from dirt, oil or any other injurious material which may prevent the proper adhesion of the mortar. In general, the percentage of wear shall not exceed fifty (50) when tested in accordance with the Standard Method of Testing for Abrasion of Coarse Aggregate by the use of the "Los Angeles Machine", ASTM C535.

The stones shall be carefully placed and shall not be dropped into place. Stone and Concrete shall be cast in alternate layers, as specified hereunder. They shall be cast to avoid damage to the forms or to the partially set adjacent masonry. Stones shall be washed and saturated with water before placing. The stones shall not be larger than one third (1/3) of the cross section of the concrete, with a maximum size of 250mm and should not be placed closer than 150mm to each other. The volume of stones shall not exceed thirty per cent (30%) of the mass concrete volume and care shall be taken to ensure that the minimum concrete cover over any stone is 100mm.

5.7 MEASUREMENT & PAYMENT

5.7.1 GENERAL

All measurements & payments shall be for completed work within the neat lines shown on drawings unless otherwise specifically directed.

No measurement and payment shall be made for the under-mentioned specified works for reinforcement. The cost thereof shall be deemed to have been included in the unit rate of the respective items of the BOQ.

Unless otherwise specifically stated in the Bill of Quantities or herein, all items of reinforcement shall be deemed to be inclusive of, but not limited to the following:

- Reinforcement bar bending schedule to be provided by the Contractor for approval.

- Providing materials, attendance and costs for all sampling and testing.

- Cost of M.S. binding wire and concrete, metal or plastic chairs and spacers or hangers.

- Cleaning, cutting and bending, placing and fixing in position including binding with wire and other material and placing supports and spacers.

- All sorts of transportation involved in the process.

- All reinforcement shall be provided in lengths shown in drawings and as per Specifications. Should the Contractor provide lengths of reinforcement which are greater than that shown on the drawings no payment for extra lengths shall be made.

- For same size bars shorter than 40 ft (12 m), overlaps unless clearly shown on drawings or as specifically required by the Engineer, shall not paid. When same size continuous bars longer than 40 ft (12 m) are shown on the Drawings, without the splices being shown, necessary steel in the splices will be paid for on the basis of the individual bars not being shorter than Forty (40) Feet (Twelve (12) meters).

- When different size bars are shown on the Drawings, without the splices being shown, the necessary steel in the splices will be paid.

- If bars are substituted upon the Contractor's request and as a result more steel is used than specified, only the amount specified shall be measured for payment.

- For bent bars, the length along centre-line of bar will be paid.

- Wastage and rolling margin shall not be paid.

Measurement shall be made in tonnes of reinforcing steel acceptably placed on the basis of the lengths of bars installed in accordance with the approved Drawings or bar schedules or as directed by the Engineer-in-Charge. Lengths of each size of bars shall be converted to weights by the use of the unit weights per linear metre for each size as per ASTM A-615 or BS 4449 Standards as approved by the Engineer-in-Charge. Steel in laps indicated on the Drawings and as required by the Engineer-in-Charge will be measured for payment.

Pay Item No.	Description	Unit of Measurement
5.7 a	Concrete (Class B) 2500psi (175kg/cm2) cylinder strength with maximum coarse aggregate size 51mm with machine mixer with approved local aggregate	CM
5.7 b	Concrete (Class A_1) 3000psi (210kg/cm2) cylinder strength with maximum coarse aggregate size 20mm with machine mixer with approved local aggregate for lintel, stair and sill etc.	CM
5.7c	Concrete (Class A_1) 3000psi (210kg/cm2) cylinder strength with maximum coarse aggregate size 20mm with batching plant with Lime Stone aggregate	
	i. Under Ground	CM
	ii. On Ground	CM
	iii. Elevated	CM
5.7d	Concrete (Class C) 3000psi (210kg/cm2) cylinder strength with maximum coarse aggregate size 38mm with batching plant with Lime Stone aggregate	
	i. Under Ground	CM
	ii. On Ground	CM
	iii. Elevated	CM
5.7 e	Concrete (Class A_2) 3500psi (245kg/cm2) cylinder strength with maximum coarse aggregate size 25mm with batching plant with Lime Stone aggregate	
	i. Under Ground	CM
	ii. On Ground	CM
	iii. Elevated	CM
5.7 f	Concrete (Class A_3) 4000psi (280kg/cm2) cylinder strength with maximum coarse aggregate size 38mm with batching plant with Lime Stone aggregate	
	i. Under Ground	CM
	ii. On Ground	CM
	iii. Elevated	CM
5.7 g	Concrete (Class D_1) 5000psi (350kg/cm2) cylinder strength with maximum coarse aggregate size 25mm with batching plant with Lime Stone aggregate	CM
5.7 h	Concrete (Class D_2) 6000psi (420kg/cm2) cylinder strength with maximum coarse aggregate size 25mm with batching plant with Lime Stone aggregate	CM
5.7i	Lean concrete 1500psi (105kg/cm2) cylinder strength with maximum coarse aggregate size 51mm with machine mixer with approved local aggregate	CM
5.7 j	Pre cast concrete (Class B) 2500psi (175kg/cm2) cylinder strength with maximum coarse aggregate size 51mm with machine mixer with approved local aggregate	CM
5.7 k	Pre cast concrete (Class A_1) 3000psi (210kg/cm2) cylinder strength with maximum coarse aggregate size 20mm with machine mixer with approved local aggregate	CM

5.7 l	Pre cast concrete (Class A_3) 4000psi (280kg/cm2) cylinder strength with maximum coarse aggregate size 38mm with machine mixer with Lime Stone aggregate	CM
5.7 m	Pre cast concrete (Class D_1) 5000psi (350kg/cm2) cylinder strength with maximum coarse aggregate size 25mm with machine mixer with Lime Stone aggregate	CM
5.7 n	Pre cast concrete (Class D_2) 6000psi (420kg/cm2) cylinder strength with maximum coarse aggregate size 25mm with machine mixer with Lime Stone aggregate	CM
5.7 o	Pre cast concrete (Class D_3) 7000psi (490kg/cm2) cylinder strength with maximum coarse aggregate size 25mm with machine mixer with Lime Stone aggregate	CM
5.7 p	Plum (Cyclopean/Rubble) concrete 2000psi (140kg/cm2) cylinder strength (20:80 concrete stone ratio) as per detailed specification and drawings	CM
5.7 q	Plum (Cyclopean/Rubble) concrete 2000psi (140kg/cm2) cylinder strength (30:70 concrete stone ratio) as per detailed specification and drawings	CM
5.7 r	Plum (Cyclopean/Rubble) concrete 2000psi (140kg/cm2) cylinder strength (40:60 concrete stone ratio) as per detailed specification and drawings	CM
5.7 s	Providing and laying foam concrete insulation 480-560 Kg density per CM on roof including form work having compressive strength not less than 0.50N per square mm including setting, jointing and pointing in cement mortar 1:4	CM
5.7 t	Providing and laying foam concrete in partitions etc, 800-960 Kg density per CM in precast block, compressive strength not less than 0.60N per square mm including setting, jointing and pointing in cement mortar 1:4	
5.7 u	Anti-Freezing Compound/ Admixtures with complete specification	CM
5.7 v	Providing and Fixing P.V.C. rubber water stopper in vertical or horizontal Construction/Expansion joints including cutting and jointing of approved brand	
	i. 8” (200mm) wide	LM
	ii. 10” (250mm) wide	LM

NOTE:

Maximum size aggregate shall be mentioned in the BOQ, depending upon the dimension of concrete elements, ranging from 20mm to 38mm.For plain or reinforced concrete referring class of concrete.

SECTION 6 SHEET PILING

6.1 DESCRIPTION

This item shall consist of furnishing, driving, cutting off and removal, if required, of steel sheet piles in accordance with the Drawings, or as designated by the Engineer. Sheet piles for cofferdams in connection with foundations for structures shall be included in the unit price for Item 3.14 b-Structural Excavation. Sheet piling shall be a separate pay item only when stated in the Bill of Quantities.

6.2 MATERIAL REQUIREMENTS

6.2.1 Steel Sheet Piles

Steel Sheet piles shall be of the type and weight indicated on the Drawings. The steel shall conform to AASHTO M 223 or ASTM A 572. Permanent steel sheet piles shall be coated with red lead paint conforming to AASHTO M 72 as instructed by the Engineer.

6.2.2 Bracing

Bracings or anchors for sheet piles shall be made of wood or steel according to the Drawings or as designated by the Engineer.

For temporary sheet piling like cofferdams for excavations, the Contractor shall be solely responsible for the design and construction of the bracing. The Drawings shall have the approval of the Engineer, but such approval does not in any way relieve the Contractor of his responsibility.

6.3 CONSTRUCTION REQUIREMENTS

6.3.1 Installation

All sheet piles shall be driven to the elevation shown on the Drawings or as directed by the Engineer. Where it is impossible to drive to the elevation shown on the Drawings due to sub-surface conditions, the piles may be stopped at a higher elevation with the written permission of the Engineer. However, before granting such permission the Engineer shall investigate to ascertain that the Contractor has adequate equipment for the required driving and that the piles cannot be driven to the elevation shown with the proper use of this equipment.

The tops of a permanent sheet piling shall be driven or cut-off to a straight line at the elevation indicated on the Drawings.

6.3.2 Removal

Temporary sheet piling shall be removed or cut off at the stream bed or the original ground when directed by the Engineer.

In case when the Engineer orders sheet piling to be left in place for erosion protection, the Contractor and the Engineer shall agree on an equitable price.

6.4 MEASUREMENT AND PAYMENT

6.4.1 Measurement

When stated as a separate pay item in the Bill of Quantities, sheet piling will be measured by the square meters of sheet piling or as a Lump Sum as shown on the Drawings or directed in writing by the Engineer, complete in place and accepted. Measurement of piling, which has been delivered according to Drawings and cannot be driven to the directed elevation because of subsurface conditions, shall be measured to the driven elevation.

6.4.2 Payment

Payment of Steel Sheet Piles as determined under measurement shall be made at the contract unit price per square meter or as a Lump Sum for the pay items listed below and shown in the Bill of Quantities. Such prices and payment shall be considered full compensation for all materials, labour, equipment, tools paint, bolts, Wales and incidentals necessary to complete the item. All necessary bracings, whether shown on the drawings or not, shall be included in the contract price.

The under mentioned pay items and prices shall be applicable to the type of work to be performed at site for Permanent and Temporary Sheet Piling.

Pay Item No.	Description	Unit of Measurement
6.4 a	Cutting Ransome or Larssen or similar piles as directed by the Engineer in charge	NO
6.4 b	Cutting universal piles as directed by the Engineer in charge	NO
6.4 c	Driving sheet piles (steel) by machine as directed by the Engineer in charge, hiring charges be paid separately	
	i. Up to 15ft (4.5m)	LM
	ii. 15ft (4.5m) to 25ft (7.5m)	LM
	iii. 25ft (7.5m) to 30ft (9.0m)	LM
6.4 d	Driving sheet piles (steel) by machine in tidal water as directed by the Engineer in charge, hiring charges be paid separately	
	i. Up to 15ft (4.5m)	LM
	ii. 15ft (4.5m) to 25ft (7.5m)	LM
	iii. 25ft (7.5m) to 30ft (9.0m)	LM
6.4 e	Hiring charges of sheet piling machine including fuel and operator also include loading and unloading etc. as directed by the Engineer in charge	HR.
6.4 f	Erection at site and dismantling after proper use of sheet piling machine as directed by the Engineer in charge	NO

SECTION 7 PILE WORKS

7.1 GENERAL

The work shall consist of performing all operations in connection with furnishing, driving, cutting off and load testing of RCC Cast-In-Situ and Precast Concrete piles to obtain the specified bearing value, complete in place and strictly in accordance with these Specifications and as shown on the Drawings.

The kind and type of piles shall be as shown on the Drawings and/or as specified and shall not be changed, except with the approval of the Designer.

7.2 RCC CAST-IN-SITU PILES

7.2.1 SCOPE OF WORK

All works to be performed under these Specifications shall be carried out at the proposed locations shown on the Drawings and shall include but not be limited to the following:

a) Construction of bored & cast in-situ RCC test piles for pile load tests (Test Pile).

b) Performance of load tests on piles.

c) Construction of bored & cast in-situ RCC piles for various structures under contract (working piles). Including cutting, trimming etc. Complete in all respects.

d) Performance of proof load tests on the working piles selected by the Engineer-in-Charge.

e) Keeping complete record of all the operations performed during boring, construction and load testing of the piles stated above.

7.2.2 GENERAL REQUIREMENTS

The general requirements for RC piles shall be as follows:

a) Type, Diameter and Length of Piles

i. Bored cast & in-situ reinforced concrete (RCC) piles using Ordinary Portland Cement (OPC) or Sulphate Resisting Cement (SRC) as specified shall be constructed as shown on the Drawings.

ii. Piles diameter, type and length shall be as shown on the Drawings.

iii. Unless the approval of designer, the contractor cannot change the position, the number, diameter and length of pile.

b) Tolerances in Location and Plumbness

Following construction tolerances shall be maintained:

i. The drilled shaft shall be within 3 inches of the plan position in the horizontal plane at the plan elevation for the top of the shaft.

ii. The vertical alignment of the shaft excavation shall not vary from the plan alignment by more than ¼ inch per foot of depth.

iii. After all the shaft concrete is placed, the top of the reinforcing steel cage shall be no more than 6 inches above and no more than 3 inches below plan position.

iv. When casing is used, its outside diameter shall not be less than the shaft diameter shown on the plans. When casing is not used, the minimum diameter of the drilled shaft shall be the diameter shown on the plans for diameters 24 inches or less, and not more than 1 inch less than the diameter shown on the plans for diameters greater than 24 inches.

v. The bearing area of bells shall be excavated to the plan bearing area as a minimum. All other plan dimensions shown for the bells may be varied, when approved, to accommodate the equipment used.

vi. The top elevation of the shaft shall be within 1 inch of the plan top of shaft elevation.

vii. The bottom of the shaft excavation shall be normal to the axis of the shaft within ¾ inch per foot of shaft diameter.

c) Cutting of Pile Heads

Pile heads shall be cut to the levels shown on the Drawings and the cut shall be level, smooth, and horizontal. Due care shall be taken to protect the edges and reinforcement. No extra payment shall be made for this work. Pile cut off levels shall be shown on the shop drawings to be submitted by the Contractor for approval of the Engineer-in-Charge.

d) Order of works

The order in which construction and load testing of piles shall be carried out will be decided by the Engineer-in-Charge, who will have the discretion to alter the same during the course of the work.

e) Plant

The Contractor shall keep on the site sufficient plant to meet all requirements of the work. The plant shall be in satisfactory operating condition and capable of efficiently performing the work as per these Specifications.

f) Supervisory Staff

The Contractor shall have at site at all times, only qualified, experienced and thoroughly competent persons, who shall conduct and supervise drilling, pile construction and load testing operations. Since the construction of piles requires special knowledge and utmost care, the Contractor shall have at least one qualified and experienced Engineer-In-charge specialized in this field of work that shall be present full time during execution. The Contractor shall remove from the site any employee who does not in the opinion of the Engineer-in-Charge, meet these requirements.

g) Site Conditions

The Contractor is responsible for any damage to the existing superstructures, sub-structures utility lines caused due to piling work. The contractor shall ensure that pile construction works shall not interfere with the work of the other Contractors working in the area.

Where approval has been given to the Contractor for carrying out concreting operations at night or in places sunshine hours are limited, the Contractor shall provide adequate lighting at all points where mixing, transporting, placing of concrete is in progress.

When concrete is to be manufactured, transported and placed in hot weather, specific precautions as required by the Engineer-in-Charge shall be observed in accordance with the provisions of sub-sections 5.3.2.5(f) and 5.3.4(c).

h) Quality Assurance

Quality of concrete for piles shall comply with Section5 – Plain & Reinforced Concrete.

The materials, used in pile construction (cement, aggregates, steel reinforcement etc.) shall conform to the requirements of relevant Sections of technical provisions.

i) Standards and Codes of Practice

The latest edition of International Standards and codes such as American, British or German etc., shall be used. All materials and workmanship shall, unless otherwise specified, comply with these standards and codes.

The Contractor shall make available at the site for the use of the Engineer-in-Charge, one copy of each of all relevant Standards & Codes used and quoted in the documents and Drawings at his own expense. No additional cost will be paid to the contractor for providing such documents.

7.2.3 SUBMITTALS

The Contractor shall be required to make following submittals:

1. Method Statement:

The Contractor shall submit to the Engineer-in-Charge before start of piling work a detailed description of the equipment, materials and procedures that will be used. The description shall include equipment specifications, loading capacities, protective devices, test apparatus, detailed installation procedures, test procedures and other documents ordered by the Engineer-in-Charge. Contractor's construction procedures shall be type-written and shall include charts and diagrams as applicable and necessary, to fully explain the subject procedures, methods and equipment operation in order to allow effective review by the Engineer-in-Charge. The method statement shall be submitted to the Engineer at least 2 weeks prior to commence the work.

2. Survey and Location:

The Contractor shall carry out a levelling survey and provide excavated ground elevations for each pile location. The elevations shall be given with respect to a permanent Bench Mark. The locations of piles shall be established by the Contractor as per shop drawings as approved by the Engineer-in-Charge. Establishing the pile locations accurately in the field shall be the sole responsibility of the Contractor.

3. Protective Measures:

The Contractor shall submit to the Engineer-in-Charge procedures for the following:

a) Both hot and cold weather concreting procedures shall be submitted to the Engineer-in-Charge by the Contractor regardless of the need for the immediate implementation of such procedures. Procedures shall include insulation, enclosures and the like, finishing procedures and timing and duration of curing shall be described.

b) Protection of concrete against damage due to mechanical contact and construction operations,

c) Proposal regarding necessary facilities for drainage of the excavated areas, it shall be the Contractor's sole responsibility to keep the site free of ponding water during rain and during boring and construction of piles.

4. Placement Schedule:

The Contractor shall submit a placement schedule for review prior to start of concrete placement operations. Daily concrete pour schedules shall be submitted 24 hours in advance of planned pours.

5. Testing Programme:

The Contractor shall submit test programme for all specified requirements along with the testing schedule.

6. Test Reports:

The Contractor shall submit test reports showing the results of required tests and compliance with specified standards and codes. Test reports shall be certified by the Contractor at the testing agency approved by the Engineer-in-Charge.

7. Samples:

The Contactor shall submit to the Engineer-in-Charge for acceptance prior to purchase, fabrication or delivery samples of materials or products where required by the Engineer-in-Charge.

Substitute products, materials or fixtures proposed by the Contractor shall be submitted as samples to the Engineer-in-Charge for his information about materials.

8. Shop Drawings:

The Contractor shall submit for Engineer-in-Charge a review and acceptance detailed shop drawings showing layout, arrangement, dimensions locations of piles, pile diameters and lengths, pile marks and details of construction showing reinforcement of the piles. The drawing shall also indicate the cut off level, tip elevation of each pile and all other necessary details required for completion of the construction work or required by the Engineer-in-Charge.

Shop drawings shall be submitted to the Engineer-in-Charge for his acceptance and approval.

7.2.4 PRODUCTS

The products and materials shall meet the following requirements.

1. General:

All materials used in the Works shall be subjected to inspection and testing as and when directed by the Engineer-in-Charge.

Should the Engineer-in-Charge decide not to carry out tests on a material or materials himself or under his direction, the Contractor shall, whenever required, obtain from the Manufacturer and submit to the Engineer-in-Charge the certificates, showing that tests of materials having been carried out in accordance with the requirements of this Specification. Engineer-in-charge can verify the test reports in his own presence or his representative.

Before ordering any materials proposed to be used in the execution of the Works, the Contractor shall submit to the Engineer-in-Charge for his written approval the name(s) and address (es) of the firm(s) from which he proposes to order the material(s).

If the Engineer-in-Charge is in doubt about the quality of the delivered materials, the Contractor shall demonstrate through the relevant tests that the quality of the materials fully satisfies the requirements of this Specification.

2. Concrete:

Concrete for bored & cast-in-situ piles including their caps, shall be in accordance with the requirements specified in the Section 5 - Plain Reinforced Concrete using Ordinary Portland Cement (OPC) or Sulphate Resisting Cement (SRC) as specified. In addition to meeting the strength requirements, the concrete for bored & cast in-place piles shall have adequate workability for the method of placing employed in the casting of piles and the consistency will meet the requirement as stipulated in the Section as above.

The concrete shall be supplied in sufficient quantity to ensure that the concreting of each cast in-place pile proceeds without interruption. The concrete shall be of class as specified in accordance with the Specifications and Drawings.

3. Concrete Aggregates:

Coarse and fine aggregates used for concrete under these Specifications shall be furnished by the contractor in accordance with the provisions of and in complete conformity with the requirements of the Specifications in Section 5 – Plain & Reinforced Concrete.

4. Reinforcing Steel:

Reinforcing steel shall conform to the requirements set forth in Sub-section 5.4 – “Concrete Reinforcement” of the Section 5 – Plain & Reinforced Concrete. All placing shall be in accordance with the Drawings furnished or as approved by the Engineer-in-Charge.

5. Drilling Fluid:

The drilling fluid used for all types of drilling shall be clean water, free from suspended sediments. The Contractor may be allowed to use bentonite slurry, barite slurry, and loss circulation material as drilling fluid with the prior approval of the Engineer-in-Charge.

6. Casing of Holes:

Casing of holes shall be according to the provisions given below:

a) The hole shall be cased up-to its bottom.

b) The casing shall be made of cylindrical steel pipes of inside diameter equal to the pile diameter and shall have sufficient strength so as to maintain position and shape during drilling operations. Casing used during concreting should be free from internal projections and encrusted concrete which might prevent the proper formation of piles. It shall also be free from distortion and shall be of uniform cross-section throughout.

c) The casing may be omitted only where it can be shown to the satisfaction of the Engineer-in-Charge that lowering of reinforcement cage and concreting operations will not cause caving of the bore hole.

d) It shall be the Contractor's responsibility to pull out the casing from the holes at the time of concreting of piles. No extra payment shall be made for pulling out the casing or for leaving the casing inside the hole.

7.2.5 EXECUTION

The procedures for execution shall be as follows:

1) DRILLING:

Drilling shall be performed as described below:

a) Various Method of Drilling:

I) Percussion drilling: is a manual drilling technique in which a heavy cutting or hammering bit attached to a rope or cable is lowered in the open hole or inside a temporary casing. The technique is often also referred to as 'Cable tool'. Usually a tripod is used to support the pulley and tools.

Drilling is used to obtain very detailed information about rock types, mineral content, rock fabric and the relationships between rock layers close to the surface and at depth. Mud-rotary drilling-this method is used for drilling through soft rocks, sand and clay layers especially in the search for coal, oil or gas.

In percussion drilling, a heavy bit is repeatedly lifted and dropped, progressively boring the earth. In rotary drilling, the drilling results from the continuous scraping or the bit under constant pressure. The hole is cleaned out as the drilling progresses, either with a drilling fluid (mud), with high velocity air or, in auger drilling, by the mechanical lifting of the auger.

In cable tools drilling, a chisel faced bit is repeatedly raised and dropped, the bit breaks and pulverizes the materials, a slurry of water and cutting, which is formed by the drilling action, is periodically removed by a bailer. Water is continually added to the borehole as needed. With manual methods, the 40 to 80 kg drill is lifted and dropped through a tripod and pulley arrangement operated by four to six people. Or mechanically, by a motor and winch arrangement.

II) Rotary drilling: A rotary rig is the equipment used for drilling in most wells, which includes an engine and a hoisting, rotating and mud circulating system.

The operating equipment of a rotary rig can be divided into three systems: hoisting, rotating, and circulation.

Rotary rigs are often identified by their derricks, steel towers that support many of the rig's important components.

A rotary rig the equipment used for drilling in most wells, or hole for piles which includes an engine and a hoisting, rotating and mud circulating system.

This system is used for large diameter holes on all type of soils, gravel, boulders and rock.

III) Reverse circulation drilling or RC drilling: is a method of drilling which used dual wall drill rods that consist of an outer drill with an inner

tube. These hollow tubes allow the drill cutting to be transported back to the surface in a continuous, steady flow.

The reverse circulation well drilling system is used for large diameter wells on loose alluvial soils.

This system is generally used for large diameter wells or hole for piles and consists of returning the drilled material and flushing medium to the surface inside the drill pipes.

The pressures and flow of the drilling fluid at, and immediately behind, the drilling bit effectively flushes the drilled material away from the bit and also prevent the borehole from collapsing. Further back from this the hydrostatic head of the drilling fluid ensures the stability of the hole and its viscosity (calculated according to the flow of fluid provided from the drilling rig and the diameter of the hole) must be such as to allow the transport to the surface of the drilling material.

The fluid consists of water or natural light mud, but if needed, also bentonite polymer based mud can be used, for stabilizing the bored hole.

The excavation system can use the force of impact of a percussion tool or the combined action of the rotation of the tool and the torque applied to it.

Optimal depth: from 3up to 400/500 m

Optimal diameter: from 600 up to 1.000 mm

Soil Type: It is best to use this technique in the drilling of loose alluvial soils including boulders and large stones (these last ones especially with percussion). This technique can also be applied those consistent formations, like sandstones, conglomerates, marls (but with less effectiveness).

b) <u>General:</u>

i) Before starting the piling work, the contractor shall complete clearing, levelling and setting out of the site. Any obstacles shall be removed, as directed by the Engineer-in-Charge. If the presence of existing underground utilities is known or suspected, the Contractor shall carry out such diversion or protection of these as directed by the Engineer-in-Charge.

ii) All excavations shall be carried out as nearly as possible to the exact dimensions of the pile foundations to minimize backfilling.

iii) All surplus excavated material from excavations not required for back filling shall, if considered unsuitable by the Engineer-in-Charge, be disposed of as directed.

iv) All installation procedures shall be subject to the Engineer-in-Charge's approval. No pile boring shall take place within 48 hours of the concreting of any pile which is within a radius of 10 feet (3.05 meters).

v) The sequence of work shall be proposed by the Contractor and as approved by the Engineer-in-Charge. The test piles shall be constructed and load-tested prior to the start of main piling. Additionally, proof load tests shall also be carried out on working

piles during construction of piles. The piles for proof load tests shall be selected by the Engineer-in-Charge.

c) Method of Drilling:

The drilling of holes for piling shall be done by straight or reverse rotary rig or any other suitable method proposed by the Contractor, subject to approval of the Engineer-in-Charge. Regardless of the method used for drilling holes, the following specifications shall be adhered to by the Contractor.

i) After completion of drilling operations the bore hole length shall be checked and recorded.

ii) The deviation from the vertical shall not exceed 0.5 degree (1 in 114) on any section of the length for the holes.

iii) Drilling operations shall be carried out in such a way as to avoid any disturbance of the soil especially at the bottom of the hole. (i.e., sand boiling).

d) Stabilizing the Holes:

The Contractor shall ensure at all times that the hole does not collapse during and after boring. The Contractor may use bentonite slurry or any other drilling method with written approval of the Engineer-in-Charge. When bentonite slurry is used strict compliance with Sub-section-f herein below shall be ensured. The nominal diameter of pile is defined as the minimum cross-section of unlined portion of borehole. The possible enlargement of the pile shaft during boring, placement and compaction of the concrete shall not be taken for measurement and for increase in the admissible load. It may also be noted that no extra payment shall be made for using bentonite slurry or adopting alternative drilling method(s) for advancing the boreholes in satisfactory manner.

e) Removal of Mud:

The excavated material from boreholes shall be disposed of by the Contractor under instructions of the Engineer-in-Charge at no extra cost.

f) Clean out and Control at the Bottom of the Piles:

After the bore has reached its final penetration as stipulated on the Drawings and as may be additionally ordered by the Engineer-in-Charge, on the basis of data obtained in the field, and after it has been completely cleaned of all earth and otherwise made ready to receive the reinforcement and thereafter the concrete, the Contractor shall so inform the Engineer-in-Charge. All disturbed soil and loose materials shall be pumped out in such a manner that after cleanout operation, the bottom of borehole remains horizontal and in undisturbed condition. The clean out pumping arrangement shall be such that the lower end of the pump can be moved all over the cross-section by a routine operation. The suction of the pump shall be adjustable. At the end of clean-out operations, a break shall be made for a period of at least five minutes, and then pumping shall be resumed and shall continue until the bottom of hole is cleaned. The Engineer-in-Charge shall check the actual bore penetration achieved, the cleanliness of the boreholes and the amounts and directions, if any, by which the borehole is out of position and/or out of plumb and having satisfied himself on these and on any other points which he may consider relevant, shall sign pour slip for the borehole authorizing the Contractor to proceed with the placing of reinforcement. The Contractor shall under no circumstances proceed with

the placing of reinforcement in the boreholes or with the subsequent concreting without having first obtained the written authority signed separately for each and every borehole.

g) <u>Bentonite Slurry:</u>

Where the use of bentonite slurry is approved for the purpose of maintaining the stability of the walls and base of bore, the Contractor's proposals in accordance with clause (v) herein below shall include details of the slurry. These shall include inter-alia.

- The source of the bentonite
- The constitution of the slurry
- Specific gravity, viscosity, shear strength and pH value of slurry.
- The methods of mixing, storing, placing, removal and recirculating the slurry, and
- The provision of stand-by equipment.

i) Tests shall be carried out to ensure that the proposed constitution of the slurry is compatible with the ground water: Proposals for the constitution and physical properties of the slurry shall include average, minimum and maximum values. The specific gravity of the slurry shall not be less than one and one tenth (1:1/10) in any case at any time. The Contractor shall use additives where necessary to ensure the satisfactory functioning of the slurry.

ii) A manufacturer's certificate showing the properties of the bentonite powder shall be delivered to the Engineer-in-Charge for each consignment delivered to site: Independent tests shall be carried out at laboratory approved by the Engineer-in-Charge on samples of bentonite frequently.

iii) The Contractor shall carry out tests at site during the course of the piling to check the physical properties of the bentonite slurry in the works. These tests shall include, inter-alia, density, viscosity, shear strength and pH tests. The test apparatus and test methods shall be proposed by Contractor as recommended by manufacturer and as approved by the Engineer-in-Charge.

iv) The frequency of tests shall be that which the Contractor considers necessary to ensure that the bentonite slurry is in accordance with his proposals and as such other times as the Engineer-in-Charge may direct.

v) Should the physical properties of any bentonite slurry deviate outside the agreed limits, such slurry shall be replaced, irrespective of the number of times it has been used by new bentonite slurry of correct physical properties. Adequate time shall be allowed for proper hydration to take place consistent with the method of mixing, before using slurry in the works.

vi) The Contractor shall control the bentonite slurry so that it does not cause a nuisance either on the site or adjacent waterway or other area. After use it shall be disposed of in a manner approved by the Engineer-in-Charge.

vii) The level of the slurry in the bentonite shall be maintained so that internal fluid pressure always exceeds the external water pressure.

viii) If chiselling is used when boring through hard strata or to overcome obstructions, the stability of the excavation shall be maintained by methods acceptable to the Engineer-in-Charge.

2) CONCRETING:

Concreting of piles shall be done as given herein below:

a) Placing of Steel Reinforcement:

The cage of reinforcement shall be assembled on the ground and securely tied by means of binding wire in such a manners to form a rigid cage. It shall be lowered in the bore hole carefully keeping the cage concentric with the bore hole. Adequate concrete spacers shall be provided around the cage to ensure the required concrete cover to be available on all sides of the cage. Concrete spacer blocks specially pre-cast for this purpose shall be securely attached to the reinforcement at a suitable spacing and each quarter point so as to ensure that the concrete cover stipulated on the drawings is maintained throughout and that the reinforcement cage is not displaced in the casing during the course of subsequent concreting operations. In addition concrete spacer blocks shall be located immediately below and immediately above the lap at 4 points spaced around the cage. Particular care shall be taken to ensure that none of the spacer blocks move out of position to the inside of the reinforcement cage due to spacer blocks or lapped reinforcement or any other reasons which might interfere with concrete placement. Depth of the hole shall be measured just before and after the lowering of cage. In case it is found that the soil has caved into the hole during the lowering of the cage, the contractor shall be required to adequately clean the hole to the satisfaction of the Engineer-in-Charge, before the start of concreting at his own cost.

b) Composition of Concrete:

Composition of concrete shall be as specified, under section 5

c) Batching of Concrete:

Batching of concrete shall be in accordance with the provisions of section 5 – Plain & Reinforced Concrete.

d) Mixing of Concrete:

Mixing of concrete shall be done in accordance with the provisions of section 5 – Plain & Reinforced Concrete.

e) Conveying:

Concrete shall be conveyed from mixer to piles as rapidly as practicable by methods which will prevent segregation or loss of ingredients, as specified in Section 5 – Plain & Reinforced Concrete. Any wet batch hopper through which the concrete passes shall be conical in shape. There shall be no vertical drop greater than 5 feet. Belt conveyers, chutes, or other similar equipment will not be permitted for conveying concrete except where the use of such equipment is approved in writing by the Engineer-in-Charge, in advance of any use.

f) Placing:

i) General

Once the bore hole has reached the required depth and the reinforcement cage properly installed, and such depth has been checked and recorded concreting operations shall be carried out. Approval of the Engineer-in-Charge shall be obtained before starting any concrete pour. Concrete pouring will not be permitted when in the opinion of the Engineer-in-Charge weather conditions prevent proper placement. Unless otherwise approved concrete pouring shall be performed only in the presence of a duly authorized representative of the Engineer-in-Charge.

ii) Mixing-Placing Interval:

Concrete shall be placed within thirty minutes, after it has been mixed.

iii) Placing Temperature:

Concrete shall be delivered to the piles at the coolest temperature which is practicable to produce under current conditions but in no case at a temperature in excess of 90℉ (32℃) or lower than 41℉ of (5℃).

iv) Placing Method

Pouring of concrete shall be done by an efficient tremie technique. The method and equipment used shall be subject to the prior approval of the Engineer-in-Charge. The tremie pipes shall have to be large enough with due regard to the size of the aggregate. For 3/4 inches (19.5 mm) aggregate, the tremie pipe shall be of diameter not less than 6 inches (15 mm) and for larger aggregate, larger diameter tremie pipes shall be used. The hopper and tremie pipe shall have to be a closed system embedded in the placed concrete, through which water cannot pass. When concrete is deposited by tremie, the tremie seal shall be affected in a manner which will not produce undue turbulence in the water around the pipe. The discharge end shall be kept submerged continuously in the concrete and the shaft kept full of concrete to a point well above the water surface. The tremie shall not be moved horizontally during a placing operation. The rate of placing concrete in the borehole shall be neither less than 30 feet (9.15 meters) per hour and no more than 50 feet (15.24 meters) per hour.

When a casing is used, it shall be lifted up-to height less than the height of casing already filled in with concrete. The bottom of casing shall stop to an elevation of 5 feet (1.52 meters) lower than the top of the concrete. Particular care shall be taken in order to avoid earth slide inside the hole.

During the progress of pouring, the Contractor will ensure that standby equipment is available in order to cope with plant break down if encountered.

The Contractor shall not be permitted to place concrete while it is raining. Should it rain while the concrete placement is already in progress, the Contractor shall carry on with proper and sufficient precautions, the concrete placement operation until the pile is completed and shall cover the concrete already placed and under setting condition with polythene or similar impervious sheets. No additional payment shall be made for any such emergency and protection works.

All tremie tubes shall be scrupulously cleaned after use for subsequent concreting. Concrete in piles shall be continued up-to two feet above cut off levels as shown on the Drawings and shall be broken down to cut-off levels prior to placement of pile caps. The contractor shall break back the concrete in the top portion of the piles to the final elevation which will be 3 inches above the bottom of the pile cap and at the same time exposing the length of pile reinforcement required for lapping and binding with the pile cap. The contractor shall also establish and record the actual co-ordinates of the centres of the broken-off pile tops with respect to theoretical centre line of each pile cap as shown on the Drawings and the tolerance in this respect shall not exceed 2 inches (50 mm) in any direction. No separate payment will be made for manufacturing, placing and breaking of this part of concrete.

v) Protection and Curing

As each pile cap is completed, the projected length shall be immediately and carefully protected from any condition that will damage or adversely affect the hardening of concrete. Concrete shall be cured for 28 continuous days by an approved method.

vi) Stripping and Finishing

Any cracked or defective concrete in the head of the completed pile shall be cut away and made good with new concrete well bonded into the old. The reinforcement in the pile shall be exposed for a sufficient distance to permit it to be adequately bonded to the pile cap. This shall be done carefully to avoid shattering or otherwise damaging the rest of the piles. The reinforcement shall then be cleaned and bent to form an anchorage into the concrete of the super-structure as directed by the Engineer-in-Charge.

Where a temporary casing is used, the top of the pile shall be brought up sufficiently above the required finished level to allow for slumping on withdrawal of the casing and to permit all laitance and weak concrete to be removed. Particular attention shall be paid to the compaction of the concrete in the top 3 feet (0.91 meters) or so of the pile.

vii) Damaged Piles

Should any pile be damaged or not conforming to the requirements of this Specification the Contractor shall be responsible for repairing or replacing the pile to the requirements and satisfaction of the Engineer-in-Charge without cost to the Employer.

Should the Engineer-in-Charge doubt the efficiency of any pile so repaired, he may order the Contractor to construct additional piles, at points selected by him without cost to the Employer. The Engineer-in-Charge may direct the Contractor to proof load test the doubtful pile. Any piles that are damaged or imperfect and thus rejected by the Engineer-in-Charge shall be removed and discarded.

When the rejected pile is withdrawn, the space shall be filled solid with gravel or broken stone without extra payment therefore. Debris from pile cut-offs and damaged piles shall not be buried in required fill under slabs at grade or in required embankments but shall be disposed of by the Contractor off the site of the work. Piles which, in the opinion of the Engineer-in-Charge, are defective in any way shall be rejected and replaced by the Contractor without any extra cost.

viii) Safety Precautions

Before commencing piling operations, reference shall be made to Pakistan statutory safety requirements. In addition, the safety precautions in British Standard CP 2004 shall be strictly followed. The presence of the gas mains, electric cables, water mains and other services that may be damaged and cause injuries shall be investigated before work is commenced. The site shall be kept clear of dangerous obstructions.

High tension overhead power lines shall not be approached nearer than 15 feet (4.57 meters) because of the danger of sparking. A safety supervisor shall be appointed on site, the supervisor being qualified in accordance with the statutory regulations. First-aid boxes in the charge of a responsible person shall be kept at all the locations. Fencing shall be provided to prevent free access to the site and all open pits and boreholes shall be covered.

If lighting by electricity is provided, it is preferable that the voltage for trailing cables shall not exceed 60 V. Electrical installations shall be properly earthed. Cables shall be protected from accidental damage and kept clear of movable equipment plugs and socket connections shall be of water- proof type. Safety helmets and safety footwear shall always be worn by all workers. Piling sites are often wet and use of rubber boots shall be essential.

All boring and concreting equipments shall be cleaned regularly. Helmets, driving caps, etc., shall be inspected regularly for damage or fracture. If cast in-place piles are finished below ground level, proper covers shall be provided to prevent workmen from falling into the holes.

7.2.6 LOADING TESTS ON PILES

The procedure for loading test on piles shall be as given below:

a) Pile load tests shall be conducted to failure on test piles prior to commence actual piling work. The number and location of test piles shall be given by the Engineer-in-Charge in the field. Test piles shall be constructed 'first, cured for 28 days and then load tested for load carrying capacity by the procedure specified in ASTM D1143.

   Failure load shall be considered as the test load at which rapid continuing, progressive movement of test pile occurs, or at which the total axial movement of pile exceeds 15 % of the pile diameter or width.

   Proof load tests shall be conducted on selected working piles during and after execution of piling work of the constructed piles. The number of proof load tests, selection of proof load test pile, and magnitude of load shall be decided by the Engineer-in-Charge. The proof load should be 150% of design load. In case of failure of a working pile it shall be considered as a damaged pile to be replaced by another pile at no extra cost to the Employer.

b) The Contractor shall be responsible for bringing all equipment and supplies to the site for satisfactory performance of the test according to ASTM D1143, or any other method approved by the Engineer-in-Charge.

c) The Contractor shall submit to the Engineer-in-Charge an up-to-date calibration certificate from a laboratory approved by the Engineer-in-Charge, showing correctness of the gauge and/or load cell to be used with the hydraulic jacks.

d) The apparatus shall be calibrated as per requirements of ASTM D1143. The Contractor shall submit to the Engineer-in-Charge details of calibration within 7 days prior to commencing testing for his review and approval.

e) The pile head shall be cut-off or built up to the necessary elevation and shall be capped appropriately to produce a horizontal bearing surface.

f) Care shall be taken to ensure that the center of gravity of the ken ledge is on the axis of the pile and that the load applied by the jack is coaxial with the pile.

g) Settlement of pile head shall be recorded using dial gauges and precise levelling in accordance with ASTM D1143.

h) The record of pile load test shall be kept on an approved format as given in Forms-1 to 3 of these specifications. The Contractor shall prepare load-time settlement curves for each such load test. Two copies of the relevant field data and the graphs shall be supplied to the Engineer-in-Charge within 48 hours of the completion of the test.

7.2.7 RECORD AND REPORT

The following tests, records and reports shall be prepared by the Contractor at his own expense.

1) Records:

The Contractor shall keep accurate records of all the works accomplished under this Section. All such records shall be preserved in good condition and order by the Contractor until they are delivered and accepted by the Engineer-in-Charge. The Engineer-in-Charge shall have the right to examine such records at any time prior to their delivery to him.

The following information shall be included in the records for each pile.

a) Pile number and elevation of top of bore hole and top of pile.

b) Type of rig used and a brief description of drilling operations.

c) Type of soil encountered in the hole with values of cohesion and angle of internal friction.

d) SPT resistance values (N-values)

e) Date and depth of bore when drilling operations were performed and piles constructed.

f) Total depth of each bore hole.

g) Size and length of casing, if used.

h) Quantity of concrete and steel used for the construction of each pile.

i) Quantity of constituents for each batch of mix, water cement ratio and the result of all quality control tests.

j) Date and time of load testing of piles, load and settlements readings during the loading and unloading of the test piles (For test piles only).

k) Graph of time-load-settlement relationship for test (For test piles only).

l) Remarks concerning any unusual occurrence during drilling, concreting and load testing of piles.

2) The presence of Engineer-in-Charge's representative or the keeping of separate records by his representative shall not relieve the Contractor of the responsibility for the work specified in this clause. Payment will not be made for any work for which records have not been furnished by the Contractor

3) Reports:

Reports of each pile construction and pile load test shall be communicated to the Engineer-in-Charge as follows:

a) Oral reports as the work proceeds.

b) A report in duplicate not later than 48 hour after the completion of each hole, concreting of piles and load testing of piles. Performa record of piling work for pile load test record is enclosed as Form-2 and Form-3.

c) Daily record for bored piles on the format shown in Form-1.

d) Five copies of the final report of the works within one month of completion of the last pile.

4) The final report shall include:

a) Layout showing the "As-built" arrangement of piles, their exact locations, dimensions, length, reinforcements, cut off elevation and the location of test piles.

b) A tabulation of the loads and settlement readings during the loading and unloading of the test piles

c) A graphic representation of the test results in the form of time-load-settlement curves.

5) Confirmatory Boring:

Confirmatory boring shall be carried out as directed by the Engineer which shall include the following information:

a) Depth of Borehole.

b) Depth of water table.

c) Type of soil strata encountered at different depths.

d) Sampling of soil using NX size (2.16in dia. core) double tube core barrel sampler, at specified depths.

e) SPT test at 1.5m interval or as specified.

f) Direct shear and Triaxial shear tests as specified.

7.3 PRECAST CONCRETE PILES

7.3.1 GENERAL

The general requirements of Precast concrete piles shall comply with sub-section 7.2.2 unless otherwise specified hereof and approved by the Engineer-in-Charge. The submittals shall comply with Sub-section 7.2.3 and products for production of reinforced concrete piles shall comply with Sub-section 7.2.4 Sub-paras (1) to (4).

7.3.2 MANUFACTURE

The concrete and reinforcing steel for manufacture of precast piles shall be produced and placed according to the applicable provisions of Section 5 – Plain & Reinforced Concrete.

All concrete load bearing plies shall be manufactured in accordance with the details shown on the drawings or as directed by the Engineer-in-charge in writing. The plies shall be cast on level, and tight platforms shall be constructed to prevent settlement during the casting and curing operations; all concrete shall be thoroughly compacted by adequate vibration, spading and roding during the placing operation, and shall be thoroughly worked around the reinforcement and into the corners of the forms. Vibrations shall be applied uniformly over the entire length of the pile and shall be of sufficient duration to ensure a thorough compaction. Pick-up points and date of casting shall be distinctly marked on each pile. Unless otherwise specified. Or directed by the Engineer-In-charge in writing the dimensions of the plies shall be as shown on the approved drawings.

7.3.3 PILE SHOES

Pile shoes when required shall be of the design as called for on the Drawings or directed by the Engineer-in-Charge.

7.3.4 STORAGE AND HANDLING

Storage and handling of the plies shall be executed in a way that does not subject them to over-stress, spalling or other Injuries. Piles shall remain undisturbed after casting and shall not be subjected to handling till the specified curing period ends. They shall be lifted by means of a suitable bridle or slings attached to them at the marked pick-up points. Piles which are over-stressed or otherwise injured during curing or handling shall be removed away from the site of work by the contractor at his own expense.

7.3.5 PLACING OF PILES

Plies shall be driven as accurately as practicable in the correct location, true to line both laterally and longitudinally and to the vertical line as indicated on the drawing. A lateral deviation from the correct location at the cut-off elevation of not more than 3 inches shall be permitted. A variation in slope of not more than 2 Inches per 10 feet of longitudinal axis shall only be permitted. The correct relative position of piles shall be maintained by the use of template or by other approved means. Any pile driven out of correct locations shall be pulled out and re-driven by the contractor at no additional cost. No lateral force of any nature or magnitude shall be permitted to pull a pile into correct position or vertical alignment.

7.3.6 DRIVING OF PILES

7.3.6.1 PILE LENGTH

The criteria for pile length and bearing capacity will be determined by the Engineer according to the results from test piles and load tests. The piles shall be driven to such depths, that the bearing loads indicated on the Drawings are obtained.

The criterion for pile length may be one of the following:

1. Piles in sand and gravel shall be driven to a bearing value determined by use of the pile driving formula or as decided by the Engineer-in-Charge.

2. Piles in clay shall be driven to the depth ordered by the Engineer-in-Charge. However, the bearing value shall be controlled by the pile driving formula if called for by the Engineer-in-Charge.

3. Piles shall be driven to refusal on rock or hard layer when so ordered by the Engineer-in-Charge.

The Contractor shall be responsible for correct pile lengths and bearing capacities according to the criteria given by the Engineer-in-Charge.

7.3.6.2 **PILE DRIVING**

Plies shall be driven by means of a steam hammer or an air hammer of a size and type suitable for the work, as approved by the Engineer-In-charge. The weight of the moving parts of the hammer shall not be less than 8000 pounds, unless otherwise authorized by the Engineer-In-charge. The hammer shall be operated at all times at the steam or air pressure and at the speed recommended by the manufacturer. Boiler or compressor capacity shall be sufficient to operate the hammer continuously at full rated speed. During driving, piles shall be protected by a cushion and cap approved by the Engineer-In-charge. Pile drivers shall have firmly supported leads extending to the lowest point the hammer must reach to drive the piles to cut-off elevation without the use of a follower. Each pile shall be driven continuously and without voluntary Interruption till the required depth of penetration has been attained. Deviation from this procedure shall be permitted by the Engineer-In-charge only in case the driving is stopped by causes which could not reasonably have been anticipated. Water Jet shall be allowed to be used to assist driving only when specifically authorized by the Engineer-in-charge, who shall grant such permission only where satisfactory driving cannot be obtained otherwise. Where jetting is authorized, the Jetting equipment shall be of a type and capacity approved by the Engineer-In-charge. The lowest 3 feet shall however, be always driven without jetting. Unless otherwise authorized by the Engineer-in-charge no pile shall be driven within 100 feet of concrete less than seven days old. Unless otherwise specified or directed by the Engineer-in-charge all pile tops shall be driven to cut-off elevation.

7.3.6.3 **PILE DRIVING FORMULAS**

Pile driving formulas may be used to determine the number of blows of hammer per unit of pile penetration needed to obtain the specified bearing capacity for piles driven in the sub-soils at the site. Piles shall be driven to a final resistance as indicated on the plans determined by the following formula:

For Drop Hammer

$$Qall = WH/[6(S+2.5)]$$

For single-acting steam or air hammers and for diesel hammers having unrestricted rebound of rams.

$$Qall = WH/[6(S+2.5)]$$ (Use when driven weights are smaller than striking weights)

$$Qall = WH/[6\{S+0.25(WD/WS)\}]$$ (Use when driven weights are larger than

striking weights).

For double-acting steam or air hammers and for diesel hammers having enclosed rams.

Qall =	E[6(S+2.5)]	(Use when driven weights are smaller than striking weights)
Qall =	E[6{S+0.25(WD/WS)}]	(Use when driven weights are larger than striking weights)

In the above formulas:

Qall = Allowable pile load in Kilograms.

W = Weight of striking parts of hammer in Kilograms.

H = The height of fall in centimetres for steam and the observed average height of fall in centimetres of blows used to determine penetration for diesel hammers with unrestricted rebound of hammer.

S = Average net penetration per blow in centimetres for the last 10 to 20 blows of steam, air, or diesel hammer, or for the last 15 centimetres of driving for a drop hammer.

E = The actual energy delivered by hammer per blow in Kilogram centimetre

WD = Driven weights in Kilogram

Note: Ratio of driven weights to striking weights should not exceed three.

WS = Weight of striking parts in Kilograms.

Modifications of basic pile driving formula:

a) For piles driven to and seated in rock as high capacity end-bearing piles: Drive to refusal (approximately four (4) to five (5) blows for the last 0.625 centimetres of driving). Re-drive open end pipe piles repeatedly until resistance for refusal is reached within two and half (2.5) centimetres of additional penetration.

b) For piles driven through stiff compressible materials unsuitable for pile bearing to an underlying bearing stratum:

   Add blows attained before reaching bearing stratum to required blows attained in bearing stratum.

c) For piles into limited thin bearing stratum:

   Drive to predetermined tip elevation, and determine allowable load by load test.

   The bearing power as determined by the appropriate formula in the foregoing list will be considered effective only when it is less than the

crushing strength of the pile. Other recognized formula for determining pile bearing power may be used when given in special specification. However, it shall be understood that the relative merits and reliability of any of the pile formula can be judged only on the basis of comparisons with the results of load tests.

7.3.7 DAMAGED AND MISPLACED PILES

Any pile which is cracked or broken because of internal defects or by improper handling or driving or which is otherwise injured so as to impair it for its intended use or any pile driven out of proper location shall be removed and replaced by the contractor at his own expense. The Engineer-in-charge may require the contractor to pull out certain selected plies (up to a maximum of 2 per cent of the total number of the plies driven subject to a minimum of 2 plies) for test and Inspection to determine their condition. Any pile so pulled out and found to be damaged to such an extent as, In the opinion of the Engineer-In-charge, would Impair Its usefulness In the completed structure, shall be removed from the site of the work, and the contractor shall furnish and drive a new pile to replace the damaged one. Piles pulled out and found to be in a sound and satisfactory condition shall be re-driven and in such a case payment for the initial driving, pulling out and re-driving shall be made to the Contractor.

7.3.8 CUT-OFF

A pile which cannot be driven to the required depth of penetration because of an underground obstruction shall be pulled out, the obstruction removed, and the pile re-driven - all at the contractor's expense. If for any reasons It Is not possible to drive a pile to the required depth of penetration, the Engineer-in-charge shall determine, whether an acceptable friction bearing capacity has been attained and, if so, shall permit the contractor to cut the pile off perpendicular to the axis of the pile at the cut-off, elevation as shown on the drawing. Otherwise, the contractor shall continue to drive the pile or pull out and re-drive the pile In order to obtain the required depth of penetration.

The cut-off method shall be used in a way that does not damage the portion of the pile to be left in place nor the pile reinforcement. Tops of piles shall be embedded in the concrete footing as shown on the Drawings. Concrete piles shall, when approved by the Engineer-in-Charge, be cut off at such a level that at least five (5) cm of undamaged pile can be embedded in the structure above. If a pile is damaged below this level, the Contractor shall repair the pile to the satisfaction of the Engineer-in-Charge. The longitudinal reinforcement of the piles shall be embedded in the structure above to a length equal to at least (40) times the diameter of the main reinforcing bars. The distance from the side of any pile to the nearest edge of the footing shall not be less than twenty (20) cm.

When the cut-off elevation for a pre-cast concrete pile or for a cast-in-place concrete pile is below the elevation of the bottom of the pile cap, the pile may be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete construction.

7.3.9 SPLICING

Piles should be lengthened when so required, by splicing after getting approval of the Engineer-in-charge. For this purpose the longitudinal reinforcement of the pile shall be exposed for a length equal to at least 50 diameters of the bars. If necessary, the concrete shall be cut away to accomplish this. Bars of the same size and of a length sufficient for the required extension shall be fastened to the exposed bars and transverse reinforcement as shown on the drawing for the pile head; concrete cuts shall be made perpendicular to the axis of the pile; and all concrete shall be removed above the elevation of the 50 diameter length cut. Bars shall, be lapped for the full length of the bars exposed. Alternatively the splicing can be done by welding the reinforcement bars if approved by the Engineer-in-charge. In such cases only enough concrete shall be removed to provide adequate working space for the welding operation.

When reinforcement has been properly placed by lapping or welding the top of the pile shall be roughened and the necessary formwork placed. Immediately before pouring concrete, the top of the concrete shall be thoroughly wetted and covered with a thin coat of neat cement mortar. Concrete of the same quality as that used to cast the pile shall then be placed finished and cured as specified for all piles, except that forms shall remain in place for at least 72 hours after placing the concrete. Driving of a spliced pile shall not be resumed till it is approved by the Engineer-in-Charge.

7.3.10 LOADING TESTS OF PILES

The loading tests on Piles shall comply with the requirements of Sub-section 7.2.6.

The Contractor shall keep accurate records of all the works accomplished under this Section. All such records shall be preserved in good condition and order by the Contractor until they are delivered and accepted by the Engineer-in-Charge. The Engineer-in-Charge shall have the right to examine such records at any time prior to their delivery to him.

The following information shall be included in the records.

a) Pile number, location and elevation of top of pile.

b) Total depth of pile

c) Quantity of concrete and steel used for the construction of each pile

d) Quantity of constituents for each batch of mix, water cements ratio and the result of all quality control tests.

e) Date and time of load testing of piles, load and settlements readings during the loading and unloading of the test piles (For test piles only).

f) Graph of time-load-settlement relationship for test (For test piles only).

g) Remarks concerning any unusual occurrence during load testing of piles.

Items (a) to (d) shall be reported on a format approved by the Engineer-in-Charge. The items (e) to (g) should be reported on forms.

The presence of Engineer-in-Charge's representative or the keeping of separate records by his representative shall not relieve the Contractor of the responsibility for the work specified in this clause. Payment shall not be made for any work for which records have not been furnished by the Contractor.

7.4 MEASUREMENT AND PAYMENT

7.4.1 COMPOSITE RATE

The measurement and payment for the items of Pile Works hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified here in, including the site clearance as approved by the Engineer-in-Charge.

Pay Item No.	Description	Unit of Measurement
7.4 a	Cast in situ concrete 4000psi (280kg/cm2) cylinder strength with maximum coarse aggregate size 38mm with Lime Stone aggregate in pile to any depth, complete in all respects	CM
7. 4 b	Boring of pile with straight rotary boring machine upto 15m depth from ground level in all types of soil, gravel boulder and rock complete in all respect	
	i. 24" (0.6m)dia	LM
	ii. 36" (1.0m) dia	LM
7.4 c	Mobilization/ De-mobilization of boring Rig/ sheet piling machine including loading and unloading etc.	
	i. Up to 25kms	NO
	ii. 25 kms to 50 kms	NO
	iii. or each Km beyond 50 Km	NO
7. 4 d	Preparation and lowering of steel cage (any dia) as per drawings to any depth	
	i. 60 grade	TON
	ii. 40 grade	TON
7. 4e	Pile load test for cast in situ piles and preparation of report and its interpretation	
	i. 60 Ton	NO
	ii. 120 Ton	NO
	iii. 240 Ton	NO
	iv. 360 Ton	NO
	v. 550 Ton	NO
	vi. 800 Ton	NO
7.4 f	Confirmatory Boring (Nx Size) as per drawing and as directed by the Engineer	LM
7.4 g	Permanent Pile Casing for Piles as per drawing and as directed by the Engineer	TON

SECTION 8 DAMP PROOF COURSE ANDWATER PROOFING

8.1 DAMP PROOF COURSE

8.1.1 SCOPE

The work shall include furnishing all labour, material and equipment and performing all services to provide the damp-proofing in foundations and over plinths of Structures as shown on the drawings and/or as directed by the Engineer-in-Charge.

8.1.2 RELATED WORKS

- Section 5 - Plain and Reinforced Concrete
- Section 9 - Cement Concrete Block Masonry
- Section 11 - Brick Masonry
- Section 13 – Roofing

8.1.3 INSTRUCTIONS

Damp proofing shall not be applied when the ambient temperature is below 4 degree Centigrade. The work shall be done by workmen experienced in the application of damp proofing, and the Contractor shall co-ordinate damp proofing operations with other phases of the work to prevent staining or damaging finished work. The Contractor shall repair or replace damaged finished work to the satisfaction of the Engineer-in-Charge. Damp proofing shall be applied as shown on the Drawings.

8.1.4 DAMP PROOFING MATERIALS

All materials i.e. cement, sand, aggregate, water, polythene sheet and bitumen shall conform to the specifications given in respective section.

(i) Concrete work shall comply with the requirements of “Non-Structural Concrete” specified in Section 5 of this specification.

(ii) Polyethylene sheet shall not weigh less than 1.64 lbs per 100 sft(80 grams per SM) i.e. 500 Gauge.

(iii) Water proofing material shall be Specified Industrial Bitumen (SIB) Grade 10/20

(iv) Primer complying with ASTM D-41

(a) Damp Proof Course

Damp Proof Course unless otherwise specified shall be minimum one inch thick 1:2:4 Plain Cement Concrete placed at the specified plinth level in accordance with the provisions of Section 5 – Plain& Reinforced Concrete.

Damp Proof Plaster

Damp Proof Plaster is generally for vertical faces and unless otherwise specified is applied with 1:3 Cement Sand Plaster complying with the provisions of Clause 15.1 – Plaster, Finishes.

(b) Polythene Sheet

Polythene Sheet shall be used over bitumen painted surface where specified and shall consist of 0.13mm thick polythene sheet (500 gauge) complying with ASTMD 2103, as approved by the Engineer-in-Charge.

(c) Water Proofing Agent

The specified water proofing agent or asphaltic materials shall be delivered in sealed containers bearing the Manufacturer's original labels. Bituminized Kraft paper shall be delivered in rolls as per Manufacturer's original packing. All materials shall conform to the Specifications designated and shall be approved by the Engineer-in-Charge. Damp proofing materials shall conform to the requirements shown on the Drawings and given hereafter.

(d) Bitumen

Bitumen for damp proofing shall meet the requirements of Clause 13.3.2 under Section 13 – Roofing and as approved by the Engineer-in-Charge

(e) Hessian Cloth

Hessian Cloth impregnated with bitumen shall be as specified for use on plain plinth surfaces.

8.1.5 EXECUTION

8.1.5.1 PREPARATION OF SURFACES

Surfaces to receive damp proofing shall be smooth, clean and dry. Holes, joints and cracks shall be painted flush with mortar. Before damp proofing, surface shall be swept clean of all foreign matter and shall be inspected and approved by the Engineer-in-Charge. The surface shall be prepared complying with the provision of Clause 13.15.2.

8.1.5.2 PLACEMENT

(a) General

The selection and combination of various water proofing and damp-proofing materials for different locations shall be as shown on the Drawings or as directed by the Engineer-in-Charge. Unless otherwise directed or approved by the Engineer-in-Charge, the procedures given in this sub-section shall be adopted.

(b) Damp Proofing under Floors and Foundations

A priming coat of the suitable thinned bitumen mixed with kerosene oil shall be applied to all parts of the surfaces to be damp proofed before the application of bitumen coating. The bitumen coat shall be applied uniformly in such a manner as to cover pores completely and to thoroughly bond with the surface, using not less than 1.71 Kg per square meter for each coat and laying single layer of polythene sheet 0.13mm thick (500 gauge) on damp proof course or as specified. The bitumen coat shall be applied after it is heated upto 325±8^{o}F (162±5^{o}C).The polythene Sheet shall be placed in such a way as to ensure proper bond with the asphalt layer.

c) Damp Proofing under Masonry Walls

(i) A layer of 1:2:4 plain cement concrete or as specified of thickness as shown on the drawings will be placed over the area to be damp-

proofed under brick masonry, cement concrete block masonry or stone masonry walls.

Horizontal D.P.C. shall extend to the full width of the wall i.e. up to the external faces. No portion of doors opening, etc. shall be left while laying D.P.C. The period of curing of concrete for subsequent construction over it shall be not less than 72 hours. Every care should be taken that concrete is not left dry during this period.

The wall top, at the required level, shall first be cleaned, kept moist for at least 2 hours. Forms shall be mortar tight. Concrete shall then be laid and finished to a level, smooth and hard surface first by wood float and then steel trowel. After removal of forms, the sides of concrete shall be finished with mortar 1:3 grey cement - sand to uniform surface free of defects. The concrete shall be cured and protected from weather for 10 days.

A priming coat of primer shall be applied at the rate of 0.5 litre/SM before the application of bitumen coating.

Bitumen Grade 10/20 shall be applied in 2 coats at the rate of 20 lbs per 100 sft per coat. Bitumen shall be heated to flow freely but not heated over specified temperature by the Manufacturer. Subsequently single layer of polythene sheet 0.13mm thick (500 gauge) on damp proof course shall be laid.

Where specified 1:2:4 concrete mixed with an approved Water Proofing Agent shall be placed as Damp Proof Course under walls.

(ii) Alternatively Damp Proofing with Hessian Cloth Impregnated with bitumen where specified at 1.25 kgs of bitumen per square metre shall be applied on smooth DPC or plastered surface. The coating of bitumen and sand blending shall be carried out as specified.

d) <u>Damp Proofing Vertical Surfaces</u>

The vertical D.P.C. shall consist of 0.75 inch thick 1:3 cement sand mortar with 5% pudlo and two (2) sand blinded coats of hot S.I.B.

(a) Clean the wall surface and keep it moist for at least 2 hours.

(b) Apply 0.75 inch thick 1:3 cement sand plaster. Finish smooth and cure for 10 days.

(c) Apply damp-proofing consisting of primer, two (2) Bitumen Coats, Sand Blinding or polythene sheet.

e) <u>Covering over Top Coat of Bitumen</u>

The topcoat of bitumen shall be covered with any of the following material as indicated in the item.

Sand Blinding

Sand for blinding bitumen shall be clean coarse dry sand, without sharp edges and impurities liable to damage the bitumen, and shall be spread over bitumen at the rate of one 1.00cft to 1.25 cft per 100 sft.

Polyethylene Sheet Covering

Specified Polyethylene sheet shall be laid over bitumen, with 6” overlap and laps or joints welded.

8.2 WATER PROOFING ROOFS

8.2.1 SCOPE

The work of insulation, water proofing and roofing of the flat or sloped roofs shall consist of provision of all labour, material and equipment for installing the insulation, water proofing and roofing whichever required in accordance with the Drawings, specified or as directed by the Engineer-in-Charge.

8.2.2 CODES AND STANDARDS

The work shall conform to the requirements of the following Codes and Standards, unless otherwise specified:

ASTM D41-11	Primer for use with asphalt in damp proofing and water proofing
ASTM D2103-15	Polyethylene film and sheeting
BS 747-77	Specifications for roofing felt.
BS 1521-72	Water proof building papers
BS 4016-72	Building paper (breather type)

8.2.3 WATER PROOFING MATERIALS

8.2.3.1 ASPHALT/BITUMEN

Special industrial asphalt shall be of 10/20 penetration, or any other type approved by the Engineer-in-Charge conforming to the following minimum and maximum limits:

Specific gravity	1.02/1.04 at 25^{o}C
Penetration, 100 gm	10/20 at 25^{o}C
Ductility (cms)	417 at 25^{o}C
Softening Point	77^{o}C / 93^{o}C
Working temperature	157^{o}C /167^{o}C

Asphalt/bitumen primer shall be from a manufacturer approved by the Engineer-in-Charge conforming to ASTM D 41, and applied at the rate of 1.45kg/sm.

8.2.3.2 FELT

The felt shall be an asphalt impregnated type 1C fibre base. The number of plys thickness shall be as specified in the Drawings. The felt shall be smooth and stout building paper having safe water proofing qualities. Weight of 3 ply standard roll of 20 x 1 metre should not be less than 54 Kilograms. The brand/make of felt shall be as specified and approved by the Engineer-in-Charge.

8.2.3.3 ISOLATION MEMBRANE/POLYETHYLENE SHEET

Isolation membrane shall be polyethylene sheet 0.13mm thick (500 gauge). The contractor shall provide sample of the sheet for approval by the Engineer-in-Charge.

8.2.3.4 JUTOID WATER PROOF MATTING

The jutoid matting shall be asphalt impregnated jute base matting as approved by the Engineer-in-Charge. The matting shall be stout jute matting having safe water proofing qualities. The thickness of the matting shall be as specified.

8.2.3.5 RUBEROID WATER PROOFING MEMBRANE

Ruberoid water proofing membrane shall be applied along with asphalt felt where specified. The thickness of the membrane shall be 4mm weighing 4 kgs per square meter. The physical properties of membrane when tested according to ASTMD5147 shall be as follows:

Property	Test Method	Values
Tensile Strength @ (nom.), lbf/in	ASTM D5147	90
Elongation @ (nom.), %	ASTM D5147	45
Low Temperature Flexibility (max.), F	ASTM D5147	7
Tear Strength (nom.), lbf	ASTM D5147	98
Dimensional Stability, %	ASTM D5147	<1

8.2.3.6 BLANCO FELT FOR WATER PROOFING

Blanco felt for water proofing shall be of standard manufacturer approved by the Engineer-in-Charge.

8.2.4 EXECUTION

8.2.4.1 ROOFING

(i) Grading Roof With Cement Concrete 1:2:4

(a) Materials

Cement, coarse sand and graded stone aggregate 20 mm nominal size, shall be used as specified in the item.

The specifications for the materials and method of preparation of concrete shall conform in general to the specification described in Section 5 – Plain & Reinforced Concrete. The grading of aggregates shall be limited between 3/4 inches maximum and 3/16 inches minimum.

(b) Laying

Before laying cement concrete for grading, the level marking to the required slope/gradient shall be made only with cement concrete on the surface of the slab at suitable spacing with the help of string and steel tape (Measuring tape) so that the mason can lay the concrete to the required thickness, slope / gradient easily in between the two level markings.

On getting the level marking approved, the surface should be sprinkled with thick cement slurry and the concrete should be laid carefully, without throwing from height, in predetermined strips.

The concrete should be consolidated by specially made wooden tamping. After the tamping is done the surface should be finished to required slope/gradient with wooden trowels without leaving any spots of loose aggregates etc.

The mixed cement concrete must be laid in position, within half an hour of its mixing. In case any quantity of concrete remains unused for more than half an hour the same should be rejected and removed from the site.

(c) Finishing

The slope of finished terrace shall not be more than 1 in 120 unless a steeper slope is ordered by the Engineer-in-Charge. The minimum thickness of the concrete at its junction with Khurra or parapets shall be 5 cm. The concrete. Shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/gola/filler at the junction of the parapet wall and the roof slab.

The finished concrete surface shall present a smooth surface with correct slopes and uniform rounding. The concrete should be free from cracks. Excess trowelling shall be avoided.

(d) Thickness

Average thickness shall be 1-1/2 inches to 3 inches and as specified.

(e) Curing

Curing shall be done either by spreading straw/Hessian cloth over the graded surface, keeping the same wet for full 10 days or flooding the graded area with water by making ponds with weak cement mortar or sand, for 10 days. Occasional curing by simply spraying water now and then shall not be permitted.

(ii) <u>Grading Roof with Cement Mortar</u>

(a) Materials

Cement and coarse sand shall be as specified in Section 5 – Plain & Reinforced Concrete.

(b) Cement mortar

Cement mortar 1:3 (1 cement: 3 coarse sand) /1:4(1 cement: 4 coarse sand) specified in the item of work shall conform to the specification described in Section 11 - Brickwork.

(c) Preparation of the surface

The surface shall be cleaned properly with brooms brush and cloth to remove all dirt, dust, mortar droppings etc.

Laying

Same as described under Clause 8.2.4.1(i) (b) above for concrete, except that cement mortar shall be tamped with wooden and steel trowels and surface finished with steel trowel.

(d) Finishing

1. The slope of finished surface shall not be more than 1 in 120 unless a steeper slope is specified.

2. The finished surface of the grading shall present a smooth surface with correct slopes and uniform roundings wherever they are provided. The mortar surface shall be free of cracks. Excess trowelling shall be avoided.

(e) Thickness

The minimum thickness of cement mortar grading at the junction with khurra or parapet wall shall be 20 mm. The cement mortar shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/gola/filler at the junction of parapet wall and the roof slab. The maximum thickness that shall be adopted for grading with cement mortar shall be 50 mm. It is not at all desirable to lay the cement mortar grading for greater thickness and in that case it is advised to go in for grading with Cement Concrete.

(f) Curing

Curing for the grading with cement mortar shall be done exactly as described under Clause 8.2.4.1(i) above for concrete.

(iii) <u>Preparation of Surface</u>

(a) Flat Roofs

All surfaces to receive roofing and water proofing treatment shall be sound, clean, smooth, dry and free of debris, loose material or defects which would have an adverse effect on the water proofing application or performance. The work shall not start until the preparatory work has been inspected and approved by the Engineer-in-Charge.

(b) Sloped Roofs

Treated wood nailing strips 254 x 50 mm size shall be embedded in the roof with top of strip flush with the deck at 900 mm on centres or as shown and the drawings and/or directed by the Engineer-in-Charge. Metal gravel strips, scuppers and roof drains shall be placed and metal flashing, flanges etc., shall be provided and installed in time. Cant strips shall be installed at the angle formed by the roof deck and the vertical surfaces.

(iv)<u>Installation of Roof Felt / Matting</u>

(a) Bitumen for built-up roofing shall not be applied when it is above 205^{o}C, (400^{o}F) nor shall it be heated above 245^{o}C (475^{o}F).

(b) The terms Felt/Matting used are synonymous. Felt shall be stacked in properly protected piles. Felt surfacing material shall always be dry and the several layers of felt shall be laid free from wrinkles.

(c) Roofing shall not be applied during rain or while surfaces are damp; it shall be applied only to surfaces that are clean and dry.

(d) Method of laying the different layers of built-up roofing shall be strictly in accordance with the recommendations of the manufacturer and the method proposed by the Contractor and approved by the Engineer-in-Charge.

(e) Built-up roofing shall not be laid when the temperature at the location of the work is below 5°C (40°F).

(f) Heating of asphalt/bitumen shall be strictly regulated by means of an accurate thermometer of approved type, kept constantly suspended in the heating kettle while the work is in progress.

(g) Entire deck surface and parapet walls shall be painted with asphalt primer or as specified and allowed to dry thoroughly. Primer shall be kept several centimetres back from joints of pre-cast panels.

(h) Mopping of surface with asphalt/bitumen shall be performed so that the surface shall be completely covered. Bond coats of asphalt shall be at the rate of 1.25 Kg per square metre or as specified. At no point shall felt touch the underlying concrete and the rate of application shall be such that the asphalt mopping shall not be more than one metre ahead of the roll of felt. All asphalt shall be applied with mops except that the hot surfacing application shall be poured from a dipper.

(i) Felt shall be laid with each sheet lapping the preceding one. Each sheet shall be lapped with an exposed lap of 300 mm. All end laps shall be 100 mm minimum. The laying of felt shall, in general, be started at low points working upwards to high points of the surface. The roofing felt shall be rolled while mopping, rubbing and pressing the felt sheets as it spreads on to the surface, so as to ensure thorough sticking and a smooth firm surface, free from wrinkles or bubbles. Roofing felt shall be extended to points and position as shown on the drawings.

(v) <u>Damp Proofing of the Roof without Felt / Matting</u>

(a) The damp proofing of the roof with bitumen coating without Felt/matting shall be carried out in accordance with the applicable items of preparation under Clause 8.2.4.1(iii) (a) above.

(b) The bitumen at the specified rate and the layers shall be applied by mopping of surface in accordance with the procedure according to the items (a), (c), (e), (f), & (h) of Clause 8.2.4.1(IV) above.

(c) Blinding with Coarse, Sand/Washed Shingle as specified shall be sprinkled and penetrated into bitumen coat to seal the surface properly.

(d) Where specified, 0.13mm thick (500 gauge) polyethylene sheet shall be spread over final coat of bitumen and rammed with minimum 75mm side laps and 100mm end laps staggered with layers bonded to gather with asphalt. The surface shall be broomed to ensure that it is free of wrinkles.

(e) The Contractor shall take care to maintain the slopes, levels and protect the work from any damage during the construction and maintenance period. The Contractor shall have to remove, replace and rectify such damaged work.

(vi) <u>Ruberoid Water Proofing</u>

The following shall be sequence of operation for lying Ruberoid water proofing:

- Asphalt Saturated Felt

- Ruberoid Compound
- Ruberoid Reelia Roofing (of the specified ply)
- Ruberoid Compound
- Washed Gravel

The roof surface shall be prepared as per (iii) above. The work shall be performed according to the instructions of the manufacturer.

Two or three underlay sheets will be unrolled and placed in position on the roof. Each sheet overlapping the adjoining one by 2 inches. Where the sheets meet the parapet or other roof obstructions they should be turned up 6 inches and bonded with Ruberoid Compound to the concrete for a width of about 15 inches.

The first spread of the underlay should be 18 inches wide so that the laps of the Ruberoid Reelia Roofing break joints with those of the underlay. Each length of the Ruberoid Reelia Roofing is in turn fitted in position and rolled back half way so that when unrolled it will resume its former position. The Ruberoid compound heated to the fusing point will then be poured from a suitable container such as watering can without a rose or a bucket and dipper at the rate of 30 lbs per hundred sft. On the underlay. As Ruberoid Reelia Roofing is rolled out pressure is applied so as to ensure adhesion while the compound is still hot. The other half of the length is then rolled up and the process repeated. The joints of the Ruberoid roofing should overlap 2 inches and care should be taken to see that ample compound is applied so that it flows out along-with edges. The length of the Ruberoid roofing should not exceed 15 feet. It is advisable that the laying operation for underlay and Ruberoid roofing should follow each other in such a way that a minimum of incomplete work is exposed to weather.

The Ruberoid roofing should be inserted for a depth of about 2 inches in the parapet wall by cutting chases in the first convenient course of parapet and covering these with cement plaster. It should be clearly understood that the underlay is not bonded with compound to the concrete substructure except at vertical abutments etc.

Over this surface of the Ruberoid roofing a bitumen compound will be spread at the rate of 30 lbs per hundred sft. In the same manner as described above washed gravel graded from 3/8 inch downward will be spread at the rate of 3 Cu.ft. Per hundred Sq.ft. over the bitumen compound and pressed to the surface by means of wooden thappies so that it adheres well to the bitumen compound.

vii) <u>Providing Blanco Roofing Felt</u>

The following will be the sequence of operation for laying Blanco roofing felt:

1. Sticking layer of bitumen
2. Layer of 2 ply Blanco felt
3. Flood coat of bitumen
4. Washed gravel

The roof surface shall be prepared as per (iii) above shall be filled in with 1:3 cement mortar. The work shall be carried out according to the instructions of the manufacturer.

Over the surface thus prepared a layer of bitumen heated to the fusing point will be spread from a suitable container such as watering cans without a rose or a bucket and dipper at the rate of 30 lbs per hundred Sq, ft.

Over this the Blanco felt roofing will be laid and the same will be pressed hard on the surface so that it may adequately adhere to it. Where the felt meets the parapet or other roofing obstruction they should be turned up 6 inches and bonded with bitumen to the concrete for a width of about 15 inches. The length of the roofing felt should not exceed 15 feet. The joints of the felt should overlap 2 inches.

Over this surface of roofing felt bitumen will be spread at the rate of 30 lbs. per hundred sft. In the same manner as described above. Washed gravel graded from 3/8 inch downward will be spread at the rate of 3 Cu.ft. Per hundred Sq.ft. over bitumen compound and pressed to the surface by means of wooden thappies so that it stick well to the bitumen.

Viii)Jutoid Water Proof Matting

Jutoid can be nailed into position over a wooden surface or can be fixed on a concrete base. If the area to be covered is more than 40 inches in width or 28 yards in length then another roll of similar dimension can be joined together by allowing an overlapping of about 4 inches in such a manner that the overlapping piece is on the higher level in case of a slope and the piece inserted below as the joint comes from the lower level of the slope. This allows the water to smoothly flow over the joint without striking it or penetrating inside to effect the water proofing. The overlap would have to be fixed with a special adhesive. This adhesive is heated, mixed with kerosene oil in specified quantities and applied hot at the joints and at the outer edges of the structure.

ix) Flashings

Roofing joints and parapets shall be provided base flashings as shown on the Drawings or directed by the Engineer-in-Charge. The base flashings can be either of the following types:

Where built-up base flashings are required, they shall be made by continuing the built-up roofing upon the cant and over the tip and securing the edge with galvanized roofing nail used with metal discs. The nails shall be spaced not over 100 mm apart.

Where metal base flashings are required, 3 layers of felt shall be applied extending up 150 mm on the vertical surface and out on the roof surfaces 100 to 150 mm respectively cementing the same in place with asphalt plastic, troweled on. These flashing strips shall be applied over the top ply of roofing and under the metal base flashing. The portion of metal flashing extending out over roof surfaces shall be covered with two additional plies of felt, 400 mm and 450 mm wide respectively and both cemented in place with bitumen.

8.3 MEASUREMENT AND PAYMENT

8.3.1 COMPOSITE RATE

The measurement and payment for the items of the work of D.P.C. & Water Proofing hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

Pay Item No.	Description	Unit of Measurement
8.3 a	Providing and laying DPC of 2000psi (140kg/cm2) cylinder strength PCC with thickness 1.5" including water proofing agent (Pudlo) etc. complete in all respect	SM
8. 3 b	Providing and laying tack coat of bitumen grade 10/20 at the rate of 0.6 kg/sm on DPC	SM
8. 3 c	Providing and laying felt/waterproof matting with 3 ply on DPC, including overlaps	SM
8. 3 d	Providing and laying polyethylene sheet 500gauge (0.13mm thick) on DPC as directed, including overlaps	SM

SECTION 9 CONCRETE BLOCK MASONRY

9.1 SCOPE

The work under this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and performing all operations in any floor and at any height in connection with the supply and installation of ordinary cement concrete solid, hollow and thermal block masonry work including wall ties, anchors, damp-proof courses, complete in strict accordance with this section of the Specifications and applicable drawings, and subject to the terms and conditions of the Contract.

9.2 MATERIALS

9.2.1 FOR BLOCK

Cement, aggregates and water for concrete blocks shall conform to the requirements as specified in Section 5 for Plain and Reinforced Concrete.

9.2.2 FOR MORTAR

The cement and sand mortar for concrete block masonry shall be as specified.

9.2.2.1 SAND

Sand for mortar shall comply with the requirements for BS-1200. It shall be graded in accordance with the following table and the various sizes of particles shall be uniformly distributed. Sand that has been in contact with seawater shall not be used unless it has been thoroughly washed to the satisfaction of the Engineer-in-Charge.

Table 9.2 (a)
Grading of Sand

Sieve Size Number	Percent Passing by Weight	
	Min.	Max.
#4	100	Not Applicable
#8	95	100
#16	70	100
#30	40	75
#50	10	35
#100	2	15
#200	0	0

The sand shall conform to the provisions of 5.3.1.3 – Plain & Reinforced Concrete for limits of deleterious material.

9.2.2.2 CEMENT

Cement shall be Ordinary Portland Cement conforming to ASTM C 150 or BS-12.

9.2.2.3 WATER

Water shall be clean and free from any harmful impurity. Where the quality of the water is doubtful, it shall be tested in accordance with BS- 3148.The water shall comply with the provisions of Clause 5.3.1.6 - Plain & Reinforced concrete.

9.2.2.4 ADDITIVES

Additives where used, shall be proprietary products used in the proportions and manner recommended by the manufacturer. The additives shall in no way adversely affect the mortar strength or contain chemicals, which may be harmful to other building materials. To add gypsum to cement is strictly forbidden.

9.2.2.5 MORTARS AND GROUT

Materials for mortar, sand, binding agent and water, shall be mixed by volume or by weight as specified for at least 3 minutes with the minimum amount of water to produce a correctly mixed mortar or grout of workable consistency in a mechanical batch mixer. For small jobs, hand mixing may be permitted, the ingredients being mixed with sufficient water to produce a correctly mixed workable mortar.

Mortar shall be as strong, but no stronger than the materials it bonds together. Mortars shall be mixed in batches, which can be used within a period before the setting process commences. Once a mix begins drying off, it shall be rejected. No ingredients shall be added to it once the setting process has begun.

9.2.2.6 THERMAL INSULATION CORE

Thermal insulation core of the sandwich block shall be made of either expanded polystyrene or extruded polystyrene.

When tested in accordance with BS EN 1602, for a sample of five specimens, the average apparent density shall be not less than 25 kg/m^3.

Thermal conductivity of the polystyrene core shall be declared by the polystyrene manufacturer according to BS EN ISO 10456 at 35ºC and 60% relative humidity (RH).When tested in accordance with BS EN 12667 or ASTM C 518, at 35ºC & 60% RH, polystyrene core thermal conductivity shall not exceed the declared value.

Polystyrene shall be of the flame-retardant type. When tested in accordance with BS EN11925-2, the flame spread shall not exceed 150 mm within 60 s. alternatively; the Oxygen index shall not be less than 24% by volume when tested in accordance with ASTM D 2863.

Polystyrene core shall have a dovetail shape. Other shapes can also be used.

Polystyrene core shall be either moulded or extruded to shape without cutting.

9.3 CONCRETE BLOCK MAKING

Concrete Blocks shall be of the sizes required as per drawings (for solid and hollow block same as 4”x8”x12, 6”x8”x12” and 8”x8”x12”) and shall conform to the requirements of ASTM C-90 “Standard Specification for Load bearing Concrete Masonry Units” or ASTM C-129 “Standard Specification for non-Load bearing Concrete Masonry Units” unless specified otherwise. The Solid and Hollow blocks shall be factory manufactured/fabricated and be machine moulded. The block making machines shall be of the standard approved by the Engineer-in-Charge. They shall be operated according to the instructions laid down by the manufacturers. The contractor shall submit samples/literature of various manufacturers for Engineer-in-Charge’s approval. The contractor should note that only blocks supplied by the approved manufacturer(s) shall be allowed to be used in the work.

The blocks shall be continuously water cured by sprinkling water for a minimum of 10 days and covered between sprinkling operations with 4 mils thick polyethylene

sheeting. During curing period no surfaces of the block will be allowed to dry.After 10 days water curing period blocks shall be allowed to dry in shade for at least twenty (20) days before use in masonry. If steam curing is to be employed, it shall be approved by the Engineer in writing, and shall be carried out as per ACI 517. It shall only be allowed at a properly equipped facility, supervised by qualified personnel.

The shrinkage of cement concrete blocks is much greater at the time it dries for the first time after moulding and subsequent curing. It is, therefore, essential that contractor shall take full care to see that blocks are sufficiently and thoroughly dried so that their initial shrinkages are completed before the blocks are laid in the wall. Under no circumstances blocks will be used in the work until they are completely dry.

Cured concrete blocks shall be stored off the ground, stacked on level platforms which allow air circulation under stacked units. Units shall be covered and protected against wetting.

Care shall be exercised in the handling of all concrete blocks. No damaged blocks shall be used in the work.

The hollow blocks shall be manufactured as per pattern shown on the drawing. These block units shall be provided by the Contractor for use where required in building structures from approved type of materials. Units shall have uniformly fine smooth surfaces of uniform colour. These shall be free of any honey combing or other imperfections or deformations, all edges true and straight, and at right angles with each other and without any chipped or otherwise broken edges.

The blocks cast on different dates shall be stacked separately and must be labelled showing the date on which they were cast.

Reinforced cement concrete hollow block masonry shall be provided where shown on the drawings. Hollow block manufactured by moulding machine shall have well formed cavities, sharp and well defined edges and corners, smooth surfaces without any imperfections or deformations.

9.4 PROPERTIES OF BLOCKS

All blocks shall be of the size and shape required to complete the work shown in the Drawings or as instructed by the Engineer-in-Charge.

The cement, sand and coarse aggregate shall be volume batched and their proportion may be adjusted so as to provide the concrete of the required strength when tested and shall be mixed in a concrete mixer in accordance with the provisions of Section 5 - 'Plain and Reinforced Concrete.

The compressive strength of various solid and hollow blocks shall be as follows when tested in accordance with ASTM C 140:

Sr. No.	Type of Concrete Masonry	Min. Compressive Strength (psi)		Location
		Average of 6 Units	Individual Unit (min.)	
1.	Solid load bearing Masonry units	2175	1740	Exposed to frost action
2.	Hollow load bearing Masonry units	1800	1450	Exposed to moisture &weather
3.	Solid/Hollow non-load bearing Masonry units	1000	870	Not exposed to moisture& weather
4.	Non Load bearing Thermal Blocks*	1000	870	Exposed to moisture &weather

***Note:** Thermal blocks shall maintain their integrity during the compressive strength test i.e. failure pattern during compressive strength test shall not show evidence of separation between the polystyrene core and the outer concrete leaves. Any evidence of separation

noticed before or during the test shall be a cause for rejection of the lot represented by the sample.

Normally 1:3:6 or 1:2:4 concrete mixes should meet the above strength requirement as per Clause 5.3.2.2 Section 5 – Plain & Reinforced Concrete. The specific gravity should be between 2.3 to 2.4.

The proportion shall however be confirmed by contractor by trial mix and approved by Engineer-in-Charge for actual site conditions.

Average Water absorption for all the six samples shall not exceed 10 percent. The average moisture content of all the concrete masonry units shall not exceed 30 percent of the total water absorption of units.

The Contractor shall provide test certificates providing the average minimum crushing strength of the blocks prior to the commencement of the construction. Further test certificates shall be provided as required by the Engineer-in-Charge to ensure that all batches of blocks have the minimum specified crushing strength.

A laboratory approved by the Engineer-in-Charge shall carry out the test. Evidence shall be produced that the block manufacturer has an efficient method of quality control. The Engineer-in-Charge may require testing of samples of blocks periodically and the Contractor shall make necessary arrangements accordingly. The method of sampling for all tests shall be in accordance with ASTM C 140.

9.5 SUCTION RATE

The Contractor shall, at his own cost, satisfy the Engineer-in-Charge that the suction rate of the block when determined in accordance with Appendix "A" of BS 3921 does not exceed 20 g/dm^2/ min. or that the Contractor is able to adjust it so that it does not exceed this value on site.

9.6 SOLUBLE SALT CONTENT

For exposed blockwork, the contents by weight percent of soluble sulphate, calcium, magnesium, potassium and sodium radicals, shall not exceed 0.30, 0.10, 0.30, 0.03 and0.03, percent respectively when ascertained in accordance with BS 3921, at the cost of the Contractor.

9.7 REINFORCING AND ANCHORS OF BLOCK MASONRY

Unless otherwise stated reinforcing and anchors shall conform to under-mentioned sizes:

Joint reinforcing shall be 1.32mm (0.05-inch) diameter mild steel wire mesh design, galvanized after fabrication. Steel wire woven into 12mm mesh 75mm wide. Reinforcing bar anchors shall be 25 mm dia. deformed bar minimum 10 inch long.

Two 6mm dia bar shall be provided at every fourth course for anchoring of block masonry to columns. Two 10 mm bars at every fourth horizontal course shall be provided for anchoring masonry walls to plinth beam/floor beam, as shown on the drawings.

Dovetail anchors and slots (if used as an alternate anchorage) shall be not less than 18 gauge galvanized steel.

9.8 ERECTION

Blocks shall be laid true to line, level and laid in accurately spaced courses in stretcher bond with vertical joints of each course located at centre of units in alternate courses below. Vertical joints shall be buttered in the entire height of blocks. Each course shall be bonded at corners and at intersections of walls and shall be properly bonded. Courses of block shall be kept plumb throughout and corner reveals shall be true and in plumb.

Standard width of mortar joints for both horizontal and vertical joints shall be 10mm (maximum). Mortar joints in walls shall have full mortar coverage on vertical and horizontal faces between the blocks. Mortar joints on wall including struck joints, shall be thoroughly compacted and pressed tight against the edges of the blocks with proper tools. Blocks terminating against soffits of beam or slab construction shall be wedged tight with wedges and the joints shall be packed solidly with mortar between the top of the block and the bottom of slab or beam. Control expansion joints shall be kept free from mortar or other debris.

Unless otherwise shown on the drawings or specified by the Engineer-in-Charge, the spaces around doorframes and other material or built in items shall be solidly filled with mortar. Spaces around the door and window holdfasts shall be filled in with 1:3:6 concrete. Work required to be built in with masonry including doorframe anchors, wall plugs, and dovetail anchors and accessories shall be built in as the erection progresses.

The block work shall be carried up in a uniform manner and no portion shall be carried more than one metre above the adjoining one at any time. All masonry shall be kept strictly true and square and the whole properly bonded together and levelled round each floor.

Sleeves, Chases, holes, sinking and mortices for other trades shall be correctly located and formed to the sizes as required by the relevant trades. Chiselling of completed walls or the formation of holes shall only be carried out as per design drawings with the approval of the Engineer-in-Charge.

Walls of blocks indicated, as being non-load bearing shall be constructed on the in situ concrete floor slab unit after the floor formwork is struck and the concrete has obtained sufficient strength to support their-weight. Toothing into load-bearing walls shall not be permitted.

All bolts, anchors, ties, pipe sleeves, flushing metal attachments, lintels and the like required to be built into the work shall be correctly inserted and executed as the work proceeds.

Walls or partitions abutting concrete columns or walls shall be securely anchored and tied with metal anchors or ties at not more than 450mm vertical centres. Wall ties cast in with concrete shall be bent down after the removal of formwork and shall be securely jointed into the mortar beds of walling.

Care shall be taken during construction of cavity walls so as to avoid the filling up of cavity with mortar. G.I. flashing and weep holes shall be provided wherever specified on the drawings or as per the instructions of the Engineer-in-Charge. Weep holes will be formed by oiled rods, removed after the mortar is set, at specified locations.

9.9 SCAFFOLDING

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the Engineer-in-Charge shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc. shall be included by the Contractor in the unit rate for masonry items.

Damage to masonry from scaffolding or from any other object shall be repaired by the Contractor at his own cost.

9.10 JOINTING

Jointing is the forming of joints as work proceeds. Joints shall be as follows:

- Exterior exposed joints shall be tightly formed to a weather joint with the point of the trowel.
- Interior exposed joints shall be tightly formed to a concave joint.
- Joints which are subsequently covered with plaster or other finish materials shall be struck flush.

9.11 TOLERANCES

All block work shall be erected plumb and true to line and level with the maximum variation in any storey height or any length of wall being one mm in one metre. The maximum tolerance in the length, height or width of any single masonry unit shall be $\pm$ 3mm.

9.12 DAMP PROOF COURSE

Damp-proof course shall be laid on an even mortar bed, free from projections, which may puncture the material. Where the damp-proof course is to be stepped, only flexible membrane shall be used. All damp proof course, unless otherwise specified, shall consist of 1:2:4 cement concrete 50mm thick, mixed with 2.5kgpudlo per bag of cement or other approved quality water proofing compound as per manufacturer's specifications and shall be laid at required levels as per drawings and instructions of the Engineer-in-Charge. The D.P.C shall be tamped consolidated, levelled, edges and corners made to the requirements of concerned drawings including finishing and curing complete.

9.13 SOLID BLOCK WORK AROUND OPENING OF HOLLOW MASONRY

Around all openings in hollow block masonry, the Contractor shall provide solid block work of same thickness as that of hollow block masonry wall and of width as indicated on the Drawings. Solid block shall be laid around openings in such a manner that these are bonded integrally with hollow block masonry.

9.14 REINFORCED HOLLOW BLOCK MASONRY

Where specified on the Drawings, reinforced hollow block masonry shall be provided. Horizontal and vertical reinforcement shall be cold worked deformed bar. Two bars of (8mm) diameter shall be provided at every third horizontal course at 600mm centres, while the vertical reinforcement shall be two bars of (12mm) diameter at 800mm centres. Bars shall be anchored and held firmly vertical in respective beams and columns in the manner shown in shop Drawings. The reinforced hollow part of the block wall shall be solidly filled with Concrete (1:2:4) at intervals of one meter maximum height as the laying of block masonry work proceeds. The filled concrete shall be consolidated thoroughly by rodding to avoid formation of voids. Contractor shall submit shop drawings of anchoring and placing of reinforcement in hollow block masonry for approval of the Engineer-in-Charge.

9.15 REINFORCED MASONRY WALLS (Quetta Bond)

The reinforced pocket type walls are common for engineered structural masonry construction. Vertical wall reinforcement can be placed in vertical ducts (pockets) formed between solid or hollow masonry units. This is the case when so called "quetta bond"(a brick and a half wall thickness bond) is constructed. In "quetta bond" close spacing of vertical re-bars is possible. The reinforced pocket type masonry also allows for forming reinforced masonry columns, where ducts (pockets) of bigger size can accommodate multiple bars as well as stirrups for concrete infill or grout confinement.

For this type of reinforced masonry the vertical re-bars are placed into position ideally before the laying of masonry units. Horizontal reinforcement is placed in the bed joints at vertical spacing maximum 600 mm. The vertical reinforced ducts are filled with concrete or grout as the construction of the wall progresses. Contractor shall submit shop drawings of anchoring and placing of reinforcement in hollow block masonry for approval of the Engineer-in-Charge.

Reinforced pocket cavity masonry wall construction is shown on Figure 9.1

9.16 CURING AND REPAIRS

All block masonry shall be water cured and shall be kept wet for at least seven days, by an approved method, which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements of the specifications for water used in the manufacture of blocks.

If, after the completion of any block masonry, the work is not in alignment or level, or does not, conform to the lines and grades shown on the Drawings or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Engineer-in-Charge grants permission, in writing, to patch or replace the defective area.

9.17 MASONRY SHORT OF HEIGHT

In case of different thickness of slab in different areas or rooms or for any other reasons, whatsoever if chiselling of masonry is required, the Contractor shall do so at his own cost. Where for any reason whatsoever, the height of the wall is short of

ceiling height, the actual height shall be made good with 1:3:6 nominal mix concrete. This concrete shall neither be measured nor be paid under item of concrete but will be paid for under the item of wall masonry. Similarly where the lintel heights are such that the Contractor has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiselling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate of masonry.

9.18 MEASUREMENT AND PAYMENT

9.18.1 COMPOSITE RATE

The measurement and payment for the items of the work of Cement Concrete Block Masonry here of shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work, as specified herein, including the site clearance as approved by the Engineer-in-Charge.

Measurement and payment of in-fill concrete or steel reinforcement, if used, shall be paid under relevant item of these Specifications.

Pay Item No.	Description	Unit of Measurement
9.18 a	Providing and laying block masonry up to 12ft (3.65m) height with local solid block (1800psi strength) size 4”x8”x12 with CS mortar including scaffolding, racking of joints, curing complete in all respect	
	i. CS Mortar Ratio 1:2	CM
	ii. CS Mortar Ratio 1:4	CM
9.18b	Providing and laying block masonry up to 12ft (3.65m) height with local solid block (1800psi strength) size 6”x8”x12 with CS mortar including scaffolding, racking of joints, curing complete in all respect	
	i. CS Mortar Ratio 1:2	CM
	ii. CS Mortar Ratio 1:4	CM
9.18c	Providing and laying block masonry up to 12ft (3.65m) height with local solid block (1800psi strength) size 8”x8”x12 with CS mortar including scaffolding, racking of joints, curing complete in all respect	
	i. CS Mortar Ratio 1:2	CM
	ii. CS Mortar Ratio 1:4	CM
9.18 d	Providing and laying block masonry up to 12ft (3.65m) height with local hollow block (1200psi strength) size 4”x8”x16” with CS mortar including scaffolding, racking of joints, curing complete in all respect	
	i. CS Mortar Ratio 1:2	CM
	ii. CS Mortar Ratio 1:4	CM
9.18 e	Providing and laying block masonry up to 12ft (3.65m) height with local hollow block (1200psi strength) size 6”x8”x16” with CS mortar including scaffolding, racking of joints, curing complete in all respect	
	i. CS Mortar Ratio 1:2	CM
	ii. CS Mortar Ratio 1:4	CM

9.18 f Providing and laying block masonry up to 12ft (3.65m) height with local hollow block (1200psi strength) size 8”x8”x16” with CS mortar including scaffolding, racking of joints, curing complete in all respect

i. CS Mortar Ratio 1:2 CM

ii. CS Mortar Ratio 1:4 CM

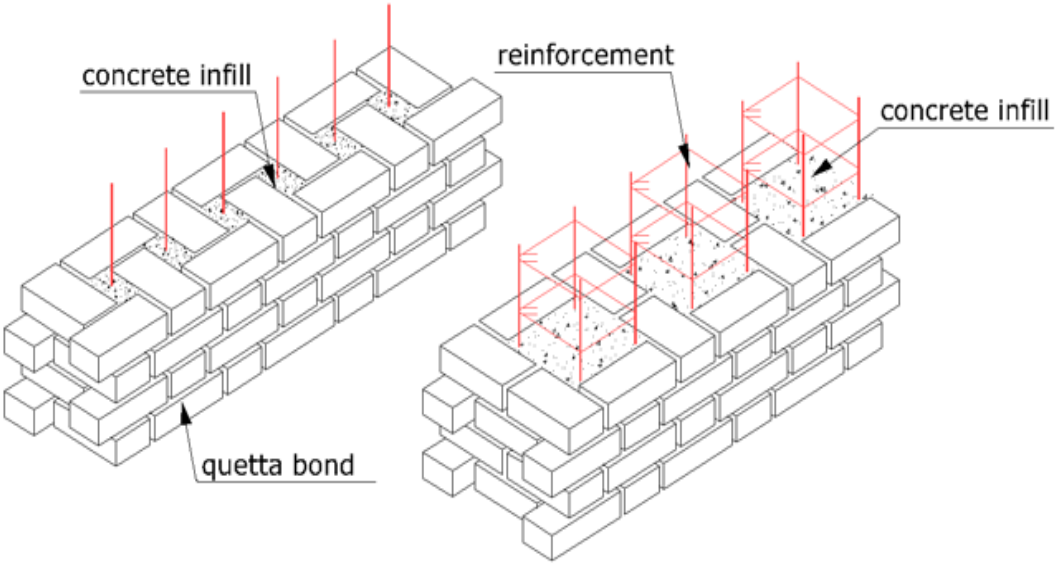


Fig 9.1: Reinforced Masonry Walls (Quetta Bond)

SECTION 10 STEEL REINFORCEMENT

10.1 DESCRIPTION

This work shall consist of furnishing, fabricating and placing of steel reinforcement of the type, size, shape and grade required in accordance with these specifications, and in conformity with the requirements shown on the Drawings and Special Provisions or as directed by the Engineer.

10.2 MATERIAL REQUIREMENTS

All materials shall conform to the requirements hereinafter given. Test reports from approved sources shall be submitted to the Engineer for all steel reinforcement used. These reports shall show the results of chemical and physical tests made.

i) Deformed Billet-Steel Bars (Grades 40 and 60) for Concrete Reinforcement AASHTO M-31 (ASTM A-615).

ii) Deformed and Plain Stainless Steel Bars for Concrete Reinforcement ASTM A-955.

iii) Zinc-Coated (Hot Dipped Galvanized) Steel Bars for Concrete Reinforcement ASTM A-767.

iv) Steel Wire and Welded Wire Reinforcement ASTM A-1064.

v) Structural Shapes for Concrete Reinforcement ASTM A-36

Corrosion protection / corrosion resistant steel reinforcement shall be used within one (1) kilometer of coastline or in any corrosive environment where chloride ion action is likely to cause steel corrosion.

10.2.1 EPOXY COATED STEEL REINFORCEMENT

Epoxy coated steel reinforcing bars shall be used, in moderate to high corrosive environment, or where specified in the drawings.

Reinforcing bars for epoxy coating shall comply with ASTM A-615 and epoxy coating shall comply with ASTM A-775.

At least 90% of all epoxy coating thickness measurements after curing shall be 175 to 300µm for bars sizes Nos. 10 to 16 [Nos. 3 to 5] and 175 to 400µm for bar sizes Nos. 20 to 57 [Nos. 6 to 18]. A finding that more than five (5) percent of the coating thickness measurements are below 125µm shall be considered cause for rejection. The upper thickness limit shall not apply to repaired areas of damaged coating.

On average, there shall not be more than 3 holidays per meter on a coated steel reinforcing bar (holiday is a discontinuity in a coating that is not discernible to a person with normal or corrected vision.). The average applies to the full production length of a bar. A wetting agent shall be used as per Test Methods ASTM G-62 in the inspection for holidays on the coated steel reinforcing bars.

The requirements for coating continuity, flexibility and adhesion as per ASTM A-775 for epoxy coated steel reinforcing bars shall be met at the manufacturer's plant prior to shipment.

10.2.2 STAINLESS STEEL (SS) REINFORCEMENT

Stainless Steel Reinforcement Bars shall be used in very important structures; where highest corrosion resistance is required. SS bars shall only be used if specified in the drawings and Bill of Quantities or upon written instructions of the Engineer. The type of stainless steel shall be 304 or 316as specified, conforming to ASTM A-955. SS bars shall have mill de-scaled and pickled surface. SS bars with mill-scale or over-pickled surface shall not be used as reinforcement.

10.2.3 HOT DIPPED GALVANIZED (HDG) STEEL REINFORCEMENT

HDG steel reinforcement bars shall be used for moderate to high corrosion protection or where specified. HDG bars shall conform to ASTM A-767. Class-I galvanizing shall be used for higher corrosion protection. If class of corrosion protection is not specified, Class-II protection shall be provided.

10.3 CONSTRUCTION REQUIREMENTS

10.3.1 FABRICATION OF BENT BARS

a) Order Lists

Before materials are ordered all order lists and bending diagrams shall be furnished by the Contractor, for the approval of the Engineer. The approval of order lists and bending diagrams by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of such lists and diagrams. Any expenses incident to the revisions of material furnished in accordance with such lists and diagrams to make it comply with the drawings shall be borne by the Contractor.

b) Storing and Surface Condition of Reinforcement

Steel reinforcement shall be stored above the surface of the ground on platforms, skids, or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, detrimental rust, loose seals, paint, grease, oil, or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Surface seams, surface irregularities, or mill scale will not be cause for rejection, provided the minimum dimensions, cross-section area, and tensile properties of a hand-wire brushed specimen meets the physical requirements for the size and grade of steel specified.

Epoxy Coated Reinforcement

In addition to the requirements mentioned above, following precautions shall be taken in handling and storage of epoxy coated reinforcement.

Coated and uncoated steel reinforcing bars shall be stored separately.

Coated bars shall be transported and handled with care. All systems for handling coated bars shall have padded contact areas. All bundling bands shall be padded, or suitable banding shall be used to prevent damage to the coating. All bundles of coated bars shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge to prevent bar-to-bar abrasion from sags in the bundles. The bars or bundles shall not be dropped or dragged.

All systems for handling the coated bars at the jobsite shall have padded contact areas.

Coated bars or bundles shall not be dropped or dragged. Coated steel reinforcing bars shall be off-loaded as close as possible to their points of placement or under the crane so that the bars can be hoisted to the area of placement to minimize re-handling.

Coated bars or bundles shall be stored above the ground on wooden or padded supports with timbers placed between bundles when stacking is necessary. Space the supports sufficiently to prevent sags in the bundles.

Long-term storage shall be minimized and material delivery shall be scheduled to suit construction progress. If circumstances require storing coated steel reinforcing bars outdoors for more than two (2) months, protective storage measures should be implemented to protect the material from sunlight, salt spray and weather exposure.

Permissible amount of damage and repair of epoxy coating shall be as follows:

1 The maximum amount of repaired damaged coating shall not exceed 1% of the total surface area in each 0.3m of the bar. This limit on repaired damaged coating shall not include sheared or cut ends that are coated with patching material. If the amount of repaired damaged coating in any 0.3m length of a coated bar, exceeds 1%, that section shall be removed from the coated steel reinforcing bar and discarded.

2 All damaged coating due to fabrication or handling (to the point of shipment) shall be repaired with patching material.

3 Repaired areas shall have a minimum coating thickness of 175 µm.

4 When coated bars are sheared, saw-cut, or cut by other means during the fabrication process, the cut ends shall be coated with patching material. Coated steel reinforcing bars shall not be flame cut.

5 Repair of damaged coating shall be done in accordance with the patching material manufacturer's written recommendations.

Hot Dipped Galvanized Reinforcement

In addition to the requirements mentioned above, following precautions shall be taken in handling and storage of HDG reinforcement.

In addition to the requirements mentioned above, following precautions shall be taken in handling and storage of HDG reinforcement.

HDG and uncoated steel reinforcing bars shall be stored separately.

HDG bars shall be transported and handled with care. All systems for handling HDG bars shall have padded contact areas. All bundling bands shall be padded, or suitable banding shall be used to prevent damage to the bars. The bars or bundles shall not be dropped or dragged.

All systems for handling the coated bars at the jobsite shall have padded contact areas.

HDG bars or bundles shall not be dropped or dragged. HDG steel reinforcing bars shall be off-loaded as close as possible to their points of placement or under the crane so that the bars can be hoisted to the area of placement to minimize re-handling.

c) Fabrication

Bent bar reinforcement shall be cold bent to the shapes shown on the drawings or required by the Engineer. Bars shall be bent around a pin having the following diameters (D) in relation to the diameter of the bar (d):

Stirrups & column tie bars	D = 4xd
Other bars having:	
d<3.5 cm (1-3/8") (No.11 bar)	D = 5xd
d>3.5 cm (1-3/8")	D = 10xd

10.3.2 PLACING AND FASTENING

a) Protection of Material

Steel reinforcement shall be protected at all times from injury. When steel, placed in position as shown on the Drawings, has easily removable and detrimental rust, loose scale, or dust, it shall be cleaned by a satisfactory method, approved by the Engineer.

Epoxy Coated Reinforcement

Following additional protection shall be adopted for epoxy coated reinforcement:

When placing coated steel reinforcing bars, all wire bar supports, spacers, and tying wire shall be coated with dielectric material, for example, an epoxy-coated or plastic coated material compatible with concrete which will not damage or cut the coating.

After placing, walking on coated steel reinforcing bars shall be minimized. The placement of mobile equipment shall be planned to avoid damage to the coated bars.

Placed coated bars shall be covered with opaque polyethylene or other suitable protective material if cumulative environmental exposure of the coated bars, including previous uncovered storage time, of greater than two months prior to concrete embedment is expected. Provisions shall be made for adequate ventilation to minimize condensation under the cover.

When immersion-type vibrators are used to consolidate concrete around epoxy-coated steel reinforcing bars, the vibrators shall be equipped with rubber or nonmetallic vibrator heads.

Hot Dipped Galvanized Reinforcement

Following additional protection shall be adopted for HDG reinforcement:

When placing HDG steel reinforcing bars, all wire bar supports, spacers, and tying wire shall be coated with Zinc or a dielectric material, for example, an epoxy-coated or plastic coated material compatible with concrete.

When immersion-type vibrators are used to consolidate concrete around epoxy-coated steel reinforcing bars, the vibrators shall be equipped with rubber or nonmetallic vibrator heads.

When the extent of coating damage exceeds 2% of the surface area of the coated steel reinforcing bar in any 0.3–meter length, the coated bar shall be

rejected. When the extent of the damage does not exceed 2% of the surface area in any 0.3–meter length, all damaged coating discernible to a person with normal or corrected vision shall be repaired with a zinc-rich formulation complying with ASTM A-767. Repair shall be done as per instructions of the manufacturer and concreting shall not be started before repair material has completely cured.

b) Placing and Fastening

Reinforcing steel shall be accurately placed in the position shown on the Drawings and firmly held during the depositing and finishing of the concrete. Cover, the distance between the external face of the bar and the face of the finished concrete, shall be as indicated on the Drawings. Reinforcing steel bars embedded in concrete shall not be bent after they are in place. Bars shall be tied at all intersections with 16 gauge black annealed wire except that where spacing is less than 1 ft (0.3m) in each direction, alternate intersections need to be tied. All intersections shall be tied in the top mat of reinforcement placed on bridge decks and the top slabs of box culverts. Abrupt bends shall be avoided except where one steel bar is bent around the other.

Stirrups and ties shall always pass around the outside of main bars and be securely attached thereto. All reinforcing steel shall be securely held at the proper distance from steel forms, which remain in place by means of galvanized steel bars or chairs placed on the forms. All reinforcing steel, except as mentioned above, shall be securely held at the proper distance from the forms by means of templates, concrete blocks or galvanized steel chairs. Metal chairs shall not be used against formed surfaces, which will be exposed in the finished structure after the forms are stripped. Blocks for holding reinforcement away from contact with the forms shall be precast concrete blocks of approved shape, and dimensions and shall have 16-gauge black annealed tie wires embedded in them. The precast concrete block shall have a compressive strength equal to that specified for the class of concrete to be placed in the work. Layers of bars shall be separated by approved metal chairs or bolsters.

Any broken or damaged concrete spacer blocks shall be removed before concrete is placed. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks as spacers will not be permitted. Reinforcing steel when placed in the work shall be free from flake rust, dirt and foreign material and before any concrete is placed, any mortar which may be adhering to the reinforcing steel shall be removed. No concrete shall be deposited until the Engineer has inspected the placing of the reinforcing steel and given permission to place the concrete. The Contractor shall allow the Engineer four hours time after the reinforcement and forms are in place to conduct the inspection. Any bar of incorrect size, length or shape shall be removed and replaced with correct bars. Any bar located or spaced incorrectly shall be relocated or spaced correctly before permission is given to place concrete and such replacements and corrections shall be at the Contractor's expense. All concrete placed in violation of these provisions shall be rejected and removed.

When formwork for casting concrete is made of uncoated steel or stainless steel, the use of galvanized steel reinforcing bars shall necessitate an electrical isolation of the galvanized steel reinforcing bars from the formwork.

c) Splicing

All reinforcement shall be furnished in the full lengths indicated on the Drawings unless otherwise permitted. Splicing of bars, except where shown

on the drawings, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible and with a minimum separation of not less than forty (40) times bar diameters. Not more than one third (1/3) of the bars may be spliced in the same cross-section, except where shown on the drawings.

Unless otherwise shown on the Drawings, bars shall be lapped with a minimum overlap of forty (40) times the bar diameter. In lapped splices, the bars shall be placed in contact and wired together. Lapped splices will not be permitted at locations where the concrete section is insufficient to provide a minimum clear distance of one bar diameter or one and one third (1-1/3) the maximum size of coarse aggregate between the splice and the nearest adjacent bar. Welding of reinforcing steel shall be done only if detailed on the Drawings or if authorized by the Engineer in writing. Spiral reinforcement shall be spliced by lapping at least one and one half (1-1/2) turns or by butt welding unless otherwise shown on the Drawings.

Splicing / connection of uncoated steel bars and galvanized bars shall be isolated through use of vinyl tape or other non conducting material.

d) Lapping of Bar Mat

Sheet of mesh or bar-mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The overlap shall not be less than one mesh in width.

e) Covering

The minimum covering, measured from the surface of the concrete to the face of any reinforcement bar shall, unless otherwise shown on the Drawings or directed by the Engineer, not be less than 5 cm except as follows:

Top of slab	4.0 cm
Bottom of Slab	3.0 cm
Stirrups and ties in T-beams	3.5 cm

In the footings of abutments and retaining walls the minimum covering shall be 7.5 cm. In work exposed to the action of sea water the minimum covering shall be 10 cm.

Table 404-1: Difference in Properties of Steel Bars used in Construction Industry

Sr. #	Properties	NO.	Description	Unit	M.S Bar	Deformed	Deformed	Steel
					G-40	Bar G-60	Bar G-75	Tendons
1	Chemical	i	Carbon	%	0.3	0.27	0.3	0.6-0.9
		ii	Sulphur	%	0.025	0.05	0.05	0.04
		iii	Phosphorus	%	0.025	0.05	0.05	0.04
		iv	Nitrogen	%				0.012
		v	Silicon	%	0.15-0.35			0.1-0.35
		vi	Chromium	%				
		vii	Manganese	%	0.4-1.1	<2	<2	0.5-0.9
2	Mechanical	i	Yield Strength	Ksi	32-33	60	75	
		ii	Elasticity	Ksi	27,000-30,000			
		iii	Tensile Strength	Ksi	53-55	69-109	87-119	
		iv	Elongation	%	23	>15	>13	
3	Physical	i	Boiling Point	Centigrade	1350-1550			
		ii	Density	Lbs/ft^3	480-500			

10.4 MEASUREMENT AND PAYMENT

10.4.1 MEASUREMENT

The quantity to be paid for shall be the calculated theoretical number of metric tons of reinforcement steel bars, mesh or mats as determined from the approved bar bending diagrams and incorporated in the concrete and accepted, except when reinforcement is paid for under other pay items.

The weight of plain or deformed bars or bar mat will be computed from the theoretical weight of plain round bars of the same nominal size as shown in the following tabulation:

Table 10-2: ASTM Standard Bar Weights

Bar Designation		Nominal Unit Weight	
Inch	**SI**	**Lbs. Per Foot.**	**Kg. Per Meter**
# 3	10	0.376	0.560
# 4	13	0.668	0.994
# 5	16	1.043	1.552
# 6	19	1.502	2.235
# 7	22	2.044	3.041
# 8	25	2.670	3.973
# 9	29	3.400	5.059
# 10	32	4.303	6.403
# 11	36	5.313	7.906
# 14	43	7.650	11.380
# 18	57	13.600	20.240

Clips, ties separators, and other material used for positioning and fastening the reinforcement in place and structural steel shall not be included in the weight calculated for payment under this item. If bars are substituted upon the Contractor's request and as a result more steel is used than specified, only the amount specified shall be measured for payment.

When laps are made for splices, other than those shown on the Drawings or required by the Engineer and for convenience of the Contractor, the extra steel shall not be measured nor paid for.

When continuous bars are shown on the Drawings, without the splices being shown the necessary steel in the splices will be paid for on the basis of the individual bars not being shorter than twelve (12) meters.

For bent bars, the length along centre-line of bar will be paid.

10.4.2 PAYMENT

The accepted quantity measured as provided above shall be paid for at the contract unit prices respectively for the pay items listed below and shown in the Bill of Quantities which price and payment shall be full compensation for furnishing materials, labour, equipment and incidentals necessary to complete the item.

Pay Item No.	Description.	Unit of Measurement
10.4 a	Providing, fabricating, laying 40 grade deformed bar reinforcement for all kinds of RCC work in foundation, plinth and up to 12ft (3.65m) height including cutting, bending, binding, wastage over-laps, cost of binding wire as per AASHTO M-31	TON
10.4 b	Providing, fabricating, laying 60 grade deformed bar reinforcement for all kinds of RCC work in foundation, plinth and up to 12ft (3.65m) height including cutting, bending, binding, wastage over-laps, cost of binding wire as per AASHTO M-31	TON

SECTION 11 BRICKWORK

11.1 SCOPE

All brick masonry required to be constructed under these specifications for masonry buildings, structures, piers, abutments, and perforated as directed by the Engineer-in-Charge, shall consist of the materials herein specified and cement sand mortar shall be proportioned, mixed, and bricks placed in accordance with the requirements stated herein. The requirements set forth herein shall apply to all brickwork, except when such requirements are specifically modified by the Engineer-in-Charge for any particular item of work.

11.2 APPROVAL OF SUPPLY SOURCE

All products supplied under this section must be obtained from an approved source with respect to strength and quality. The contractor will not be permitted to change the source of supply without the permission of the Engineer-in-Charge.

11.3 CLAY MASONRY UNITS (BRICKS)

The clay bricks shall be manufactured from good firm loam with a clay content ranging from 10 to 20 percent as per BS 6669, which will give plasticity index of 7. The earth shall be free from objectionable quantities of lime, gravel, coarse sand and roots or other organic matter. Salts and calcium silicates in the earth shall not exceed 0.5% and 2.0% respectively as given in BS 187.

The common burnt clay bricks shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warp age and organic matter, have a frog 100 mm in length 40 mm in width and 10 mm to 20 mm deep on one of its flat sides as per BS 4729. Bricks made by extrusion process and brick tiles may not be provided with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.

11.3.1 DIMENSIONS

Nominal size of clay bricks/tiles shall be as follows as per BS 4729:

Bricks	9 inches x 4-1/2 inches x 3 inches (225x113x75mm)
Tiles	12 x 6 x 2 inches (300x150x50mm)
	12 x 6 x 1-1/4 inches
	9 x 4-1/2 x 2 inches

The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in colour and emit clear ringing sound when struck. Bricks required for construction works usually measure 225x113x75 mm as nominal size. However, Bricks/Tiles used for special works shall measure according to the special needs.

11.4 CLASSIFICATIONS

Bricks as they come from the kiln are stored and stacked in stacks of one or two thousands separately, accordingly as they are First Class, Second Class, Third Class (under burnt or 'pilla' Fourth Class (over-burnt or 'Jhama') and Fifth Class (Sundried) Bricks.

11.4.1 FIRST CLASS BRICKS

The size of bricks shall be as specified. They shall be well burnt without being vitrified. They shall be of uniform colour, regular in shape and size, with sharp and square corners and parallel faces. They must be homogeneous in texture and emit a clear ringing sound when struck. They shall be free from flaws and cracks. They shall not absorb more than 1/6th of their weight of water after being soaked for one hour at a temperature of 24 to 26^{o}C, and shall show no signs of efflorescence on subsequent drying. The average compressive strength of six representative bricks shall not be less than2000 pounds per square inch. The average weight of ten bricks shall not be less than 5.5 lbs. (2.5 kgs).

11.4.2 SECOND CLASS BRICKS

Second class bricks shall be as well burnt as first class, or slightly over-burnt but not vitrified in any part and must give a clear ringing sound when struck. In this class of bricks slight irregularities in size, shape, or colour will be accepted but not such as to give irregular or uneven courses when used. Second class bricks may have slight chips or flaws. They shall not absorb more than 1/4th their weight of water after one hour's immersion in water of 24 to 26^{o}C. Their compressive strength shall not be less than1500 pounds per square inch. The average weight of bricks shall not be less than 5.5 lbs. (2.5 kgs).

11.4.3 THIRD CLASS BRICKS OR UNDER-BURNT OR PILLA BRICKS

These bricks are not as fully burnt as first or second class bricks. Any defects in uniformity or shape must not be such as to cause difficulty in obtaining uniform courses with their use. Their compressive strength shall not be less than 1000 lbs. per square inch. The use of third class bricks is prohibited except as substitutes for sundried bricks.

11.4.4 FOURTH CLASS JHAMA BRICKS

Jhama bricks are bricks so over-burnt as to get vitrified or distorted and are useless for exact work. Their compressive strength shall not be less than 725 lbs. per square inch. They may be broken up for ballast provided the vitrified mass has not become porous or spongy in the process of being over-burnt.

11.4.5 FIFTH CLASS OR SUNDRIED BRICKS

Sundried bricks shall be un-burnt bricks. Any defects in uniformity or shape must not be such as to cause difficulty in obtaining uniform courses with their use. Their compressive strength shall not be less than 500 lbs. per square inch.

11.5 GENERAL PHYSICAL CHARACTERISTICS

A good clay brick should have a fine, compact and uniform texture. It should be sound, hard and well burnt, and should give a metallic tinkle when struck with a hammer or another brick. It should be of uniform colour and free from cracks, fissures, holes, air bubbles. Lumps, pebbles and stones and particles of lime, etc. It should not contain soluble salts in excess of 0.5%.

11.6 COMPRESSIVE STRENGTH

Bricks/Brick tiles shall be classified on the basis of their minimum average compressive strength of six samples, specified and summarised here below:

Designation	Min. Average compressive strength(psi)
First Class	2000
Second Class	1500
Third Class	1000
Fourth Class	725

11.7 SAMPLING AND TESTS

Samples of bricks shall be subjected to the following tests:

a) Dimensional tolerance
b) Water absorption
c) Efflorescence
d) Compressive strength

11.7.1 SAMPLING

For carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken by one of the methods given below:-

Sampling Bricks or Tiles from a motion

Whenever practicable samples shall be taken whilst the bricks or tiles are being moved; for example, during loading or unloading. In this case the bricks or tiles shall be taken at random from each of a number of convenient portions of the consignment or batch. The portion chosen should be small enough in relation to the whole to provide the minimum number of samples specified below.

Sampling Bricks or Tiles from a stack

Samples shall be taken each at random from a stack of bricks or tiles. The number of bricks required for the tests shall be taken from across the top of the stack, the sides accessible and from the interior of the stack by opening the trenches from the top.

Whichever method is employed a sample of 50 bricks/tiles shall be taken at random from every consignment of 50,000 bricks/tiles or part thereof.

The samples thus taken shall be stored in a dry place not in contact with the ground until the tests are made. The bricks for tests shall be taken at random from the sample.

11.7.2 TESTING OF SAMPLES

11.7.2.1 VISUAL & DIMENSIONAL CHARACTERISTICS

The Visual & Dimensional Characteristics of bricks/tiles as specified under 11.4.1, 11.4.2 & 11.4.6 shall be checked on a sample of 20 first class & 2nd class bricks.

11.7.2.2 COMPRESSIVE STRENGTH

The average compressive strength of six representative bricks, when tested according to ASTM Designation C-67 shall have a minimum average compressive strength for various classes as given in Sub-Section 11.5. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%.

11.7.2.3 WATER ABSORPTION

The average water absorption of first class & second class bricks for a sample of six bricks when tested shall be not more than as specified in Clause 11.4.1 and 11.4.2.

11.7.2.4 EFFLORESCENCE

The bricks checked for water absorption as per Clause 11.6.4 shall shown signs of efflorescence in drying.

11.7.3 CRITERIA OF ACCEPTANCE

If more than 10% bricks in the stacks do not conform to any of the specification requirements, than the whole consignment shall be rejected.

11.8 BRICK WORK

11.8.1 CLASSIFICATION

The brick work shall be classified according to the class designation of bricks used. The specifications stated hereof are for First class brick masonry in cement sand mortar except specified otherwise.

11.8.2 MORTAR

The cement sandmortarfor the brick work shall be as specified. For sundried brick mud mortar shall be used.

A. MUD MORTAR

1. Composition

Mud mortar for brickwork and masonry shall be prepared from good earth and water, Sand or shopped straw shall be added to the earth that is too clayey. Mud mortar for plastering shall be prepared from earth, water and chopped “bhoosa”.

2. Materials

a) Earth

Earth shall be good firm loam with clay content ranging from 10% to 20% will give plasticity index of 7. The earth shall be free from objectionable quantities of lime, gravel, coarse sand and roots of other organic matter. Salts and calcium contents shall not exceed 0.5% and 2% respectively; i.e. it shall be good brick earth or selected clay obtained from approved sources. Clay containing more than 0.5% soluble salts, more than 0.2% sulphates and 4% organic content or efflorescent salts or taken from a locality where there are white ants shall not be used. In case of brick earth it shall be reduced into fine powder & free from stones, grass, kankar, roots and other matter.

b) Water

Only fresh and clean water free from earth, vegetations, organic impurities and any other substances likely to cause effloresence or otherwise prove harmful to the work shall be used. Water containing injurious amounts of oils, acids, alkalis. Salts, sulphides, chlorides, carbon dioxide shall not be used. The pH Value of water shall range between 6 & 8.Broadly speaking water which does not show an intensive odour or brackish taste shall be acceptable.

3. Preparation

Earth/Clay shall be mixed with water on a plane ground surface especially cleared for the purpose and tempered for at least two days. During this period it shall be worked up at intervals with men's feet and Hand Shovel. Sand or chopped straw shall be added, as desired, to the earth that is too clayey. Mud mortar for plastering shall be prepared as specified above and 1.8 kg of chopped "bhoosa" shall be thoroughly mixed with 0.03 cum of mortar.

4. Consistency

The consistency of mud mortar shall be of a type that it shall readily slide off the face of trowel, but the mortar shall not be so wet that it parts into large drops in falling. No water shall be added to the mortar after it is delivered to job.

5. Pits

Unless otherwise specified or directed by the Engineer-in-charge, the contractor shall make his own arrangements for obtaining the necessary earth / clay for the mortar. When permitted by the Engineer to take earth from the site of work, the contractor shall fill all pits with good earth and dress them off properly on the completion of work.

6. Restriction of Use

Mud mortar shall not be used for any masonry or brickwork likely to remain under water at any time or likely to bear pressure other than directly vertical.

B. CEMENT MORTAR

COMPOSITION

Cement mortar shall consist of one part Portland cement to specified number of parts of dry loose sand (Fine aggregate) by volume and sufficient water to produce proper consistency for intended use. Waterproofing agent not exceeding 25% by volume of dry cement shall be added when specially required or directed by the Engineer-in-Charge.

1. Materials

a) Portland Cement

Portland Land cement shall conform to ASTM C 150Type I or B.S.S.12.

b) Sand

Sand shall be such that it passes through a No.16 sieve and not more than 30 percent, passes through a sieve of 100x100 meshes in the square inch. The sand used or supplied shall be clean sand, gritty to the touch and free from any admixture of clay, loam, salts, organic matter or other impurities. The sand shall be of such cleanness that when a handful of it is shaken in a glass with clean water and allowed to stand for one hour the precipitation of mud (or flour in the case of screenings) on the sand shall not exceed 10%. If more than this precipitate is found, the sand shall be washed.

The source of the sand is subject to the approval of the Engineer-in-Charge from the designated sources.

c) Water

Water shall conform to specifications for water for mud mortar clause 11.7.2.

2. Mix

Unless otherwise specified or directed by the Engineer-in-Charge, the ingredients for cement mortar shall be proportioned by volume.

3. Preparation

a) Methods and equipment used for mixing mortar ingredients – including their mixing in dry state – shall be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer-in-Charge. Normally cement and sand is thoroughly mixed in a dry state on a pucca platform or in troughs as directed by the Engineer-in-Charge. It shall be gauged with a quantity of water sufficient to make the mortar workable. Water shall be added with a fine rose. Only such quantity of mortar shall be prepared as can be used before the initial setting time.

b) If a mixer is used, it shall be of the approved design. The mixing time after all the ingredients are in the mixer, except for the full amount of water, shall be not less than two minutes. Water shall be added at a uniform rate during the mixing time.

c) Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within thirty (30) minutes after addition of the water to the mix shall be wasted. Re-tempering of mortar will not be allowed. Mixing troughs and pans shall be thoroughly cleaned and washed at the end of each day's work. When colour for face work is specified to be mixed in it shall be of approved quality and brand and shall be added in such quantity to obtain the required shade, water proofing material shall be added only when specifically directed.

C. LIME MORTAR

a) Composition

Lime mortars, as specified herein, shall consist of one of the following combinations mixed in specified proportions and water sufficient to produce proper consistency for the use of mortar;

1. Stone lime and Surkhi
2. Kankar Lime and Sand
3. Slaked Kankar or Stone Lime & Cinder

b) Materials

1. Lime

Lime for lime mortars shall be obtained from suitable calcinations of naturally occurring forms of Calcium Carbonates (Lime stone or Kankar).

2. Surkhi

Surkhi used as substitute for sand shall be made by grinding fully burnt first class bricks, brick bats or burnt clay to powder. On no consideration surkhi shall be obtained from over burnt or under burnt bricks and bats or from kiln lining. Surkhi shall pass through a screen of 12x12 meshes in 6.45 square cms and in case, it is required for works to remain under water, the size of mesh shall be 8x8. It shall in no case pass one of 50x50 meshes in the 6.45 square cms.

3. Cinder

Cinder shall be obtained from an approved source. It shall be free from admixtures of clay, dust, vegetation or foreign matter. Only clean surface clinker coal i.e. residue from furnaces of steam boilers using coal fuel only shall form the parent material. After having been ground in mill and screened, the whole of it shall pass through a screen of 12x12 meshes in the 6.45 square cms but does not pass through a mesh of 50x50 mesh shall be used.

4. Sand

Sand shall conform to specifications, requirements and stipulations specified for sand para 11.7.2 (ii) (2) (b) of cement mortar.

5. Water

Water shall conform to Specifications described under para11.7.2 (ii) (c), “Cement mortar”.

c) Mix

Unless otherwise specified or directed by the Engineer-in-Charge, the ingredients for lime mortar shall be proportioned by volume.

1. Mortar for Masonry and Brickwork

Thoroughly slaked and screened stone lime/kankar lime and surkhi/sand shall be measured in boxes and mixes on a pucca platform or in a mixing trough as specified. The troughs, if used, shall be capable of being washed and drained. These ingredients shall be mixed twice in a dry state and then ground in a grinding mill with a quantity of water sufficient to produce a mortar of specified consistency.

2. Mortar for Plastering and Pointing

Unless otherwise specified one part of lime mixed with two parts of surkhi by volume shall be kept under water for at least 12 hours and then made to pass through a screen of 12x12 meshes per 6.45 sq. cms. Requisite coloring material shall be added to it and the mortar applied as fresh as possible.

11.9 SOAKING OF BRICKS

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. The soaking of bricks would be for 2 to 3 hrs. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks

are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note I:

The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note II:

If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

11.10 BRICK MASONRY CONSTRUCTION

11.10.1 DURABILITY

There are four main causes which impair the durability of brickwork: frost action, crystallization of soluble salts, chemical action and moisture movement. Since it is the presence of water in brickwork which is responsible for bringing these causes into action the first safeguard is to protect the work by avoiding unnecessary exposure and providing damp-proof courses, where practicable.

Frost can affect both the bricks and the mortar, and its effects are fairly straightforward. The affected part spalls or crumbles with the action of ice-forming in its saturated pores. Crystallisation of salts and chemical action depend on the presence of soluble salts which may originate in the bricks or the mortar or both. The movement of salts to the surface of the wall is influenced by pore structure of its elements, so that some of the salts from the brick may come out at joints and vice versa. It is possible to control to some extent the incidence of efflorescence and crystallization by ensuring that the parts at which these actions would be least harmful are most porous. In the case of chemical action, an important type of failure occurs when clay bricks containing a dangerous proportion of calcium sulphate are bonded in mortar containing cement or covered with a rendering containing cement. In certain damp conditions the sulphate can combine with cement and cause general expansion and failure of work.

11.10.2 BONDS

Bond is the name given to any arrangement of bricks in which no vertical joint of a course is exactly over a vertical joint in another course immediately above or below it, and has the greatest possible amount of lap, which is usually one-fourth the length of a brick.

To ensure good bond the following rules should be rigidly adhered to:

a) Bricks must be arranged in a uniform manner.

b) Fewest possible bats are employed.

c) Vertical joints in every other course must be perpendicularly in line on the internal as well as the external face.

d) Stretchers are to be used only on the faces of the wall; the interior should consist of headers only, as also the footings and corbels.

e) When bedded the length of a brick should equal twice the width, plus one mortar joint.

f) Lateral lap between perpends is ¼ of brick length.

Common types of bonds used in brickwork are described as follows:-

a) <u>English bond</u>

It consists of one course of headers and one course of stretchers alternately. In this bond, bricks are laid as stretchers only on the boundaries of courses, thus showing on the face of the wall. The joints in a course running through from back to front of a wall must not be broken. The course which consists of stretchers on the face is known as a stretching course. The courses above or below should consist of headers with the exception of the closer brick, which is always placed next to the quoin header to complete the bond. These courses are called as heading courses.

It may be noticed that in walls the thickness of which is a multiple of a whole brick the same course will show

Either

a) Stretchers in front elevation and stretchers in back elevation.

Or

b) Headers in front elevation and headers in back elevation.

But in walls whose thickness is an odd number of half brick, the same course will show

Either

a) Stretchers in front elevation and headers in back elevation.

Or

b) Headers in front elevation and stretchers in back elevation.

In setting out the plan of a course to any width, the quoin or corner brick should be drawn: then next to the face (which in front elevation shows headers) closers should be to the required thickness of wall; after which all the front headers should be set out and, if the thickness is a multiple of a whole brick, headers in rear should be set out. The intervening space, if any, should always be filled in with headers.

b) <u>Double Flemish bond</u>

This bond has headers and stretchers alternatively in the same course, both in front and back elevation. It is weaker than the English Bond because of the greater number of bats and stretchers, but is considered by some to look better on the face. It is also economical, since a greater number of bats may be used in it and thus bricks broken in transit may be utilized. By using the Double Flemish Bond for walls one brick in thickness, it is easier to obtain a better appearance on both sides than with the English Bond.

c) Single Flemish Bond

It consists in arranging the bricks as Flemish Bond on the face, and English Bond as backing. This is often done on the presumption that it attains the strength of the English Bond and the external appearance of the Double Flemish. It is generally used where expensive bricks are specified for facing. The thinnest wall where this method can be introduced is 1-1/2 brick thick.

d) Stretching Bond

Stretching bond is used for walls half-brick thick such as partition walls, brick nogging in partitions. All bricks are laid as stretchers upon the face.

e) Heading Bond

All bricks in this bond show as header on face. It is used chiefly for rounding curves, for footings, corbels and cornices.

f) Racking Bond

Walls as they increase in thickness increase in transverse strength but proportionally weaker in longitudinal direction, owing to the fact that stretchers are not placed in the interior of walls. This defect is remedied by using racking courses at regular intervals of four to eight courses in the height of a wall. The joints of bricks laid in this position cannot coincide with the joints of ordinary courses directly above or below, the inclination to the face usually being determined by making the longitudinal distance between the opposite corners equal to the length of brick. It is not advisable to use one racking course directly above another, since there is always a weakness at the junction of the racking with the face bricks.

Racking bonds are most effective when placed in the stretching courses in walls of even an even number of half bricks in thickness. In this way they are effective over a greater area than if they were placed in the heading course.

The alternate courses of racking bonds should be laid in different directions in order to make the tie as perfect as possible. There are two varieties of racking bonds, viz. Herring bond and diagonal.

11.10.3 LAYING

a) General

The brick laying shall be carried out complete with all embedment and installations for completion of the construction as shown on drawings and directed by the Engineer-in-Charge.

Bricks shall be laid in English Bond unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.

Note:

Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where

thickness of footing is uniform for a number of courses, the top course of footing shall be headers.

All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when laying, each brick shall be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow spaces are left inside the joints.

b) Bedding of Bricks

While bedding bricks, both the bed and side joints must be thoroughly flushed or filled up with mortar.

c) Levelling

While bedding bricks, great care should be taken to keep all courses perfectly level. To do this, the footing and the starting course should be carefully levelled, using a spirit level with a stack at least 10 feet long.

11.10.4 CONSTRUCTION OF WALLS

a) The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances:

(i) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

(ii) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.

(iii) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

(iv) Relative displacement between loads bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.

(v) A set of tools comprising of wooden straight edge, Masonic spirit levels, square, 1 metre rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other.

b) Raking

The brick work shall be built in uniform layers. No part of the wall during its construction shall rise more than one metre above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal by setting back 2-1/2 inches at each course, with a maximum of twelve courses, to reduce the possibility and the unsightliness of defects caused by any settlement that may take place in the most recently built portion of the wall. Toothing shall not be permitted as an alternative to racking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

c) Other Factors

All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge.

Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be properly radiated and keyed into position to form cut (marrow) corners as specified. Where bricks cannot be cut to the required shape to form cut (marrow) corners, cement concrete 1:2:4 (1 cement :2 coarse sand: 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.

Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.

In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

To facilitate taking service lines later without excessive cutting of completed work, sleeves shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.

Top of the brickwork in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throating shall be provided where indicated.

Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer-in-Charge.

(d) Stability

The stability of brickwork is affected in three general ways:

1. By loading a given area of ground beyond its ultimate resistance, by an irregular concentration of great pressures on a soft sub-soil, by the tendency of the sub-stratum to slid or by eccentric loadings, the walls are thrown out of the upright, crack or disintegrate.

2. By bad bonding, resulting in disintegration.

3. By side thrusts which may be distributed or concentrated, and their tendency is to overturn the walls; they are provided for by designing the walls of a sufficient thickness, or by placing buttresses at regular intervals.

11.10.5 JOINTS

The horizontal joints shall be parallel whereas vertical joints in alternative courses shall be directly over one another. The thickness of the vertical joints shall be approximately 6 millimetres and the thickness of horizontal joints shall be 10 millimetres.

FINISHING OF JOINTS

The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

11.10.6 CURING

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

11.10.7 SCAFFOLDING

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work and safe working.

11.10.8 SINGLE SCAFFOLDING

Where plastering, pointing or any other finishing has been indicated for brick work, single scaffolding may be provided, unless otherwise specified. In single scaffolding, one end of the put-logs/pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put-log/pole shall be left out. Such holes shall not be allowed in the case of pillars, brick work less than one metre in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls. The holes for putlogs/poles shall be made good with brick work and wall finishing as specified.

11.10.9 DOUBLE SCAFFOLDING

The brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.

11.10.10 BRICK LAYING IN FREEZING WEATHER

a) Protection of bricks:

All bricks delivered for use in freezing weather shall be fully protected immediately upon delivery by a weather-tight covering that will prevent the accumulation of water, snow or ice on the bricks; loose board covering shall not be permitted.

b) Heating of sand:

All sand shall be heated in such a manner as will remove all frost, ice or excess moisture but will prevent the burning of scorching of the sand.

c) Heating of bricks:

All frosted bricks shall be defrosted by heating them to a temperature of approximately 180^{o}F.

d) Heating of water:

All water used shall be heated to a temperature of approximately 180^{o}F.

e) Slaking or soaking of lime:

All slaking of quick lime or soaking of hydrated lime shall be done at a temperature of at least 60^{o} F and this temperature shall be maintained until lime is incorporated into the mortar.

f) Protection of mortar against freezing:

After the mortar has been mixed it shall be maintained at such temperature as will prevent its freezing at all times and if necessary the contractor shall use metal mortar board equipped with oil torches. No anti-freeze liquid, salt or other substance shall be used in mortar, except when specified or permitted by the Engineer-in-Charge.

g) Enclosures and artificial heat:

All work under construction shall be protected from freezing for a period of 48 hours by means of enclosures, artificial heat or by other suitable methods duly approved by the Engineer-in-Charge.

11.11 BRICK WORK IN ARCHES

The detailed specifications for brick work mentioned in 11.7shall apply, in so far as these are applicable. Arch work shall include masonry for both gauged as well as plain arches. In gauged arches, cut or moulded bricks shall be used. In plain arches, uncut bricks shall be used.

Brick forming skew-backs shall be dressed or cut so as to give proper radial bearing to the end voussiors. Defects in dressing of bricks shall not be covered by extravagant use of mortar, nor shall the use of chips or bats etc. be permitted. The bricks of the spandrel wall at their junctions with extrudes of the arch shall be cut to fit the curvature of the arch.

11.11.1 CIRCULAR ARCHES

These shall be either (a) plain arches, and shall be built in half brick concentric rings with break joints, or (b) gauged arches built with bricks cut or moulded to proper shape. The arch work shall be carried up from both ends simultaneously and keyed

in the centre. The bricks shall be flush with mortar and well pressed into their positions so as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full of mortar and thickness of joints shall not be less than 5 mm nor more than 15 mm.

After the arch is completed, the haunches shall be loaded by filling up the spandrels up to the crown level of the arch. Care shall be taken to load the haunches on two sides of the spandrels.

When the arch face is to be pointed (and not plastered), the face bricks shall be cut to proper shape or moulded, so as to have the joints not more than 5 mm thick. These shall be laid with radial joints to the full depth of the arch. The voussoirs shall break joints to the full depth of the arch.

11.11.2 FLAT ARCHES

These shall be gauged arches of brick cut or moulded to proper shape. The extrados shall be kept horizontal and the intrados shall be given slight camber of 1 in 100 of the span. The centre of the arch from which joints shall radiate, shall be determined by the point of the inter-section of the two lines drawn from the ends of the arch at the springing level and at 60° to horizontal.

In flat arches, bricks shall be laid with radial joints to the full depth of arch and voussoirs breaking joints with each other. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The thickness of the joints shall not exceed 5 mm. Flat arches may be used for the sake of appearance but for purpose of carrying loads of the wall above, these shall be used in conjunction with relieving arches, lintels placed below.

11.11.3 CENTRING AND SHUTTERING

The centring and shuttering for the arch shall be as approved by the Engineer-in-Charge before the arch work is started. It shall be strong enough to bear the dead load of the arch and the live loads that are likely to come upon it during construction, without any appreciable deflections.

The shuttering shall be tightened with hard wood wedged or sand boxes, so that the same could be eased without jerks being transmitted to the arch. The sequence of easing the shuttering shall be as approved from the Engineer-in-Charge. The shuttering shall be struck within 48 hours of the completion of the arch but not before 24 hours. This shall be done after the spandrel has been filled in and the arch loaded.

11.12 BRICK TILE WORK

The work shall be done in the same manner as described in Sub-section 11.7 except that brick tile shall be used instead of bricks.

11.13 HONEY COMB BRICK WORK/PERFORATED BRICK MASONRY

The honeycomb brick work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

11.14 JOINING OLD BRICK WORK WITH NEW BRICK WORK

In case the height of the bricks of old as well as new work is same, the old work shall be toothed to the full width of the new wall and to the depth of a quarter of

brick in alternate courses. In case the height of the bricks is unequal, then the height of each course of new work shall be made equal to the height of the old work by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints. For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses in height and half a brick in depth shall be cut in the main walls. A space of three courses shall be left between two consecutive recesses. The new cross wall shall be bonded into the recesses to avoid any settlement. Joining of old brick work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

11.15 MOULDING AND CORNICES

The specifications described under 11.7 shall apply in so far these are applicable. Mouldings and cornices shall be made with bricks as specified for brick work. The bricks shall be cut and dressed to the required shape as shown in the architectural drawings.

Cornices shall not ordinarily project by more than 15 cm to 20 cm and this projection shall be obtained by projecting each brick course by more than one fourth of the length. For cornices projecting more than 20 cm and requiring more than quarter bricks projection, metal cramps shall be used and paid for separately. Corbelling shall be brought roughly to shape by plastering with the specified mortar. When the mortar is still green, the mouldings shall be finished straight and true with the help of metal templates.

11.15.1 CURING AND PROTECTION

The mouldings and cornices shall be cured for at least seven days. These shall be protected from the effects of sun and rain by suitable covering and also from damage during the execution of the work.

11.16 EXPOSED BRICK WORK

11.16.1 FACING BRICKS

The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime warpage and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right angled edges. Facing bricks shall have uniform colour and even texture. Unless otherwise specified, facing bricks shall be machine moulded only. As far as possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and broken corners shall not be used.

Facing bricks shall be of 1st class unless otherwise specified, water absorption shall not exceed 20 per cent by weight and efflorescence rating shall be nil. Mortar, Soaking of Bricks and laying shall be as specified in Para 11.7.2, 11.7.3 and 11.7.4respectively.

Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as per 0.Curing and scaffolding shall be as specified in 0and respectively.

11.16.2 FURTHER REQUIREMENTS

All face work shall be finished with neatly drawn joints and pointed if it has not to be plastered. If it has to be plastered, the joints shall be raked out before any plaster is laid on. The raking shall be done with a hook to a depth of 13mm before the mortar sets each day. Where pointing or plastering to the face work is not provided as a separate item, the joints in the face work shall be struck. For face work, the bricks

shall be of true edges, uniform colour and correct dimensions. If specially required, face work shall be laid up with pressed bricks. All brick courses shall be so proportioned that they will work out evenly with the height of the windows and doors. Backing of the pressed brickwork shall be done as per specifications for brickwork, or as specifically directed by the Engineer-in-Charge.

a) Steel reinforcement and steel ties, if any, shall be provided and installed as indicated on the Drawings or directed by the Engineer-in-Charge.

b) Openings or chases shall be provided in the brickwork as shown on the Drawings or required by the Engineer-in-Charge.

c) If, after the completion of any brickwork, brick is out of alignment or level, or does not conform to the lines and grades shown on the Drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Engineer-in-Charge grants permission, in writing, to patch or replace the defective area.

11.17 CAVITY WALL

11.17.1 GENERAL

It is a wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50 mm and not more than 115 mm. Each leaf of the cavity wall shall not be less than 75 mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

11.17.2 MATERIALS

The bricks shall be first class bricks specified in this Section. The mortar shall be cement sand mortar as specified in accordance with the provisions of Sub-section 11.7.2 (ii).

The laying of bricks masonry for cavity walls shall comply with provisions of Sub-sections 11.7.3 & 11.7.4.Curing and scaffolding shall be as per Sections 11.7.6 & 11.7.7.

11.17.3 METAL TIES

These may be of galvanised iron, wrought iron, gun metal, brass, copper, stainless steel or any such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid-point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side.

11.17.4 BONDING UNITS

Length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves are 75 mm or 115 mm. If the leaves are more than 115 mm thick, then the length of a unit will be [(2 ×115) + width of cavity].

Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1 cement: 3 sand: 6 aggregate 20 mm nominal size).

11.17.5 SPACING

Metal ties/bonding units shall be spaced not more than 90 cm apart horizontally and 45 cm vertically and staggered in each course. Additional ties shall be used near openings.

11.17.6 RESTRICTIONS

Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls

11.18 REINFORCED BRICK MASONRY

11.18.1 GENERAL

Reinforced brick masonry shall be constructed as specified and shown on drawings.

11.18.2 BRICKWORK

Brickwork shall be as specified and conform to the provision for construction of brickwork of this section. The mortar shall be cement sand mortar as specified and shall conform to the provision of Clause 11.7.2(ii).

11.18.3 REINFORCEMENT

The reinforcement for brick masonry could be 18gauge hoop irons or mild steel bars as specified. The hoop iron shall be of best quality as approved by the Engineer-in-Charge. Mild steel reinforcement shall comply with the provisions of Section 5 – Plain & Reinforced Concrete. Unless otherwise specified in drawings or schedule of quantities, the reinforcement for normal structures shall be as follows;

Wall Thickness (Inches)	Horizontal Bars (9-5/8") C/C	Vertical Bars (24") C/C
7 – ½	3/8" dia	3/8" dia
9	3/8" dia	½"
11	½"	½"
12	½"	½"

Refer to the drawings for others wall thickness and special details

a) Vertical reinforcement at jambs of opening and at ends of walls shall be doubled. Horizontal reinforcement above and below all openings shall also be doubled.

b) Reinforcement shall be continuous. Bars may be furnished in any convenient length. All splices shall be lapped at least 14" for 3/8" diameter bars and at least 18" for ½" diameter bars and horizontal reinforcement shall be bent around corners.

11.18.4 SCAFFOLDING & CURING

The scaffolding & curing shall conform to applicable provisions of Section 11.7.6, 11.7.7, 11.7.8, and 11.7.9.

11.19 BRICK EDGING

The edging shall be of bricks of class specified in the item. The specifications of bricks shall be as described in 0. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the bricks for edging. The bed of trenches shall be compacted to a firm and even surface. The brick shall be

laid true to line in cement mortar 1:4 (1 cement: 4 fine sand) with length parallel and butting the plinth protection. The top face of the brick edging shall be in one level to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the brick edging shall project above the adjacent concrete surface. Cement mortar shall conform to the specification described in Sub-section 11.7.2 (ii).

11.20 BRICKWORK IN COPING

11.20.1 SCOPE

While in all respects it shall conform to the requirements for Brick Construction specified hereof, following special requirements shall also be met with, except when it is specially modified by the Engineer-in-Charge.

The top course of all plinth, parapets, steps etc. shall be built in brick on edge. In case of parapet walls the outside half brick shall be weathered and throated. The corners shall be made by cutting fine bricks or by special bricks of 9 inches x 9 inches x 4-1/2 inches (225mm x 225mm x 110mm) size to give a radiated and keyed joints.

11.21 SUN-DRIED BRICK WORK IN MUD MORTAR

11.21.1 SCOPE

In this case, sun-dried bricks i.e. unburned bricks shall be used. Any defect in uniformity and shape shall not be such as to cause difficulty in obtaining uniform courses with their use. For all other purposes, stipulations and requirements for laying brick work shall be relied.

11.22 BRICK MASONRY WITH FIRE CLAY BRICKS AND ALUMINA CEMENT (VITRIFIED MORTAR)

11.22.1 SCOPE

All brickwork required to be constructed under these specifications and for all related purposes or as may be required by the Engineer-in-Charge shall consist of following special materials instead of those prescribed under theses specifications. However, other materials, methods of their proportioning, mixing, forming and placing as well as the stipulations and other requirements shall conform to specifications given under sub-sections 11.7.4 except when any stipulations and requirements are specially modified by the Engineer-in-Charge for any particular occasion. In case, fire clay brickwork is required in arches they shall also conform to specifications 11.8 “Brick Work in Arches”.

11.22.2 MATERIALS

a) Bricks

Only fire clay bricks of specified sizes of approved specifications/approved brands shall be used. These shall also meet the tests specified for them.

b) Cement

Special alumina cement shall conform to BS 915.

c) Sand

Sand required for the mortar shall be produced from crushed fire bricks graded as sand in conformity with Specifications laid down for sand in the sub-section 11.7.2.

11.23 GHILAFI BRICKWORK

11.23.1 SCOPE

The ghilafi brickwork shall consist of first class brickwork laid in mud mortar at the outer face and the balance work shall be executed in sun dried bricks laid on mud mortar on the inner side conforming to provisions of Sub-section 11.18.

11.24 KACHA WALL/PISE WALLING

11.24.1 SCOPE

Kacha wall shall either be of mud walling or Pise walling type as specified.

11.24.2 BUILDING OF KACHA WALLS/PISE WALLING

a) Mud walling shall be constructed from the fifth class clay bricks conforming to Sub-Section 11.4.

b) Pise walling shall be made by laying mud in 8 Cms. to 15 Cms (3”- 6”) thick layers and tightly rammed between two parallel boards which from the front and back face of the wall. As soon as the space between boards is completely filling the same shall be moved to the next length and so on till the whole is complete.

11.25 PARTATIONS WALLS

11.25.1 GENERAL

Brick masonry partition walls shall be one brick thick either flat or on edge.

11.25.2 HOOP IRON

In case the partition walls are to be reinforced, it shall be down with 1” wide, 18” gauge hoop iron placed in course not more than 12” apart and continued for 9” into the main wall on which the partition wall abuts. In case the length of the wall exceeds 20 feet or the height exceed 15 feet hoop iron shall be introduced at course not more than 6” apart. M.S bars may also be provided in place of hoop iron as specified.

11.25.3 BRICKS

Bricks used for construction of partition walls shall confirm to the specifications under sub-section 11.4 to 11.6.

11.25.4 MORTAR

The partition walls shall be set in cement mortar not less than 1:3 proportions unless otherwise specified.

11.25.5 SOAKING OF BRICKS

Soaking of bricks shall confirm to the specification under sub-section 11.7.3

11.25.6 WORKMANSHIP

Workmanship in the partition walls is to be the best quality as due to the small thickness of walls great care is to be taken. The total height of the wall in one day shall not exceed 4 feet.

11.25.7 CURING

Curing shall be carried out in the manner as detailed in sub-section 11.7.6

11.25.8 METHOD OF BONDING WITH RCC FRAME

All brick masonry walls shall be bonded with the column of the R.C.C frame by providing ¼" dia. Reinforcement protruding out of the column at every 12". The length of the bonding bars shall not be less than 12" with a hook of 1" dia. at the end and allowed to extend out through the holes provided in the form works for the column.

11.26 MEASUREMENT AND PAYMENT

11.26.1 COMPOSITE RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including scaffolding etc. and the site clearance as approved by the Engineer-in-Charge.

Pay Item No.	Description	Unit of Measurement
11.26 a	Providing and laying sun dried clay brick up to 12ft (3.65m) height in mud mortar complete in all respect	CM
11.26b	Providing and laying 1st class solid burnt brick masonry in foundation and plinth to a depth of 6ft (1.83m), 9" or more thick in CS mortar 1:4 ratio	CM
11.26c	Providing and laying 1st class solid burnt brick masonry in superstructure up to 12ft (3.65m) height, 9" or more thick in CS mortar 1:4 ratio	
11.26d	Providing and laying 1st class solid burnt brick masonry in superstructure up to 12ft (3.65m) height, 4.5" thick in CS mortar 1:4 ratio	CM
11.26e	Providing and laying of Fire Brick (High Alumina) masonry up to 12ft (3.65m) height with high alumina cement complete in all respect	CM
11.26f	Providing and laying 1st class solid burnt brick masonry 9" thick with CS mortar 1:4 ratio in steining of well or any other circular masonry up to depth of 10ft (3m)	CM
11.26g	Providing and laying 1st class solid burnt brick flooring or pitching dry bricks laid flat, filling with local sand	CM

Note:- Class of Brick may be changed by Designer as required.

SECTION 12 STONE MASONRY

12.1 SCOPE

It shall cover all stone masonry for use in foundation and plinth; superstructures and walls etc. as shown on the drawings and such other uses as may be specified or directed by the Engineer-in-Charge. The dressing of stones and use of mortar together with its ingredients and proportions shall be specified or directed by the Engineer-in-Charge. Materials used shall conform to stipulations and requirements herein set forth except when such stipulations and requirements are specifically modified by the Engineer-in-Charge for any particular item of work.

The scope shall, however, include furnishing all labour, materials, plant, equipment, scaffolding, staging, ladders, instruments and accessories; and all services necessary to complete the work which shall be finished in a workmanlike manner true to dimensions and grades shown on the Drawings.

12.2 RANDOM RUBBLE STONE MASONRY

12.2.1 MATERIAL

12.2.1.1 STONE

The stone shall be of the type specified such as granite, trap, limestone, sand stone, quartzite, etc. and shall be obtained from the quarries (referred to constructional material sources study report),approved by the Engineer-in-Charge. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture. Generally stone shall not contain crypts crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc. Stones with round surface shall not be used.

The compressive strength of common types of stones shall be as per Table 12.1 and the percentage of water absorption shall generally not exceed 5% for stones other than specified in Table 12.1. For laterite this percentage is 12%.

TABLE 12.1

Types of stone	Weight (lbs/cft)	Maximum water absorption percentage by weight	Minimum compressive strength kg./sq.cm.
Granite	165	0.5	1000
Basalt	225	0.5	400
Limestone (slab &tiles)	160	0.15	200
Sandstone (slab &tiles)	140	2.5	300
Marble	170	0.4	500
Quartzite	225	0.4	800
Laterite (block)	120	12	35

12.2.1.2 SIZE OF STONES

Normally stones used should be small enough to be-lifted and placed by hand. Unless otherwise indicated, the length of stones for stone masonry shall not exceed three times the height and the breadth on base shall not be greater than three-fourth of the thickness of wall, or not less than 150 mm. The height of stone for rubble masonry may be up-to 300 mm.

The selection and grading of stones for rubble masonry is largely done at site and the smaller stones are used in the hearting of wall.

12.2.2 DRESSING

Each stone shall be hammer dressed on the face, the sides and the beds. Hammer dressing shall enable the stones to be laid close to neighboring stones such that the bushing in the face shall not project more than 40 mm on the exposed face.

(i) Face stone:

At least 25% stones shall be headers tailing into the work at least 2/3rd the thickness of wall in super structure masonry. Such stones shall not be less than 200 sq. cm in cross sections.

(ii) Hearting Stones:

The hearting or interior filling of a wall face shall consist of rubble stones not less than 150 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing.

(iii) Quoin Stone:

Quoin stone shall be less than 0.03 cum in volume.

(iv) Jamb stones:

The jambs shall not be made with stones specified for quoins except that the stones which were required to be provided at 1 meter centre to centre on both the exposed faces shall be provided only on the jamb and the length shall be equal to the thickness of the wall for wall upto60 cm and a line of headers shall be provided for walls thicker than 60 cm as specified for bond.

(v) Courses and Thickness of Joints

Courses:

The masonry shall be carried out in regular courses of height not exceeding 50 cm and masonry on any day will not be raised more than 60 cm in height when using mortars having compressive strength less than 20 kg. /sq. cm at 28 days and 100 cm when using mortars exceeding this strength

Thickness of Joints:

The joint thickness shall not exceed 30 mm at any point on the face. Chips of the stone and spalls shall be wedged into seating bed of face stones to avoid excessive bed thickness. No pinning shall be allowed to avoid excessive joint thickness.

12.2.3 MORTAR

The mortar used for joining shall be as specified complying with applicable provisions of cement mortar Section-11 Brickwork.

12.2.4 LAYING

a) Stone shall be laid on their natural bed and shall be solidly bedded full in mortar with close joints, chips of stone spalls be wedged into the work wherever necessary. No dry work or hollow spaces shall be allowed and every stone whether large or small shall be carefully selected to fit snugly the interstices between the large stones. Masonry shall be built breaking joints in all the three directions. Bond stone and headers shall be properly laid into the work and shall be marked by the contractor with white lead paint. The bond stones shall be provided as specified in para. The masonry work in wall shall be carried up true to plumb or to specified batter.

   Random rubble masonry shall be brought to the level courses at plinth, window sills, and lintel and roof levels. Leveling shall be done with concrete comprising of one part of the mortar as used for masonry and two parts of graded stone aggregate of 20 mm nominal size.

   The masonry in structure shall be carried uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45°.

   Raking out joints

   All the joints on the faces to be pointed or plastered shall be raked out with raking tool to a depth of 20mm while the mortar is still green.

b) The stone masonry in freezing weather shall comply with all the requirements of brickwork for the same conditions as specified in Sub-section 11.7.10 – Brickwork.

12.2.5 BOND STONES

Though bond stones shall be provided in walls up-to 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back as shown on Drawings and approved by the Engineer-in-Charge. In case of highly absorbent types of stones (porous lime stone and sand stone etc.) the bond stone shall extend about two-third into the wall, as through stones in such walls a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 m^2 of the wall surface and shall be provided at 1.5 m to 1.8 m apart clear in every course.

In case of highly absorbent types of stones(porous lime stone and sand stone etc.) single piece bond stones may give rise to dampness. For all thicknesses of such walls a set of two or more bond stones overlapping each other by at least 15 cm shall be provided. Length of each such bond stone shall not be less than two-third of the thickness of the wall.

Where bond stones of suitable lengths are not available pre-cast cement concrete block of 1:3:6 mix(1 cement : 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) of cross section not less than225 square centimeter sand length equal to the thickness shall be provided.

At least one bond stone or a set of bond stones shall be provided at 1.5 m to 1.8 m apart clear in every course.(Bond stones shall be marked suitably with paint as directed by the Engineer-in-Charge).

12.2.6 QUOIN AND JAMB STONES

The quoin and jamb stones shall be of selected stones neatly dressed with hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15 cm. Quoins shall be laid header and stretcher alternatively.

12.2.7 JOINTS

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20 mm thick.

The joints shall be struck flush and finished at the time of laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

12.2.8 SCAFFOLDING

Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry Such holes, however, shall not be allowed in pillars under one meter in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with 1:3:6 cement concrete (1 cement : 3 sand : 6 stone aggregate 20 mm nominal size).

12.2.9 CURING

Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days.

12.2.10 PROTECTION

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

12.3 UNCOURSED& COURSED RUBBLE MASONRY

12.3.1 GENERAL

Random Rubble Masonry shall be un-coursed or brought to courses as specified.

12.3.2 UNCOURSED RUBBLE MASONRY

Un-coursed random rubble masonry shall be constructed with stones of sizes as referred in 12.1.2 and shapes picked up random from the stones brought from the approved quarry. Stones having sharp corners or round surfaces shall, however, not be used. No dressing of stone shall be required and stone shall be laid on its quarry bed. Each stone shall be wedged strongly into position by using sprawl or chips. The construction of un-coursed Rubble Masonry shall be carried as specified in 12.0.

12.3.3 COURSED RUBBLE MASONRY

12.3.3.1 GENERAL

Random rubble masonry brought to the course is similar to un-coursed random rubble masonry except that the courses are roughly leveled at intervals varying from 300mm to 900mm in height according to the size of stones used

12.3.3.2 STONE

Shall be as specified in 12.1.1

12.3.3.3 SIZE OF STONE

Shall be as specified in 12.1.2

12.3.3.4 DRESSING

Face stones shall be hammer dressed on all beds, and joints so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for at least 80 mm back from the face, and side joints for at least 40 mm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joint. The bushing on the face shall not project more than 40 mm as an exposed face and 10 mm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for minimum width of 25 mm along the four edges of the face of the stone, when stone work is exposed.

12.3.3.5 MORTAR

The mortar for jointing shall be as specified referred under Clause 12.1.4

12.3.3.6 LAYING

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar; chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and shall not exceed 10% of the quantity of stone masonry.

The masonry in a structure shall be carried up uniformly but where breaks are unavoidable, the joints shall be raked back at angle not steeper than 45°. Toothing shall not be allowed.

12.3.3.7 BOND STONES

Shall be as specified in sub section 12.1.6 except that a bond stone or a set of bond stones shall be inserted 1.5to 1.8 meters apart, in every course

12.3.3.8 QUOINS

The quoins shall be of the same height as the course in which these occur. These shall be at least450 mm long and shall be laid stretchers and headers alternatively. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 100 mm. In case of exposed work, these stones shall have a minimum of 25 mm wide chisel drafts at four edges, all the edges being in the same plane.

12.3.3.9 JOINTS

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than one or two cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

12.3.3.10 SCAFFOLDING/CURING

Shall be as specified under 12.1.9 & 12.1.10

12.4 DRY RUBBLE MASONRY

12.4.1 SIZE OF STONE

Dry rubble masonry shall be constructed with the largest practicable size of the stone available the larger stone being used in the lower courses.

12.4.2 DRESSING OF STONE

Stone shall be roughly dressed to secure the maximum bedding surface without unduly reducing the size of the stone. Each course shall be built through the entire thickness of the wall.

12.4.3 BOND STONE

Bond stone shall be provided in each course at an interval of 5 feet. It shall be of the height of the course in which it is to be used, at least as broad and of the greatest length procurable. No bond stone shall be less than 2 feet long. When the length is less than the thickness of the wall 2 or more stones shall be used overlapping each other by at least 6 inches to provide through bond from front to back. All bond stones shall be separately stacked before use and marked so that they can be identified after having been built in the wall.

12.4.4 LAYING

Wherever required, filling behind dry stone walls shall be done immediately with stone refuse or chips. Earth shall not be used where stone refuse is available.

12.5 PLAIN ASHLAR MASONRY

Stone shall be of the type specified. It shall be hard, sound, durable and tough, free from cracks, decay and weathering and defects like cavities, cracks, flaws, sand holes, veins, patches of soft or loose materials etc. before starting the work, the contractor shall get the stones approved by Engineer-in-Charge. Every stone shall be cut to the required size and shape and fine machine dressed to the full depth so that a straight edge laid along the side of stone shall be in full contact with it.

12.5.1 SIZE OF STONE

Normally stones used should be small enough to be lifted and placed by hand. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three- fourth of the thickness of wall nor less than 15 cm. The height of stone may be up to 30 cm.

12.5.2 DRESSING

Every stone shall be cut to the required size and shape chisel dressed on all beds and joints so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be the fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straight edge does not exceed 6 mm. Any vertical face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10mm.All angles and edges that are to remain exposed in the final position shall be true, square and free from chippings' sample of dressed stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved.

12.5.3 MORTAR

The mortar for jointing shall be as specified in Clause 12.1.4.

12.5.4 LAYING

All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truly plumb or battered as shown in drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

In case of ashlars' work without backing of brick work or coursed rubble masonry, face stone shall be laid headers and stretchers alternately unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 30 cm in height and all the courses shall be of same height, unless otherwise specified.

For ashlars' facing with backing of brick work or coursed rubble masonry face stone shall be laid in alternate courses of headers and stretchers unless otherwise directed. Face stone and bond stone course shall be maintained throughout. All connected masonry in a structure shall be carried up nearly at one uniform level throughout, but where breaks are avoidable, the joint shall be made in good long steps so as to prevent cracks developing between new and old work.

When necessary, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone sand place these into correct positions, care being taken that the corner of the stone are not damaged. Stone shall be covered with gunny bags, before tying chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work.

12.5.5 BOND STONES

Shall be as specified in 12.1.6

12.5.6 JOINTS

All joints shall be full of mortar. These shall be not more than 6 mm thick. Face joints shall be uniform throughout and a uniform recess of 20 mm depth from face shall be left with the help of the steel plate during the progress of work.

12.5.7 POINTING

All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15 mm.

12.5.8 CURING

Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days.

12.5.9 PROTECTIONS

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

12.5.10 SCAFFOLDING

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

12.6 PUNCHED ASHLAR (ORDINARY) MASONRY

12.6.1 STONE

Shall be as specified in 12.3.In case of red or white sand stone, stone shall be red or white as specified in the item. In red sand stone, white patches or streaks shall not be allowed. However, scattered spots up to 10 mm diameter will be permitted.

12.6.2 SIZE OF STONE

Shall be as specified in 12.3.1

12.6.3 DRESSING

Shall be as specified in 12.3.2 except that the faces exposed in view shall have a fine dressed chisel draft 2.5 cm wide all-round the edges and shall be rough tooled between the drafts, such that the dressed surface shall not be more than 3 mm from a straight edge placed over it

12.6.4 OTHER DETAILS

The specifications for mortars, laying and fixing, bond stone, joints, pointing, curing, protections and scaffolding shall be same as specified in 12.3.

12.7 MOULDED, SINK, CARVED ASHLAR MASONRY

12.7.1 STONE

Shall be as specified in 12.3 and 12.3.1

12.7.2 DRESSING

Every stone shall be cut to the required size and shape and chisel dressed on all beds and joints so as to be free from any waviness and to give perfectly vertical, horizontal, radial or circular joints with adjoining stones as the case may be. The dressed surface shall not be more than 3 mm from a straight edge placed on it. The face shall be gauged, cut, chamfered, grooved, and rebated sunk or plain molded and fine tooled as shown in the working drawings. The joints 6mm from the face

shall also be fine tooled so that straight edge laid along it is in contact with every point. It shall be finest surface which can be given to a stone with the chisel and without rubbing.

In case of sink or moulded masonry, the corner stone shall be dressed at true right angles or true to the shape as specified, the corners being straight and vertical. For arch dome or circular work the stone shall be dressed to required wedge shape so that joints shall be truly radial.

12.7.3 SAMPLE

The full size layout of the moulding etc. shall be prepared on platform from which sheet templates shall be cut and the stone dressed to templates to a uniform and fine finish. All visible angles and edge shall be True Square and free from chippings. A sample of dressed stone shall be prepared for approval and it shall be kept as sample after being approved by Engineer-in-Charge.

In case of Ashlar moulded and carved columns a full size model of the required moulding, carving etc. shall be prepared in plaster of Paris and kept at site of work as sample work after being approved by the Engineer-in-Charge. The stones shall be moulded and carved in accordance with the approved model to a uniform and fine finish.

12.7.4 OTHER DETAILS

Shall be as specified in 12.3.3, 12.3.4 and 12.3.6 to 12.3.9

12.7.5 CENTERING AND SHUTTERING

Centering and shuttering required for arch dome or circular moulded work shall be proposed by the Contractor and approved by the Engineer-in-Charge.

12.8 SHELVES, COPING, PLAIN, CORNICES, STRING COURSES ETC.

12.8.1 STONE

Stone shall be of uniform color and texture and of the kind as stipulated.

12.8.2 DRESSING

The exposed faces and sides of shelves shall be chisel dressed such that the dressed surface shall not be more than 3 mm from a straight edge placed on it. All visible angles and edges shall be free from chippings. The surfaces to be buried in the masonry shall be rough dressed.

12.8.3 LAYING

These shall be laid in mortar of specified mix and fixed as shown in drawing or as directed by the Engineer-in-Charge.

12.8.4 OTHER DETAILS

Specifications for pointing, curing, protections and scaffolding shall be as specified in 12.3.3, 12.3.4 and 12.3.6 to 12.3.9.

12.9 STONE MASONRY IN FREEZING WEATHER

Stone Masonry in freezing weather shall be carried out in accordance with the provisions of Clause 11.7.10 - Brick laying in freezing weather. For purpose of application of this Clause, “Brick” shall be deemed to have been replaced with stone.

12.10 DRY STONE UNCOURSED PITCHING, REVETMENT

12.10.1 GENERAL

The stone will be perfectly sound and as regular in shape as possible. Their length will be about equal to the thickness of the required pitching or revetment without the backing.

The side of the bank will be trimmed to the required slope and profiles will be put up at required intervals to ensure regular work and uniform slope throughout.

The stone will be laid closely in position and firmly bedded, the length being made perpendicular to the face of the pitching or revetment.

The toe will be thoroughly secured against slipping by a properly constructed masonry wall in cement mortar.

12.11 MEASUREMENT AND PAYMENT

12.11.1 COMPOSITE RATE

The measurement and payment for the items of the work of Stone Masonry hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified here in including the site clearance as approved by the Engineer-in-Charge.

Pay Item No.	Description	Unit of Measurement
12.11 a	Providing and laying ashlar (coursed and fine) stone masonry for superstructure up to 12ft (3.65m) height with CS mortar, complete in all respect	
	i. 1:3 ratio	CM
	ii. 1:4 ratio	CM
	iii. 1:6 ratio	CM
12.11b	Providing and laying dry un-coursed rubble stone masonry for Retaining, Breast and Compound walls up to 12ft (3.65m) height, complete in all respect	CM
12.11c	Providing and laying dry coursed rubble stone masonry for Retaining, Breast and Compound walls up to 12ft (3.65m) height, complete in all respect	CM
12.11d	Providing and laying un-coursed rubble stone masonry for superstructure up to 12ft (3.65m) height in CS mortar, complete in all respect	
	i. 1:3 ratio	CM
	ii. 1:4 ratio	CM
	iii. 1:6 ratio	CM
12.11 e	Providing and laying coursed rubble stone masonry for superstructure up to 12ft (3.65m) height in CS mortar, complete in all respect	
	i. 1:3 ratio	CM
	ii. 1:4 ratio	CM
	iii. 1:6 ratio	CM
12.11 f	Providing and laying dry coursed random stone masonry for Retaining wall, Breast wall and Boundary wall including weepholes of PVC pipe (class B) 3" dia. with weephole cover inside	CM
12.11 g	Providing and laying coursed random stone masonry for plinth, foundation, basement etc. with CS mortar including weepholes of PVC pipe (class B) 3" dia. with weephole cover inside	
	i. 1:3 ratio	CM

	ii. 1:4 ratio iii. 1:6 ratio	
12.11 h	Providing and laying random rubble dry stone masonry for R/B wall including weepholes of PVC pipe (class B) 3" dia. with weephole cover inside	CM
12.11 i	Providing and laying stone/boulder hand packed filling behind the retaining and breast wall to safeguard the weep holes of retaining and breast wall complete in all respect	CM
12.11 j	Providing and filling of filter media behind retaining and breast wall to protect the weep holes from blockage etc. complete in all respect	CM

12.12 GLOSSARY

Ashlar

Stone masonry using dressed square stone blocks of given dimensions having faces perpendicular to each other and laid in courses.

Bed Joint

The joint where one stone presses on another for example, a horizontal joint in a wall or radiating joint between the voussoirs or arch.

Block

a) Hollow Block (Open and Closed Cavity):

A concrete masonry unit with any one of the external dimension greater than the corresponding dimension of a brick and having one or more large holes or cavities which either pass through the block (open cavity) or do effectively pass through the block (closed cavity) and having the solid material between 50%and 75% of the total volume of the block calculated from the overall dimensions.

b) Solid Block:

A concrete masonry unit with external dimensions greater than the corresponding dimension of a brick and having solid material not less than 75% of the total volume of the block calculated from over all dimension.

Bond

An interlocking arrangement of structural units in a wall to ensure stability

Bond Stone (through Stone)

Selected long stone used to hold a wall together transversely.

Corbel

Stone bonded well into the wall with part of it projecting out of the face of wall to form a bearing surface.

Cornice

A horizontal moulded projection which crowns or finishes either a wall, any horizontal division of wall, or any architectural feature.

Cramp

A small piece of metal or the hardest or toughest stone procurable sunk in mortises and fixed across joints as additional ties. The ends of metal cramps are bent at right angles and stone cramps are dovetailed.

Course

A layer of stones in wall including the bed mortar

Dowels

Dowels are small sections of metal, stone or pebbles bedded with mortar in corresponding mortice in bed or side joint or adjacent stones.

Jamb

The part of the wall at the side of an opening

Joggle

A key between the stones by providing a groove in one stone to take a corresponding concealed projection in the edges on the other stone.

Natural Bed

The planes of stratification that occurs in sedimentary rocks

Parapet

A solid or pierced guard wall for flat stone terrace or balcony (or a bridge) or a curb wall at the lower part of a pitched roof which is exposed to atmosphere on face back and top

Quoin

A quoin is the external angle of wall or building. The term is also applied to stone specially selected and neatly dressed for forming such angle.

Random

Random or irregular size and shapes

Reveal

The part of the jamb between the frame and the arris

Rubble Masonry

Masonry built of stones either irregular in shapes as quarried or squared and only hammer dressed and having comparatively thick joints. As far as possible, stones for rubble masonry shall be angular.

Skewback

Sloping surface against which the springing of an arch rests

Spandrel

Space between the haunches below the decking level

String Course

A horizontal band, plain or moulded, usually projects slightly from the face of wall.

Surfacing or Dressing of Stones

The stones are dressed to have different surfaces as indicated below.

Template or Bed Block

A block of stone or concrete bedded on a wall to distribute the pressure from a concentrated load.

Self-Faced Surfaces

Surfaces of stone slabs used for roofing, flooring, lintels etc. as obtained from quarry.

Squared Back Surface

Means the surface shall be dressed back at right angles to the face of the stone.

Chisel Drafted Margin

The dressing done with a drafting chisel in narrow strips of width generally 2 to 5 cm. Chisel drafted margin shall be punch dressed.

Hammer Dressed Surface

A hammer dressed stone shall have no sharp and irregular corners and shall have a comparatively even surface so as to fit well in masonry. Hammer dressed stone is also known as hammer faced, quarry faced and rustic faced. The bushing from the general wall face shall not be more than 40 mm on exposed face and 10 mm on faces to be plastered.

Rock Faced Surface

A rock faced stone shall have a minimum of 25 mm wide chisel drafted margin at the four edges, all the edges being in the same plane.

Rough Tooled Surface

A rough tooled surface shall have a series of bands, made by means of a plane chisel 4 to 5 cm wide, more or less parallel to tool marks all over the surface. These marks may be either horizontal, vertical or at an angle of 45° as directed. The edges and corners shall be square and true. The depth or gap between the surface and straight edge, held against the surface shall not be more than 3 mm (Rough tooled stones are used where fairly regular plane faces are required for masonry work).

Punched Dressed Surface

A rough surface is further dressed by means of punch chisel to show series of parallel ridges. The depth of gap between the surface and a straight edge held against the surface shall not exceed 3 mm. Punched dressed stones are used where even surfaces are required.

Close Picked Surface

A punched stone is further dressed by means of point chisel so as to obtain a finer surface, ridges or chisel marks left over being very tiny. The depth of gap between the surface and a straight edge kept over the surface shall not exceed 1.5 mm.

Fine Tooled Surface

Close picked surface is further dressed so that all the projections are removed and fairly smooth surface is obtained. The surfaces shall have 3 to 4 lines per centimeter width depending on the degree of hardness of stone and degree of fineness required. This type of dressing is commonly adopted for ashlar work.

Polished Surface

Surfaces having a high gloss finish. Polishing of stones shall be done by rubbing them with suitable abrasive, wetting the surface where necessary with water. Alternatively polishing of stones shall be done by holding the firmly on the top of revolving table to which some abrasive material like sand or carborundum is fed. The final polishing shall be performed by rubber or felt, using oxide of lime (called by trade name as putty powder) as a polishing medium.

Moulded

Cut to profile of a molding with punched dressed surfaces, unless otherwise specified.

SECTION 13 ROOFING

13.1 GENERAL

The covering or the upper part of a building constructed to preserve it from exposure to weather is known as roof. Roofs are designed to suit the needs of different climates keeping in view the available materials. For instance, in plains where rainfall is meagre and heat intense, a thick, flat roof is more suitable to ensure greater protection from the sun. In coastal areas, however, where temperature is more or less even almost all the year round, but rainfall heavy, a pitched or sloping roof is desirable.

The Work shall include complete performance and construction of roofs shown on drawings as specified hereof.

13.2 REINFORCED CEMENT CONCRETE ROOFING

13.2.1 ROOFING

The reinforced concrete roofing shall be as shown on Drawings and shall be constructed in accordance with the provisions of Section 5 – Plain and Reinforced Concrete.

13.2.2 ROOFING PROTECTION

The roof protection consisting of water proofing with Bitumen, insulation and polythene sheet with earth layer (Av. 5 inches) and clay tiles 1.5 inches thick (9x4.5 inch) shall be installed as shown on drawings and complying with the applicable quality provisions of Section 8 – Damp Proofing & Water Proofing, Section 11 Brick work, Sub-clause 13.5 for Insulation and as approved by the Engineer-in-Charge.

13.2.3 PROCEDURE

Following procedure shall be adopted.

a. Concrete surface shall be cleaned by wire brushing and two coats of hot bitumen shall be applied at the rate of 1.6 Kg per SM

b. Bitumen surface, when still hot will be covered with polythene sheet (300 gauge), so that it sticks properly to bitumen.

c. Approved clean soil in an average thickness of 5 inches, shall be laid and compacted, as per the slope shown on the drawings or as directed by the Engineer.

d. First class burnt brick tile of approved size shall be laid on proper dressed earth, in CS mortar 1:6. All joints shall be grouted in CS mortar of 1:3 to properly seal the joints.

13.3 FIRST CLASS TILE ROOFING

13.3.1 DESCRIPTION OF WORK

It is made up of different material viz, burnt clay tiles, over R.C.C. or wooden battens. The following operation is involved in its construction.

a. Laying of first layer of first class burnt brick tiles, size 12x6x2 inch, on batten in 1:6 cement sand mortar.
b. Laying of second layer of tiles in 1:6 cement sand mortar over a bed of half an inch thickness 1:6 cement sand mortar.

c. Half an inch thick 1:6 cement sand plaster over second layer of tiles.
d. Application of a coat of 1.7 kg hot bitumen per square meter which is blinded with sand.
e. Four-inch earth filling finished with one-inch mud plaster with gobri leaping.

The work shall be performed as shown on drawings and approved by the Engineer-in-Charge. The second layer of tiles is laid by breaking joints in both directions with the first layer of tiles laid underneath. The size of tiles is as mentioned here above. Bitumen coating at the rate mentioned above. In order to safeguard against sticking of bitumen, sand shall be sprinkled over the bituminous coating at the rate of one cubic foot per 100 square feet of surface area. Battens are placed at 12 inches apart centre to centre.

13.3.2 MATERIALS

1. Tiles

Unless otherwise specified, tiles used in both the layers shall be of size specifications mentioned here above.

2. Clay

Clay used in mud mortar or earth filling should be obtained from good earth containing 20% to 30% fine sand, the clay should not contain more than 0.5 % soluble slats, more than 0.2 % sulphate and more than 4% organic contents. It shall not contain any gravel, coarse sand, kanker, roots of grass and plant. The clay shall comply with the specifications for Clay – Mud Mortar, Section 11 - Brickwork.

3. Bitumen

Bitumen shall be refined cut – back bitumen having viscosity (standard Tar Viscometer) of 110 to 150 seconds at 40 degrees C.

4 Battens

The battens shall be of specified type and size and shall have proper finished surface on top so as to give a good bearing to the tile.

The following types of battens could be used.

a. Timber battens

The battens shall be of timber complying with the provisions of Clause 16.3.

The battens shall be prepared for sizes and lengths as specified.

b. Pre-cast RCC Battens

Pre-cast RCC Battens shall be manufactured for sizes and length complying with the provisions of Section 5 - Plain and Reinforced Concrete.

c. Mild Steel Battens

Mild steel battens shall be of angle or tee sections complying with AST M-36.

The battens shall be correctly placed and fixed as specified.

13.3.3 CONSTRUCTION OF ROOF

1. Laying of Battens

The battens shall be spaced 12 inches apart centre to centre in accordance with the size of the tile as shown on drawings and shall be placed in straight and parallel lines. Battens can be of various kinds of material, like Concrete, Wood or Steel. Measurement and payment for this item shall be made under relevant item of these Specifications.

2. Slope To Roof

The necessary main slope in the roof shall be formed by sloping the beam or battens.

3. Laying Of First Layer Of Tiles

Over the battens the first layer of tiles shall be laid in specified mortar with the joints coming over the centre of the battens. Tiles shall be laid straight and square. All vertical joints shall be as fine as possible as specified on drawings and approved by the Engineer-in-Charge.

4. Laying Of Second Layer of Tiles

The second layer of tiles shall then be laid on 1/2inchthick bed of specified mortar spread over the first layer of tiles. The Joints shall be broken in both directions with the first layer of tiles laid underneath. The vertical joints shall be as fine as in the case of first layer of tiles and shall be flushed with mortar at top.

5. Bonding Of Tiles With Parapet Wall

Tiles resting on wall shall have bearing of preferably 4 1/2 inches, and in no case less than 3 Inches. These tiles shall butt closely against the brickwork of the parapet wall leaving no voids wherever possible, the ends of the tiles shall be bonded into the Brickwork with specified mortar.

6. Cement Plaster To Parapet

The portion of the parapet wall between the tiles and drip course shall be plastered with 1/2 inch thick cement sand plaster of 1:3 ratio, unless otherwise specified.

7. Curing of Bed

The bed shall be cured for seven days, and the surface shall then be allowed to dry thoroughly before bitumen is laid.

8. Application Of Bitumen - Thickness

Bitumen shall be heated to a temperature specified by the manufacturer and poured on the surface to be treated and pulled out so that the minimum thickness is 1/16 of an inch. The coat of bitumen shall be continued along with the parapet wall up to a drip course.

9. Blending of Bituminous Coating

The bitumen coat 1.70 kg/square meter shall be blended with sand at the rate of 0.30 cubic meters per 9.5 square meter of the surface area.

10. Earth filling and Mud Plaster

Four inches thick of good earth (clay) conforming to Specifications as mentioned above, shall then be put and shall be thoroughly rammed and watered. The roof shall be finished with one Inch thick mud plaster with gobri leaping in accordance with provision of Clause 15.1.12, Mud Plaster, and Finishing. This shall be done before laying the drip to ensure a close Joint with the wall.

11. Khurras

Khurras shall be made before the earth is laid as specified in Clause 13.6.

12. Pointing Of Tiles Underneath

Unless otherwise specified, on the completion of the work the underside of the tiles shall be washed and neatly pointed with 1:2 cement sand mortar.

13. Filling Spaces Between Battens

In case of wooden battens the spaces over the beam and between the battens shall be closed by one-inch planks nailed to distance pieces which in turn are nailed to the battens. Where concrete battens have been used the spaces shall be filled with 1:3:6 cement concrete block of exact size and laid in spaces with 1:3 cement sand mortar. The filling shall be equal to the battens in height and the outer faces shall be exactly in line with the edge of the beam. For Tee iron/girder beams the filling shall be with mild steel flat pieces of the same thickness as of Tee/Girder tack welded at the faces.

14. Painting with Preservations

The top surface of wooden battens in contact with the tiles and the end shall be painted with an approved preservative.

13.4 GALVANIZED CORRUGATED STEEL (C.G.S) SHEET ROOFING SPECIFICATION

13.4.1 SCOPE

Unless otherwise specified, galvanized steel sheet roofing (corrugated) shall be constructed in accordance with the following specifications.

13.4.2 MATERIALS

13.4.2.1 GALVANIZED CORRUGATED STEEL SHEETS

i. General

Corrugated steel sheets shall be made of ASTMA-36 mild steel, well annealed, even in temper and thickness free from holes, cracks, blisters and other defects. Corrugated steel sheets shall be perfectly rectangular, the corrugations parallel with the sides and regular in curve pitch and depth, and the weight of any ten sheets to be within 7 ½per cent margin of the weights given below:

ii. Weight

The weight and thickness (based on Standard Wire Gauge SWG) of corrugated steel sheets before galvanizing shall be as follows:

- No. 26SWG to be 0.500 mm thick and to weigh 0.363 Kg per square foot of girthed surface.
- No. 24SWG to be 0.630 mm thick and to weigh 0.459 Kgper square foot of girthed surface.
- No. 22 SWG to be 0.790 thick and to weigh 0.577 Kgper square foot of girthed surface.
- No. 20 SWG to be 1.000 mm thick and to weigh 0.727Kg per square foot of girthed surface.

The allowance for increase in weight by galvanizing shall be 2 oz. per square foot of girthed surface which weight includes both sides galvanization

iii. Galvanizing

Galvanization shall conform to ASTM A123. Galvanized corrugated steel sheets shall be thoroughly and evenly coated with zinc, and to be free from stains bare spots and other defects.

iv. Dimensions

The sheets shall be of standard dimensions. The diagonal distance between opposite corner of sheets shall not differ by more than ¾ inch.

iv. Paint

When not galvanized, all corrugated steel sheets shall be coated immediately after manufacture with one coat of oil paint applied by dipping or brushing over the whole of the surface of each sheet.

v. Corrugations

Unless otherwise specifically ordered the corrugations shall be of standard pattern-3 inches pitch and 3/4 inch deep. The widths shall be as under;

8/3 Corrugations	2 ft. 2 ins. measured straight and
	2 ft. 6 ins. measured along the girth
10/3 Corrugations	2 ft. 8 ins. measured straight and
	3 ft. measured along the girth.

vi. Fixing accessories

Hook bolts, screws, bolts, nuts, rivets, washers shall be galvanized or until otherwise specified by Engineer-In-charge.

Sealing material shall be bituminous mastic or of any other approved quality.

vii. Flashing Gutters

Flashing gutters shall conform to Specifications No.13.7.3for Flashing Gutters.

13.4.3 LAP

a. End lap shall be minimum of 6 inches for slope and 4 inches for vertical falls which shall be sealed with specified sealing material, complying with ASTM D-1850.

b. Side lap shall be formed on the sides of the sheet, away from the prevailing direction of wind. The side lap shall vary from one to two corrugations as specified.

13.4.4 C.G.S SHEET INSTALLATIONS

i. Purlin Spacing

Purlins shall be of the steel or timber of requisite size as specified and shall be fixed over principal rafters for installation of CGS Sheets. Purlin and all sub-structure shall be paid under relevant item of work, in these Specifications

Purlin spacing for roof covering with G.C.S. sheets shall be arranged with a view to using standard sheets of uniform length throughout, and the trusses shall be designed for purlin spacing to suit the standard length of these sheets to avoid unnecessary cuttings. Ridge purlins shall be as near to the ridge as possible having regard to the type of ridge capping to be used and the manner in which it is to be fixed.

ii. Holes

The holes for fixing bolts shall be made through crown of the corrugations and shall be either punched or drilled and shall be 1/16 of an inch larger in diameter than the bolts or fixing screws to be used.

Holes shall be in the exact position to suit the purlins and no holes for fixing bolts shall be nearer than 1-1/2 inches to the end of the sheet. These holes shall be made in a manner that the arises of the punched hole shall come on top when the sheets are laid. Where 4 sheets overlap, holes shall be drilled and not punched.

iii. Laying of Sheet.

Before the laying of sheet begins it shall be seen that all purlins are in true plane correctly spaced and securely fixed. The purlin spacing and the length of sheet shall first be checked to see that the arrangement will provide the specified overhanging at the eaves and the laps. The eave course shall be laid first and work shall start at the leeward end of the building so that side laps have better protections from rain driven by the prevailing wind. The top edges of eave sheet shall extend at least 1 ½" inches beyond the back of steel purlin or 3 inches beyond the centre line of a timber purlin.

iv. Fixing Sheets

Sheets shall be fixed to steel purlin by hook bolts and to timber purlin by mushroom-headed galvanized drive screws. Hook bolts and drive screws shall be from 1/4 of an inch to 3/8 of an inch in diameter as specified and shall be spaced at an interval of not more than 15 inches. Sheets shall be secured at every purlin by at least 2 bolts. Nuts or heads of drive screws shall have specially made washers to render the holes waterproof. Washers shall be "Limpet" patent doom and shall be bedded on bituminous felt. Screws or bolts shall be tightened sufficiently to seat washers over the corrugation.

Ridges and hips shall be laid starting from directions as laying of sheets. Final pieces shall also be provided for closing the end of ridge line at gable end.

v. Ridges and Hips

a) General accessories: Ridge or hip capping, wherever possible shall be secured to the purlin by the same bolts or screws which secured the sheeting.

b) Ridge cap shall be made up of galvanized flat steel conforming to Clause 13.4.2.1or Flat Steel Sheet ASTMA-36 or otherwise specified:

In case (a) above is not possible as the purlin is not sufficiently near the ridge, the capping shall be secured to the sheet by 1/4 of an inch to 3/8 of an inch diameter bolts: two roofing bolts to each wing capping at centre not further apart than the bolts used for sheets. The lap of the capping along the ridge shall not be less than 6 inches and shall be so arranged as to protect the joints from the prevailing wind.

c) Hip cap shall be cut to the required mitre and shall be close butted. The slope joints shall be covered with plain ridge cap which shall be secured through the roof sheet or the slope runner by one bolt on each side at the same spacing as for the roof sheets. Hip caps shall have a minimum lap of 6 inches.

vi. Special Fastening Against Cables

For any situation exposed to strong winds, sheets shall be fastened down above the eaves by continuous length of 1 ½" x ½" flat iron bars bolted down every 5 feet by ½" bolt built a foot into the wall and secured at the lower end by a 3" square washer. The fixing shall be with J-bolts.

vii. Painting Sheet

Wherever desired, sheets shall be painted with paint as approved by the Engineer-in-Charge.

13.5 INSULATION MATERIAL

i) The thermal insulation shall be rigid boards of extruded 100% closed cell polystyrene in accordance with ASTMC-578 – Standard Specification for Rigid Cellular Polystyrene Thermal Insulation or BS 3837: Part 1 Grade SHD (Special Heavy Duty) Type A, with minimum density of 36kg/m^3, of the thickness as shown on the drawing and with interlocking edges.

ii) The thermal conductivity (k value) shall not be greater than 0.03 watts/m K.

iii) The boards shall be laid with close butted and staggered joints and shall be accurately cut and trimmed to fit kerbs, parapets, fillets etc. Boards shall not be bonded to the substrate.

iv) A filter layer shall be spread over the insulation boards with standard overlaps.

v) The boards shall be protected as work proceeds against prolonged exposure to sunlight, damage and displacement before finished protection is applied.

vi) The contractor shall submit samples of the material for approval before use.

13.6 KHURRAS, PARNALAS AND SPOUTS

13.6.1 TOP KHURRAS

Unless otherwise specified, top Khurras shall be 24 inch x 24 inches x 2 inches sand shall be made of 1:2:4 cement concrete 1-1/2" inch thick, laid on 1:4:8 cement concrete. The outside edge of the Khurras shall be flush with the level of the mud plaster or leepai and the surface shall slope uniformly from that place to the outlet, which shall be 2 inches lower than the edges. Concrete shall have a slope 1:1 at the sides so as to be overlapped by earth and mud plaster. Cement concrete shall be continued into the outlet so as to ensure a watertight joint.

13.6.2 BOTTOM KHURRAS ON ROOF

Unless otherwise specified bottom khurras on top of veranda or similar roofs shall be 24X24 inches and will consist of a 1-1/2 inch layer of I**:**2**:**4 cement concrete laid on 1**:4:**8 cement concrete. The surface shall be shaped like a saucer drain, the depth of the saucer being 2 inches, and joining up with the roof drain, described in paragraph13.6.7.

13.6.3 BOTTOM KHURRAS ON GROUND

Unless otherwise specified, bottom khurras when used on the ground, in conjunction with spouts, shall be 4 feet x 2 feet x 7-1/2 inches and shall consist of bricks on edge laid in cement, laid on 3 inches of 1**:4:**8 cement concrete.

13.6.4 REVEALED PARNALAS

Unless otherwise specified, revealed parnalas shall be made by leaving a channel 7 inches wide and 2-1/4inches deep in the wall during construction, and afterwards plastering the channel with 1:3 cement plasters. The corner of the channels shall be rounded to a radius of one Inch in plastering. If revealed parnalas are left in a wall made of brickwork in mud, the bricks shall be laid in cement mortar (I:3) for a depth of 4-1/2 inches from the back and sides of the parnalas, this work being included in the rate.

13.6.5 KHASSI PARNALAS

Unless otherwise specified, khassi parnalas shall consist of two fillets of cement plaster. (1:3) raised 1-1/2 inches and spaced 9 inches apart, the space in between being plastered with 1:3 cement plasters. The fillets shall be prismatic in section (but with all corners and angles rounded), the Inner sides being at right angle to the wall and the outer sides sloping.

Unless otherwise specified, khassi parnala's shall in no case be made on top of the cement or other plaster on the wall, but made In contact with the brickwork or masonry after raking out the Joints.

13.6.6 SPOUT

Unless otherwise specified, spouts shall be made of PVC, cast iron, AC and reinforced cement concrete and shall have an open Channel 3-1/4 inches x 3-1/2 inches with a semi-circular bottom. They shall project at least 15 inches from the face of the wall and shall be built into the wall for a depth of at least 13-1/2 inches. The part built into the wall shall be sufficiently thickened to provide adequate support for the overhanging portion. Spouts shall be fixed at a slope not flatter than 1 in 6 and shall have a lip at the lower edge to allow water to drip clear.

13.6.7 ROOF DRAIN

Roof drains shall be provided on veranda and similar roofs to conduct water, discharged by the parnalas of a higher roof, to the outlet. They shall run in a straight line from the bottom khurra of one to the (top) khurra for the outlet concerned.

Unless otherwise specified, the drain shall be saucer-shaped in section, the depth being 2 inches. Drains shall be made of 2 inches thick 1:2:4 cement concrete laid on cement concrete 1:4:8 of a section to give the necessary shape, with edges flush with the roof plaster.

13.7 GUTTERS AND FLASHINGS

13.7.1 SCOPE

Unless otherwise specified, gutters and flashings shall be constructed with plain galvanised iron/steel & plain AC sheets of the following specifications.

Galvanized steel sheets shall be:-

For gutters No. 18 S.W.G. to No. 22S.W.G

For flashings No. 20 S.W:G. to No. 24 S.W.G.

The galvanised steel sheets shall conform with the provisions of Clause 13.5.

The ACC valley gutters shall be 1/4" to 3/8" thick and the sizes as specified. The AC sheets shall conform to the provisions of Clause 13.6.

13.7.2 GUTTERS

13.7.2.1 GENERAL

(i) Unless otherwise specified, gutters shall be semi-circular in shape, made of the material specified above and shall be properly finished and laid in specified shape. Gutters shall be supported with brackets fixed to wall or roofing at a specified distance apart.

(ii) The overall width of the sheet as specified shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12mm and beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

13.7.2.2 SLOPE

Gutter shall be laid with a minimum slope of 1 in 120.

13.7.2.3 LAYING AND FIXING

(i) Gutter shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

(ii) Where these brackets are to be fixed to the sides of rafters, they shall be of 40x3mm section bend to shape and fixed rigidly to the sides of rafters with 3 Nos. 10mm dia bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12 cm centre to centre.

(iii) Where the brackets are to be fixed to the purlins, the brackets shall consist of 50x3mm M.S. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 Nos. of 10mm dia bolts nuts and washers. The bracket will be stiffened by provision of 50x3mm. M.S. flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 No. 10mm dia, bolt, nut and washer. The

overhang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

(iv) The gutter shall be fixed to the brackets with 2 Nos. G.I. bolts and nuts 6mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

(v) For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.S. sheet of the same thickness as the gutter and riveted to the gutter, the other end tailing into the socket of the rain-water pipe. Where over necessary stop ends, angles etc., should be provided.

13.7.3 FLASHING

When the edge of roof sheeting or of a valley gutter is turned up against a wall, the edge shall be weather-proofed with a flashing. The flashing shall be inserted into the brickwork or masonry joints to a depth of 2 inches, the joints being filled up with 1:3 cement mortars unless otherwise specified. It shall be further secured in the joint by means of galvanized iron clip, in at least 4 Inches into the masonry. The lower edge of the flashing shall overlap the sheeting below it by at least 4 inches, the edges of the sheeting and flashing being left free to expand and contract. Wherever flashing has to be laid at a slope, it shall be stepped at each course of the masonry, the steps being cut back at an angle of not less than 30 degrees to the vertical.

Fixing accessories and holes are to be the same as used for the adjoining sheets. Each sheet should be fixed at every purlin or rail by at least two bolts situated at the side laps and three intermediate fastenings for use with galvanized or aluminium corrugated profiles.

In addition to purlin or rail fixings, side laps are to be secured by means of seam bolts at maximum 300 mm centres. The uses of self-tapping screws or blind rivets are not permitted. Provide neoprene washers under bolt heads.

13.8 FIBRE GLASS (PLASTIC) ROOFING

13.8.1 SCOPE

The scope of work includes of supply of all materials and construction of plastic (Fibre Glass)roofing complete as shown on drawings in accordance with the specifications and as approved by the Engineer-in-Charge.

13.8.2 MATERIALS

a) The preformed plastic panels or corrugated translucent sheets made from thermosetting polyester resins to comply with BS 4154 and are to match with the profile of the roofing as specified and shown on drawings.

The thickness and colour of plastic panels shall be as designated in drawings. The sheets shall be procured from an approved source.

b) The fixing accessories shall consist of G.I. bolts nut, limpets and washers for installation and jointing of sheets.

c) Roll battens/boards shall be wooden, aluminium and mild steel sections as shown on drawings. The wooden battens and section shall conform to the provisions of Clause 16.3 - Woodwork.

The steel sections shall be made of galvanised steel sections conforming ASTM A-36. The aluminium sections shall be conforming BS 1474.

13.8.3 ROOF CONSTRUCTION

The fibre glass sheets shall be laid on the previously installed boarding frame and firmly secured with the holding accessories. The over laps and ridges shall be provided in accordance with drawings or as directed by the Engineer.

13.9 WOODEN CEILING

13.9.1 BOARDS

i) Boards shall be of the class of timber and of finished thickness as specified in the description of the item and shall be in accordance with the general specifications for wood work. Only selected boards of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of boards selected for use shall not be less than 100 mm nor more than 150 mm.

ii) The specific width of boards once selected within these two limits shall be maintained throughout and shall not be varied except in the first and last lines of boards adjustment to the two walls, where remaining odd width shall be adjacent equally on both sides. The maximum length of the board in the finished work shall be 180 cm. The minimum length of board in the finished work shall be such that it will span at least two spacing of the supporting frame work except where shorter lengths are unavoidable, depending on the arrangements of the lines of heading joints which shall be carried out to the pattern ordered by the Engineer-in-Charge.

The boards shall be plained true on the exposed side.

(iii) Unless stipulated otherwise in the description of the item, the longitudinal joints of the boards shall be tongued and grooved, while the heading joints shall be of the square butt type and shall occur under the centre line of the supporting joint. Heading joints in adjacent boards shall not be placed over the same joists, those in alternate boards being arranged in the same line, except where the joints are to be concealed by headings.

13.9.2 FRAME

Generally timber for frame shall conform to the provisions of Clause 16.3 – Woodwork.

Timber frame of the class of timber and section specified in the description of the item or as ordered by the Engineer-in-Charge shall be provided. The width of the frame scantling shall not be less than 50 mm. The arrangements and spacing of the frame scantling shall be as per design furnished. The frame shall be given two coats of approved preservative paint before the boarding is screwed. The frame and paints thereof shall be paid for separately unless specifically included in the description of the item. M.S. angles shall be used for suspending the frame and paid for separately.

The bottom surface of the frame shall be checked and corrected to true plans and slopes as specified and shown on drawings.

13.9.3 MILD STEEL SCREWS

Screws shall be got approved from the Engineer-in-Charge before fixing. They shall be of the slotted counter sunk head type of length not less than the thickness of the board plus 20 mm. The designation number shall not be less than 9 for screws of length 40 to 50 mm and shall not be less than 6 for screws of length 25 to 35 mm.

13.9.4 FIXING

The outer lines of boards shall be accurately fixed, parallel and close to the wall. Each subsequent plank shall be carefully jointed up. The boards shall be fixed to the frame scantling above with two screws at each of frames and one at every intermediate joist. The screws shall be counter sunk and the screw holes filled with putty or sloping out wax.

The unexposed faces of planks shall be painted with wood preservative before fixing.

13.9.5 FINISHING

The exposed side of the boards shall be truly level and plane. The joints shall be truly parallel and/or perpendicular to the walls.

Beadings shall then be fixed to the ceiling, to the size and pattern required. These shall be measured and paid for separately unless specifically included in the description of the ceiling item.

13.10 SUSPENDED OR DROPPED CEILINGS

13.10.1 AESTHETICS

Modern dropped ceilings were initially created to hide the building infrastructure, including piping, wiring, and/or duct work, by creating a plenum space above the dropped ceiling, while allowing access for repairs and inspections. Drop ceilings may also be used to hide problems, such as structural damage. Further, drop out ceilings can also conceal the sprinkler systems while still providing full fire suppression functionality.

For many years, dropped ceilings were made of basic white tiles, but modern innovations now offer a plethora of options in sizes, colors, materials (including retro designs and faux leather, wood, or metal), visual effects and shapes, patterns, and textures as well as support systems and ways to access the plenum. Custom runs of specialty ceiling tiles can be done at relatively low cost compared with the past.

13.10.2 ENVIRONMENTAL FACTORS

Indoor environmental quality

Indoor environmental quality includes ventilation, VOC emissions, lighting and thermal system control, and thermal comfort, use of daylight for natural illumination, acoustics, and optimization of outdoor view availability.

13.10.3 SUSPENSION GRID

A typical dropped ceiling consists of a grid-work of metal channels in the shape of an upside-down "T", suspended on wires from the overhead structure, concrete or truss. These channels snap together in a regularly spaced pattern of cells. Each cell is then filled with light weight ceiling tiles or "panels" which simply drop into the grid. The primary grid types are "Standard 1" (15/16 face), Slim line (9/16" grid), and concealed grid. Panel size shall be 24x 24 inches or as shown on the drawing.

Quality of suspension wires and T-type Aluminium strips shall be as per drawings or as directed by the Engineer

13.11 PAINTING OF ROOF SLAB WITH HOT BITUMEN

13.11.1 SCOPE

Where specified bitumen coat shall be applied on roof as specified and approved by the Engineer-in-Charge. Unless otherwise approved by the Engineer-in-Charge, the bitumen shall conform to ASTM Designation D-449-14.

13.11.2 PREPARING THE SURFACE

The surface shall be painted only when it is fully dry. The surface to be painted shall be cleaned with wire brushes and cotton or gunny cloth. All loose materials and scales shall be removed and the surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil.

13.11.3 PAINTING WITH BITUMEN

The contractor shall bring the bitumen to site in its original packing and shall open and use it in the presence of the Engineer-in-Charge or his authorised representative. The containers shall not be removed from the site until the painting job is completed and the Engineer-in-Charge has satisfied himself regarding the quantity of bitumen actually used and has given his permission to remove the empty containers.

The surface prepared and treated shall be painted uniformly with bitumen of approved quality such as residual type petroleum bitumen of penetration 80/100, hot cut back bitumen or equivalent as per specifications of the manufacturer. The coat of bitumen shall be continued 15 cm along the vertical surfaces joining the roof. In case of parapet walls it shall be continued up to the drip courses. Residual type petroleum bitumen of penetration 80/100 shall be heated to a temperature of not less than 180 degree C and not more than 190 degree C and shall be applied on the roof surface at not less than 180 degree C. Similarly, hot cut back bitumen shall be heated to a temperature of not less than165 degree C and not more than 170 degree C and shall be applied on the surface at not less than 165degree C.

Care shall be taken to see that no blank patches are left. The quantity of bitumen to be applied per 10 square metres of roof surface shall be 17 kg, unless otherwise stipulated in the description of the item. It shall be carefully regulated so that the application is uniform at the stipulated rate of 17 Kg. Per10 square metres.

13.11.4 SPREADING SAND

Immediately after painting, dry, clean sharp coarse sand at the rate of60 cubic decimetre per 10Sq.m. shall be evenly spread and levelled over the surface when the bitumen is still hot.

13.12 BUILT-UP BITUMEN FELT WATER-PROOFING

13.12.1 MATERIALS:

(a) **Primer** shall conform to ASTM D-41.

(b) **Bitumen** shall conform to ASTM D-312 type-III Bitumen grade 10/20 PB4

(c) **Roofing** Felts:

Any of the following felts as indicated in pay items in bill of Quantity shall be used. All felts shall be fine granule surfaced. Roofing felts may conform to any of the following:

BS EN 13707 “Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing”.

ASTM D173 “Standard Specification for Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing”.

(d) **Flashing Felt** shall be fabric-based bitumen felt conforming to ASTM D-173, with aluminium foil on the face.

(e) **G.I. Profile** (for use on vertical waterproofing at parapets) shall be of 22 gauge, 4” wide strip, top 0.75 inch and bottom 0.5 inch bent at 45 degrees.

(f) **Sheet** Polyethylene shall weigh 2.5 lbs per 100 sft.

(g) **Mortar** shall comply with the requirements of section-11 of this specification.

(h) **Sealant** (for use with G.I. profile) shall be supplied by approved manufacturer and shall be UV and weather resistant.

13.12.2 CONSTRUCTION REQUIREMENTS

(a) General

The work shall comply with the requirements of BS 8218 “Code of practice for mastic asphalt roofing” as applicable to the work.

Waterproofing shall not be carried out when ambient temperature is below 40 ^{0}F (5 ^{0}C) or before any pipes, drains etc. have been installed. The surface to receive water-proofing shall be prepared by filling up all pits holes and crevices with 1:3 grey cement sand mortar and high spots shall be chipped off and ground smooth. The surface shall be thoroughly cleaned and shall be perfectly dry.

b) Priming the Surface

Over the prepared surface specified primer shall be applied at the rate of 0.5 liter per m^2

(c) Sticking Coats of Bitumen and Felt Layers

Over the primed surface, indicated number of layers of roofing felt shall be installed. Each layer of felt shall be preceded by a sticking coat of bitumen at the rate of 30 Lbs. per 100 Sft. Bitumen shall be heated to flow freely but not above 325 degrees F (162 ^{0}C).

The felt shall be laid with 4” end laps, free of wrinkles or air pockets underneath. While the sticking coat of bitumen is still hot felt will be pressed against the bitumen. Laying of felt layers shall be started from lower side of the roof. Felts shall be laid in shingle fashion, width overlaps along the length of felts shall be:

$$\text{Overlap in inch} = \frac{\text{Width of felt roll in feet + 2 inch}}{\text{Number or felt layers}}$$

(d) Flood Coat of Bitumen

Over the top layer of felt, a flood coat of bitumen shall be applied at the rate of 45 lbs per 100 Sft.

(e) Top Covering

At of the top specified coverings, as indicated in pay item in the Bill of Quantity, shall be applied.

13.12.3 LAYER TREATMENTS

Sr. No.	Layer Treatment	Rates Of Application	
		For Horizontal Surfaces	For Vertical Services
(a)	**5 Layer Treatment**		
1.	Primer	One gallon per 100 Sft. or 0.55 liters per m^2	One gallon per 100 Sft. or 0.55 liters per m^2
2.	Sticking Coat of Bitumen	30 lbs per 100 Sft	30 lbs per 100 Sft
3.	Bitumen Felt	One Layer	One Layer
4.	Flood Coat of Bitumen	45 lbs per 100 Sft	30 lbs per 100 Sft
5.	Top Covering	As specified	As specified

(b) 7 Layer Treatment

It shall be same as in (a) above but with 2 coats of sticking bitumen and 2 layers of bitumen felts.

(c) 9-Layer Treatment

It shall be same as (a) above but with 3 coats of sticking bitumen and 3 layers of bitumen felts.

13.12.4 WATER-PROOFING OVER VERTICAL SURFACE OF ROOFS AT PARAPETS

(a) Under the roofing felts, at the corner, apply an angular fillet of 2.5 inch x 2.5 inch in 1:3 cement sand mortar; finish smooth and cure for 10 days.

(b) Over the mortar fillet and also over the vertical surface of parapet up to a height such that the bottom of the G.I. profile rests on the tile covering, apply the following treatments:-

- Primer at the rate of one gallon per 100 Sft (or 0.5 liters per m^2).
- First sticking coat of bitumen at the rate of 30 lbs per 100 Sft.
- Carry up the roofing felt top layer.
- 2nd sticking of bitumen at the rate of 30 lbs per 100 Sft.
- Lay 10-inch wide strip of flashing felt, with bottom bent over the roofing felt.
- Fix the top of flashing felt with G. I. profile nailed to parapet at 12-inch centers.
- Apply sealant in the gap at top between flashing and the G. I. profile.

13.13 CAST IRON RAIN WATER PIPES

13.13.1 CAST IRON PIPES& FILLING

Cast Iron pipes and fillings shall conform to BS 78 for spigot and socket vertically cast pipes and BS 1211 for spigot and spun pipes. The pipes shall be perfectly, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and of uniform castings, free from laps, pin holes

or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of pipes shall be reasonably square to their axes. The pipes shall be procured from an approved source.

13.13.2 DIMENSIONS

C.I. rain water pipes shall be of the dia. specified in the description of the item and shall be in full length of 1.8 metre including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall be in each case be with socket. The pipes shall be supplied without ears unless otherwise specifically mentioned. The pipes supplied shall be factory painted (with a tar base composition) both inside and outside which shall be smooth and ten acinus. Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw. The sizes, weights, sockets and tolerances of pipes shall be as shown in Table 13.16.

TABLE 13.13 (a)

Dimensions and Weight of C.I. Rain Water Pipes

		Nominal size of pipes (Internal diameter in mm)	50	75	100	125	150
1		**PIPE**					
	a)	External diameter in mm	53	79	104	130	156
		Tolerance in mm	± 3	± 3	± 3.5	± 3.5	± 4
	b)	Thickness in mm	3	3	3	3	4
		Tolerance in mm	± 1	± 1	± 1	± 1	± 1
		Nominal size of pipes (Internal dia. in mm)	50	75	100	125	150
	c)	Nominal weight of 1800 mm					
		long pipe without ears in kg	7.50	11	14	20	26
		Tolerance in weight	(-) 10%	(-) 10%	(-) 10%	(-) 10%	(-) 10%
		Tolerance in length in mm	± 13	± 13	± 13	± 13	± 13
2		**SOCKET**					
	a)	Internal diameter in mm	63	89	114	139	167
		Tolerance in mm	± 3	± 3	± 3	± 3	± 3
	b)	Thickness in mm	4	4	4	4	4
		Tolerance in mm	± 1	± 1	± 1	± 1	± 1
	c)	Internal depth in mm	60	65	65	75	75
		Tolerance in mm	± 10	± 10	± 10	± 10	± 10

Note:

1. All dimensions are in mm.
2. Pipes weighing more than the nominal weight may be accepted provided they comply in every other respect with the requirements of the standard.
3. The above table applies only to rain water pipes fixed on wall face.
4. For pipes and fittings which are to be embedded in masonry, specifications shall correspond with those of pipes for soil, waste, and vent pipes.

13.13.3 FIXING AND JOINTING

i) Pipes shall be either fixed on face of wall or embedded in masonry, as required in the description of the item.

ii) Plain pipes (without ears) shall be secured to the walls at all joints with M.S. holder bat clamps. The clamps shall be made from 1.6 mm thick galvanised M.S. sheet of 30 mm width, bent to the required shape and size so as to fit tightly on the socket of the pipe, when tightened with screw bolts. It shall be formed out of two semi-circular pieces, hinged with 6 mm dia M.S. Bolt on one side and provided with flanged ends on the other side with hole to fit by the screw bolt and nut, 40 mm long. The clamp shall be provided with a hook made out of 27.5 cm long 10 mm diameter M.S. bar, riveted to the ring at the centre of one semi-circular piece. The clamps shall be fixed to the wall by embedding their hooks in cement concrete block 10 x 10 x 10 cm in1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning and painting of pipes.

Note: Where G.I. sheet clamps are not provided, M.S. sheet clamps of 3 mm thick and 20 mm wide shall be used for making the clamps.

iii) The pipes shall be fixed perfectly vertical or to the lines as directed. The spigot of the upper pipe shall be properly fitted in the socket of the lower pipe such that there is a uniform annular space for filling with the jointing material. The annular space between the socket and the spigot shall be filled with a few turns of cotton spun yarn soaked in neat cement slurry. These shall be pressed home by means of caulking tool. More skins of yarn shall be wrapped if necessary and shall be rammed home. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth at top at an angle of 45 degree sloping up. The joints shall be kept wet for not less than 7 days by tying a piece of gunny bag, four fold, to the pipe and keeping it moist constantly.

iv) Where pipes are to be embedded in masonry, these shall be fixed in masonry work as it proceeds. In such cases care shall be taken to keep the pipes absolutely vertical or to the line as directed by the Engineer-in-Charge. The pipe shall have a surrounding of 12 mm minimum thickness of mortar at every portion of the external surface. The mortar shall be of the same mix as is used in the masonry. The joint shall be caulked with lead as soon as the next length of pipe is placed in position. The open end (socket end) of the pipe shall be kept closed till the next length is fitted and jointed, to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe.

The depth of lead from the lip of socket shall be 25 mm minimum. In case of 100 mm dia. 75 mm and50 mm pipes, the quantity of lead required per joint shall be 1.00 kg, 0.66 kg and 0.50 kg respectively for purpose of reckoning theoretical Consumption.

In order to ensure that required quantity of lead is poured into the joint and to control wastage of lead, at the beginning, three or four samples shall be made and the quantum of lead per joint approved by the Engineer-in-Charge.

The actual consumption of lead should be within ± 5% of the approved sample job subject to the provision that a variation of ± 20% shall be allowed over the theoretical quantity of lead due to dimensional tolerances. This variation includes allowances of wastage also.

v) The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25 mm from the lip of the socket for the lead. The joint shall then be fully lead caulked approved by the Engineer-in-Charge.

13.14 CAST IRON ACCESSORIES FOR RAIN WATER PIPES

13.14.1 C.I. FITTINGS

C.I. accessories such as bends of various degrees, heads, offsets of different projections, branches and shoes shall be of approved quality complying with BS-78.Bends shall be of the nearest standard degree as actually required at site. Heads shall be of the flat or corner type as required. Offsets shall be of the projection as stipulated in the description of the item. Branches shall be single or double as described in the item and shall be of the nearest standard degree as actually required. Standard shoes shall be of overall vertical length, 180 mm for 75 mm dia., 205 mm for 100 mm dia and 275 mm for 150 dia sized pipe from top of socket to lowest tip of shoe. Shoes of longer lengths if used shall be in lengths 300 mm, 375 mm, 450 mm, or 600 mm from top of socket to lowest tip of shoe of as actually required at site.

13.14.2 DIMENSIONS

The fittings shall be of the diameter specified in the description of the item. The thickness of the fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes. The fittings shall be supplied without ears unless otherwise specifically mentioned in the item. The fittings shall be factory painted with a tar basis composition both inside and outside which shall be smooth and tenacious. Every fitting shall ring clearly when struck all over with a light hard hammer. The fittings shall be of standard size and their individual weights shall conform to the weights given in the Table 13.1

TABLE 13.14 (a)
Weight of C.I. Rain Water Pipe Fittings

Sr. No.	Description	75 mm dia	100 mm dia	150 mm dia	Unit
		Kgs.	Kgs.	Kgs.	
1.	Bends (Plain)	3.20	4.50	9.10	Each
2.	Offsets (Plain)				
a)	55 mm projection	2.70	5.00	8.20	Each
b)	75 mm projection	3.20	5.50	9.10	Each
c)	115 mm projection	4.10	5.90	9.50	Each
d)	150 mm projection	4.50	6.40	10.40	Each
e)	225 mm projection	5.00	7.30	11.80	Each
f)	300 mm projection	6.00	8.60	12.70	Each
3.	Branches (Plain)				
	Single	5.00	7.30	14.50	Each
	Double	6.80	10.00	19.10	Each
4.	Standard shoes (Plain)	3.20	4.10	8.60	Each
5.	Longer shoes (Plain)				
a)	300 mm	3.20	5.00	-	Each

b)	375 mm	4.10	5.50	-	Each
c)	450 mm	5.50	6.40	-	Each
d)	600 mm	7.30	8.60	-	Each
6.	Heads	6.40	6.80	11.30	Each
7.	Extras:				
a)	For ears cast on any fitting and short pipes	0.90	0.90	1.35	Each
b)	For inspection doors fitted on any fitting	1.80	1.80	2.25	Each

Note:

1. The above table applies only to rain water fittings which are part of pipe lines fixed on wall face. Permissible tolerance in weight of fittings shall be 5%.

2. For fittings to be used with pipe lines to be embedded in masonry, specifications shall correspond to BS 437 of pipe fittings for soil, waste and vent pipes.

13.15 MEASUREMENT AND PAYMENT

13.15.1 COMPOSITE RATE

The measurement and payment for the items of the work of Roofing hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

Pay Item No.	Description	Unit of Measurement
13.15 a	Providing and laying roof insulation comprising single layer of 1st class burnt brick tile 9x4.5x1.5 inch. laid in ¾" thick ratio 1:6 CS mortar, grouted with 1:3 CS mortar, over 4" thick compacted earth over 2 coats of 10/20 grade bitumen on concrete at 1.6 kg/sm and blended covered with polyethylene sheet 300 gauge	SM
13.15b	Providing and laying insulation material of extruded polystyrene (ASTM 578) in rigid insulation foam board on roof with density 32-35kg/cm, compressive strength 250-350kPa, R value >=5 per inch thickness and water absorption <1% by volume. Cell structure closed. Fire retardant with LOI value >=28% with thickness laid over water proofing treatment, sealant and concrete should be paid separately.	
	i. 1" (25mm) thickness	SM
	ii. 1.5" (40mm) thickness	SM
	iii. 2" (50mm) thickness	SM
13.15 c	Providing and laying insulation material of extruded polystyrene (ASTM 578) in rigid insulation foam board on wall with density 32-35kg/cm, compressive strength 250-350kPa, R value >=5 per inch thickness and water absorption <1% by volume. Cell structure closed. Fire retardant with LOI value >=28% with thickness laid over water	

	proofing treatment, sealant and plaster should be paid separately.	
	i. 1” (25mm) thickness	SM
	ii. 1.5” (40mm) thickness	SM
	iii. 2” (50mm) thickness	SM
13.15d	Providing and laying tack coat of bitumen grade 10/20 at the rate of 1.6 kg/sm on roof	SM
13.15e	Providing and laying felt/waterproof matting with 3 ply on roof, including overlaps	SM
13.15f	Providing and laying polyethylene sheet 500gauge on roof as directed, including overlaps	SM
13.15 g	Providing and fixing corrugated GI sheet including all hardware for fixing GI sheet without valleys and ridges complete in all respect	
	i. 24 SWG (1.06mm)	SM
	ii. 26 SWG (0.97mm)	SM
13.15h	Fiber glass (Corrugated) roofing including all hardware as specified herein or as directed by the Engineer	
13.15 i	Providing, fixing and hoisting best quality wood ceiling frame of required section including 3/4" thick and 6" wide plank of same wood with tounge and grove arrangement fixed with truss complete in all respect	
	i. Fir wood	SM
	ii. Kail wood	SM
13.15j	False ceiling with gypsum board, cement board or thermo sheet etc. 1” thick suspended through wires and inverse tee section aluminium strips for RCC or sloping truss roof as described in the item or as directed by the Engineer	SM
13.15k	Providing and fixing PVC class D down pipes including all hardware fixed with wall or cement concrete	
	i. 3” dia	LM
	ii. 5” dia	LM
13.15 l	Providing and fixing plain GI sheet including ridging and valley fixture at site, timber for ridge roll and ridge sheeting 6" (15cm) complete in all respect	
	i. 24 SWG	SM
	ii. 26 SWG	SM

SECTION 14 FLOORING

14.1 GENERAL

The tier or levels which divide a building in two stages or storeys are called floors. These are made of materials quite different both in composition and construction. They range from relatively thin covering, contributing little or no structural strength to a building, to much thicker materials capable of withstanding reasonable stresses, and in some designs, essential to the strength of the building.

14.2 EARTH FLOORING

14.2.1 SCOPE

Unless otherwise specified, earth flooring shall be constructed in accordance with the following specifications.

14.2.2 MATERIAL

Earth (clay) shall conform to following Specifications:

Source:

Clay shall be obtained from good earth containing 20 % to 30% fine sand.

Quality:

Clay shall not contain more than 0.5% soluble salts more than 0.2% sulphate and more than 4% organic contents. It shall not contain any gravel, coarse sand, kanker roots of the grass and plant.

14.2.3 LAYING AND CONSOLIDATION

Earth shall be placed in layers of six inches and shall be sprinkled with water and rammed to such an extent that a layer of 6inch thick loose earth evenly spread is reduced to 4 inches in thickness. The consolidated surface shall be such that a very faint impression can be made on it with the heel of a boot or the blow of a rammer.

14.3 MUD FLOORING

14.3.1 SCOPE

Unless otherwise specified, mud flooring shall be constructed in accordance with the following specifications.

14.3.2 MATERIAL

a) Earth (clay) shall conform to Specifications as mentioned above 14.2.

b) Mortar shall conform to Specifications in Section 11- Brickworks Mud Mortar.

Laying

After laying earth floors as per Specifications 14.2for Earth Flooring, the surface shall be finished with one inch thick mud plaster with gobri leaping conforming to Specifications in Section 15.1.12 for Mud Plaster.

14.4 BRICK TILE FLOORING

14.4.1 SCOPE

Unless otherwise specified brick or tile flooring shall be constructed in accordance with the following specifications:

14.4.2 MATERIAL

a) Brick or tile shall conform to Specifications as mentioned in Section 11 for Clay Bricks.

b) Mortar shall conform to Specifications as mentioned in Section 11– Brickwork, Mortars.

14.4.3 BASE

The construction and preparation of base for ground floor and subsequent levels shall comply with the provisions of Clause 14.9.

14.4.4 WETTING OF BRICKS/TILES

Bricks or tiles shall be wetted in accordance with the Specifications mentioned in Section 11 for Brick work

14.4.5 PATTERN

The laying of bricks or tiles shall be plain, diagonal, herring-bone or any other specified pattern.

14.4.6 JOINTS

a) Where pointing is not to be done the Joints shall not exceed 3/16 inch in thickness. The mortar oozing out of the joints shall be struck off with trowel or wiped off with damp cloth.

b) Where pointing is to be done the joints shall not exceed 3/8 inch in thickness. The mortar in the Joint shall be raked out one inch deep while it is still green.

14.4.7 POINTING

If otherwise specified, the joints shall be flush pointed with specified mortar.

14.4.8 THICKNESS OF BEDDING MORTAR

Unless otherwise specified the floor shall be laid on 3/4 inch thick minimum bed of specified bedding mortar spread evenly on the base.

14.4.9 LAYING OF BRICKS/TILES

Bricks/tiles shall be laid with specified mortar in position on the bedding mortar.

14.4.10 PROTECTION

Flooring shall be allowed to mature, undisturbed, and protected from the effects of weather. It shall be kept wet for at least 7 days after completion. If pointing is to be done, it shall be kept wet for at least 14 days after the completion of pointing.

14.4.11 SURFACE

Surface shall be finished to specified levels. All joints shall be uniform, true and parallel and square bricks shall be rubbed to ensure this where it is very necessary, without extra cost.

14.4.12 EDGE WITH BULLNOSED BRICKS

No damaged bricks or tiles shall be used. Bats shall not be used except to close any course of bricks or tiles. Unless otherwise specified, the overhanging edge of the paving shall be finished off by special bull-nosed bricks.

14.5 MARBLE TILE FLOORING

14.5.1 SCOPE

Unless otherwise specified marble flooring shall be constructed In accordance with the following specifications.

14.5.2 MARBLE / GRANITE

Marble slabs of an approved quality shall be used. The marble shall be super white, Lasbela, Badaloras specified.

The Contractor shall produce samples of marble tiles to be used for this item of work for selection, testing and approval. The samples shall be in finished sizes and shapes and adequate in number for testing in the laboratory as and when ordered. The tests for marble shall be as per ASTM Standards for the determination of:

Weight %age Absorption	ASTM C-97-15
Modulus of Rupture	ASTM C-99
Compressive Strength	ASTM C-170
Resistance to Abraision	ASTM C-241-15
Flexural Strength	ASTM C-880-15

The Contractor may also be required to produce samples of finished item of tile work fixed in position before he is allowed to proceed with the work on a particular item.

14.5.3 MORTARS

Cement sand mortar on which marble tiles are placed shall be 1:3 unless otherwise specified

14.5.4 BASE

For ground and subsequent floors the base shall be laid as per Specifications 14.9.

14.5.5 SIZE, COLOUR AND PATTERN

Marble / Granite shall be of the size colour and pattern, as specified.

All Marble tiles shall be machine cut in proper dimensions with following maximum tolerances for minimum size of 30cm x 30cm tile.

Thickness	± 2 mm
Width	± 1 mm
Length	± 1 mm
Surface	± 1 mm

All the four angles of tile, shall be exactly right angled (90 Degree) with surface tolerance as stated above. For a specific area, tiles of similar shade and texture shall be used.

Marble / Granite shall be of approved quality, colour and grain it may be imported or local as approved by the Engineer.

14.5.6 THICKNESS DRESSING OF EDGES AND JOINTS

All slabs shall have a true plain surface and shall be accurately sawn; truly square at edges to the full thickness. All marble slabs shall have a minimum thickness of 3/4 of an Inch. No Joints shall be more than 1/16 of an Inch in thickness. Slabs projecting over the edges of verandah or steps shall have their edges finished with a bull-nosed ending.

14.5.7 PREPARATION OF BASE

Before laying marble slabs, the surface of the base shall be washed and scrubbed with wire brushes. Where they are to be laid directly over roof slab, the later shall be roughened while it is still green.

14.5.8 THICKNESS OF BEDDING MORTARS

Marble/Granite slabs shall be laid over Specified bedding mortar not more than 3/4 of an inch thick or on tile adhesive as specified.

14.5.9 LAYING

Slabs shall be laid in position on bedding mortar in specified pattern.

Marble of approved size, colour, texture and quality shall be spread on floor and water be sprinkled for visibility of actual shade/colour of the marble tiles. Tiles with variations in shade/colours, cracks, broken edges, defective spots/holes, variation in texture or any other defect unacceptable to the Engineer shall be taken out as rejected and removed from site. Only approved tiles shall be used in works.

The Contractor shall employ skilled and trained tile workers for doing this job. He may be allowed to employ an approved specialist Sub-Contractor for this item of work. The surface over which the tiles are required to be fixed will be clean of all dirt and dust and should be properly hacked so that the mortar sticks well to the surface. The edge of the tiles shall be dressed true and square by rubbing them with carborundum stone or any other approved means and the same will be fixed in position.

The marble tiles on wall shall be laid in Sika Tile Fix 15 adhesive or any other approved adhesive. Adhesive shall be applied as per manufacturer's recommendations. Tile shall be allowed to season for at least three days during which it shall be kept moist.

Due allowance shall be made for movement of the structure and backing by including construction and expansion joints in the tile work. These shall be properly filled with approved mastic compound. Expansion joints shall be formed to coincide with the expansion joints in the building.

Over the prepared surface. Each tile shall then be set individually over the adhesive and worked by tapping tiles gently with a wooden mallet. The tiles shall be laid in pattern as per drawing and instructions of the Engineer and joints; width shall be fixed accordingly and in no case shall vary.

Tight joints for marble work should not exceed 1/16". The joints shall be grouted with Sika Tile Grout or any other grout approved equal, as per manufacturer's

recommendations in matching colours. The joints must be all in the lines running straight from room to room, room to passage, etc, and for this purpose pieces of tiles may have to be used at edges. Tiles shall be set evenly and the 4 corners of each tile shall meet flush with the adjoining 4 corners of the tiles. The whole of the flooring shall be true to level and grades where required.

Laying of tiles in any pattern shall begin from centre of the area so that the opposite side will require the same number of tile and the border design may work symmetrically.

The colour variation shall be in ranges selected during sample submittals and acceptable to the Engineer and special care shall be taken while installing in any single enclosed area as per instructions of the Engineer.

If tiles have become dirty, they shall be washed with washing soda. The surface shall be cut/grind, repaired, grind again and chemically polished to full gloss to the satisfaction of the Engineer.

Marble/Granite slabs shall be used in lieu of marble/Granite tiles where indicated.

14.5.10 LEVELS

The surface of marble slabs when laid shall be perfectly true, level, projected or sloped.

14.5.11 PROTECTION AND CURING

The floor shall be protected from the effects of weather. During the progress of work and for 10 days after laying the floor shall be kept watered. Three clear days shall be given for setting before anyone is allowed to walk over, but no weight shall be brought on the surface till 7 clear days have elapsed after the completion of laying.

Installed and polished tiles shall be protected from scratches by laying a suitable floor protective cover over them.

14.5.12 POLISHING

When properly set the floor shall be rubbed with carborandum stone or with some other hard stone of approved quality and sand. When roughness is removed, sand shall be washed off and the process continued either with very fine carborandum stone or with brick and emery powder. The surface shall then be finally smoothed down with a pumice stone. When the smoothing process has been completed, the surface shall be polished with putty powder rubbed by felt pads.

Granite to be installed at site shall be pre polished.

14.6 GLAZED TILE FLOORING

14.6.1 CERAMIC / PORCELAIN TILE WORK

14.6.2 DESCRIPTION

The work covered under this section comprises of providing and laying best quality local made / imported, glazed / matt, ceramic tiles / porcelain tiles/special tiles of approved size and pattern wherever required or shown on the drawings or mentioned in the Bill of Quantities. Ceramic tiles shall conform to BS EN 14411 “Ceramic tiles. Definitions, classification, characteristics and marking”.

14.6.3 MATERIAL REQUIREMENTS

Except as otherwise specified the following British Standard and Code of Practice shall be applicable to materials and fixing methods for ceramic tile work:

British Standard Code of Practice 5385-3 "Wall and floor tiling. Design and installation of internal and external ceramic floor tiles and mosaics in normal conditions."

The material requirement is as follows.

14.6.4 CERAMIC / PORCELAIN TILES

Ceramic tiles shall be of prime quality and may be of glazed, glossy or mat finish of color, size and pattern as specified and approved by the Engineer.

Acid Resistant Porcelain Tiles shall be of prime quality and make as approved by the Engineer and of any of the following sizes and types as may be indicated in the drawings/Bill of Quantities:

For flooring: 8” x 4” x 3/4” or 1/2” thick, glazed or non-skid (Mat Finish)

For cove moulding: 3” wide x 4” long x 6” high, 1/2” or 3/4” thick plain or glazed.

For dado: 8” x 4” x 1/2” thick, plain or glazed

14.6.5 JOINT FILLING

Joint Filler shall be white Portland cement grout, which shall bond to dry tile, shall be non-shrinking, stain resistant, permanent in colour, and shall not inhabit fungus and bacterial growth. It shall be odourless and non-toxic, of smooth consistency for easy preparation and neat, rapid installation, and shall contain non-metallic material. Grout shall be water resistant and shall not wash out under water.

14.6.6 EPOXY ADHESIVES AND JOINT SEALERS

Epoxy Adhesive and Joint Sealers shall be obtained from any approved manufacturer. Dry Bond from National Tiles & Ceramics Limited or approved equivalent may also be used. The ratio and application of adhesives and sealers shall be as per the manufacturer’s directions

14.6.7 PORTLAND CEMENT

Portland cement shall be that manufactured in Pakistan conforming to the specifications set forth in Section-5.

14.6.8 AGGREGATE:

Coarse & fine aggregate shall conform to the specifications set forth in Section-5.

14.6.9 SAMPLES AND TESTS

Samples of all materials consisting of actual tiles showing full range of colours, texture & patterns available for each type & composition of tiles indicated shall be submitted to the Engineer for approval and materials conforming to approved samples will be used throughout the work. Rejected materials shall be removed from the site immediately. Tests of materials, if required by the Engineer, shall be done at the cost of the Contractor.

At least one approved sample each of all the materials shall be kept at site in the office of the Engineer for reference & record.

14.6.10 CONSTRUCTION REQUIREMENTS

a] IN CEMENT SAND MORTAR

Surfaces to receive the ceramic/ porcelain tiling shall be clean and free of dirt, dust, oil, grease or other objectionable matter. Setting beds and tile shall be installed with their respective surfaces to true planes, level or pitched to off-sets as required by the drawings, so that the surface of the completed tiling work will be at the elevations and grades shown. Re-tempering of mortar will not be permitted. Tiles shall be laid out from the centre lines of each space outward and adjustments made along walls, partitions and borders, if any, so as to symmetrize the pattern with a minimum of cut tiles.

Joint between tiles shall be of uniform width and the same as the tile installed. Fractional changes in dimensions without varying the uniformity of joint widths shall be permitted. Tile shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Cut-tile misfits shall be laid to the straight edges. Straight edges shall be accurately set to the lines established and reset at suitable intervals to keep the joints parallel over the entire area.

Over the existing bed a topping of 1-1/2" thick PCC 1:2:4 shall be laid. Scratch coats for application as foundation coats shall not be less than 5/8" thick and shall be composed by volume of 1 part Grey Portland Cement to 3 parts dry sand, mixed with the minimum amount of water necessary to produce a workable mass. Mortar for scratch coats shall be used within one hour after mixing and re-tempering will not be permitted. Scratch coats shall be applied in sufficient quantity and with sufficient pressure to cover the entire area and to form good keys, it shall be deeply scoured or scratched and cross-scratched, it shall be protected and kept moist during the curing period. Scratch coats shall be thoroughly damp-cured, and an interval of not less than 24 nor more than 48 hours shall be permitted between application of scratch coats and application of float coats.

Float coats shall be composed by volume of 1 part Grey Portland cement to 2 parts dry sand, mixed with a minimum amount of water necessary to produce a workable mass. Float coats shall be applied in sufficient quantity to entire area and to form a good key, shall be brought out flush with the temporary screeds or guide strips so placed as to give a true even surface at the proper distance from the finish suitable for reception of tiles.

Joints shall be straight, level perpendicular and of even width throughout. Vertical joints shall be maintained plumb for the entire height of the tile work. Each tile shall be brought to true level and plane by uniformly applied pressure under a straight edge or rubber-faced block. Tiles that are out of true plane or misplaced shall be removed and reset. Damaged or defective tile shall be replaced. The tile shall be installed as follows: -

Wall tile shall be set by troweling a skim coat of neat Portland cement on the float coat or by applying a skim coat to the back of each tile unit and immediately floating the tile into place. After tile has set remove mortar using a minimum of water. Replace damaged tiles.

After the tiles have been thoroughly set, joints shall be grouted full with a plastic mix of neat, white cement immediately after a suitable area of tile has been set. The joints shall be struck flush and excess mortar shall be cut off and wiped from the mortar joints after grout has been cleaned from the surface shall be roughened at once and filled flush with the tile edge, before the mortar begins to harden. Tile skirting and coves shall be solidly backed with mortar.

Tiles shall be fit closely to electrical out-lets, piping, fixtures & other penetration so plates collars or covers overlap tiles.

At dado, tiles shall be laid in grids, pattern, unless otherwise indicated. Joints shall be aligned when adjoining tiles on floors, base, walls and trim are the same size. Tile work shall be laid out and centre tile fixed in both directions in each space or on each wall/floor area. Adjustments shall be made to minimize cutting. Uniform joint width shall be provided unless otherwise indicated.

To prevent adhesive or staining of exposed tile surfaces by Grout, a temporary pre-coating of a continuous film of protective coating indicated below can be applied:

i) Petroleum paraffin wax, applied hot.
ii) Grout release.
iii) Kraft paper.

The colour variation shall be in ranges selected during sample submittals and acceptable to the Engineer and special care shall be taken while installing in any single enclosed area, as per instructions of the Engineer. At all vertical & horizontal corners, the edges of the tiles shall be grind & cut at 45° to achieve proper & perfect joint marring visible side, surface of tiles. Before final inspection, protective coatings shall be removed & neutral cleaner shall be rinsed from tile surface. The finished work shall be clean & free of cracked chipped, broken, un-bonded & otherwise defective tile works. Tiles with any of the above defects in any area shall be removed and changed immediately.

b] <u>IN THIN SET MORTAR</u>

Tiles laid in Thin Set Dry Bond Mortar shall be applied as per details shown on drawings and shall consist of a P.C.C. base of specified thickness. Tiles shall be set by troweling a skin coat of Dry Bond Mortar on the base coat and combed with a notched edge of trowel. Back butter each tile unit to ensure 100% mortar coverage and float the tile into place, tapping the tile to ensure maximum bond strength. All other installation requirements shall be as per specifications mentioned in part [a] above.

c] <u>USING EPOXY ADHESIVE</u>

A layer of Sika Tile Fix 15 or approved equal shall be applied over the prepared surface as per instructions of the manufacturer.

The joint width in floors shall be as per instructions of the Engineer and the gap shall be filled with Sika Tile Grout (White) or any other approved equivalent with matching colour.

All other requirements shall be the same as mentioned in part [a] above.

14.6.11 <u>LAYING OF SPECIAL TILES / MATERIALS</u>

Special material like Vinyl, PVC/rubber tiles, acid resistant tiles, Caesar tile, Board tiles, Industrial tiles etc. shall be laid by the specialist workers of the material manufactures or workers approved by the Engineer, with special mortars or special adhesives/epoxy approved by the Engineer as per manufacturers recommendations over the prepared surfaces (floor/walls). Tiles shall be cut to shape and size as per requirement without any extra wastage and fixed in pattern & design as per drawing & Engineer's instructions in true lines (vertical & horizontal) & levels at any floor and any height and as per printed instructions of the manufacturers and the Engineer.

To avoid sticking of epoxy or similar mortars to exposed surfaces of tiles, apply wax coating (except inside joints) fill the mortar in joints, and finally remove the wax coat by washing floor with hot water. The contractor may adopt any other method approved by the Engineer without any additional cost.

14.6.12 MEASUREMENT

The measurement shall be made in SM. of the actual surfaces completed and approved.

14.6.13 RATE AND PAYMENT

The payment shall be made at the unit rates per SM. stated in the Bill of Quantities.

Such payment shall constitute full compensation for all materials described herein or under relative BOQ item, equipment, labour including all incidentals, necessary to complete the work. The cost of PCC (1:2:4) base is included in the cost of tile work.

14.7 MOSAIC TILES FLOORING

Unless otherwise specified mosaic tile flooring shall be done in accordance with the Specifications No. 14.4For Brick or Tile Flooring in all respect, except with the following modifications:-

The mosaic tiles shall conform to the following Specifications:

14.7.1 SOURCE

The mosaic tiles shall be obtained from an approved source. If manufactured by the Employer through a contractor, the method of manufacturing shall be 'approved by the Engineer-in-charge.

14.7.2 QUALITY

Tiles shall be hydraulically pressed and fully cured. They shall be uniform in colour, free from cracks and other defects like efflorescence and crazing, the arises to be sharp and true. Pattern tiles shall bear the approved pattern on their faces. Mosaic tiles shall have polished surfaces. The constituent materials shall be as specified by the Engineer-in-charge.

14.7.3 SHAPE

Tiles shall be true and even on face and of even thickness throughout. The backs shall be with bond under-cut key sufficient to ensure a good grip of the fixing medium. For wall tiling, tiles shall have holes formed in the edges to take galvanized or copper cramps.

14.7.4 SIZE

The size of the tile shall be as specified.

14.7.5 TEST

A fully dried tile when immersed in water for any length of time shall not absorb water more than 2.5 per cent of the weight of dry tile.

14.7.6 LAYING OF TILES

All tiles shall be kept in water for 36 hours before they are laid.

The joints shall not be more than 1/16 of an inch which shall be grouted with specified mortar.

The joints shall be rubbed with very fine carborandum stone so that slight projections or edges of mortar etc. rising above the surface of tiles are levelled.

14.8 WOODEN FLOORS

14.8.1 FLOOR BEARER GROUND FLOOR

In the case of ground floors, floor joists (bridging joists) shall rest on pillars, dwarf walls, rails or beams as may be specified.

The plinth under the flooring shall be excavated to the depth specified by the Engineer-in-charge and dressed level and rammed. If directed a suitable protective layer as approved by the Engineer-in-Charge shall be laid otherwise dwarf walls or pillars shall be built on the specified concrete foundation. The dimensions and spacing shall be as indicated in the drawings or otherwise directed by the Engineer-in-Charge.

14.8.2 FLOOR BEARER SUSPENDED FLOORS

In the case of upper floors the bridging joists shall rest on wall plates, beams, rails or on other joists as shown on the drawings, or otherwise directed by the Engineer-in-Charge.

14.8.3 FLOOR BEARERS MATERIAL AND FIXING

The timber for the floor joists shall be of the kind specified and shall be in accordance with the specifications for wood work. The full number of joists for each continuous floor shall be laid and dressed to one level and tested before flooring is commenced.

14.8.4 PRESERVATIVES

All joists wall plates, bearers and the underside of planking shall be given two coats of hot wood preservative such as so-lignum creosote or coal tar as directed by the Engineer-in-Charge. The rate does not include this work, which shall be paid for separately according to the rates for painting with these materials.

14.8.5 BOARDING MATERIALS AND SIZE

The boarding for the floor shall not be planned on the underside in the case of ground floors and suspended floors to be coiled. Unless otherwise specified or shown in the drawings, in the case of deodar, kail or chir wood, the boards or battens shall be 1-1/2”, inches thick, not more than 6” inches wide and not more than 20 feet long. In the case of teak they shall be 1 inch thick, 4 inches wide and as long as possible. No board shall be less than 6 feet long, the ends being truly squared up after any split portion has been sawn off. All boards shall be uniform and parallel in width and shall have the same thickness.

14.8.6 JOINTS

The planks shall be planed true on one side (on both sides for uncoiled upper floors) the edges to be planed, rebated or tongued and grooved as directed by the Engineer-in-charge. Unless otherwise specified, the edges shall be tongued and grooved, with concealed joints for teak wood floors, and rebated joints for other floors.

14.8.7 PLANKING METHOD OF LAYING

The outer lines of boarding shall be accurately fixed paralleled with and close to the wall. Each subsequent line shall have the side joints carefully joined up and shall then be cramped into position by floor cramps, and nailed or screwed as specified, so that the heads shall be sunk below the finished surface of floor, or otherwise fixed with "secret joints". The cramps shall not be removed until the nails or screws have been fixed. The ends of plank shall rest on the centre of joist, and the ends of no two adjacent planks shall be on the same joist. Paved floors shall be stopped under a brass strip screwed to wooden floors where the two meet.

14.8.8 NAILS AND SCREWS

The nails or screws shall be subject to the approval of the Engineer-in-charge and shall have a length at least twice the thickness of the plank, two being used at each end and one at every Intermediate joist alternately on opposite sides of the plank. All screws shall be oiled before Insertion.

14.8.9 PLANING

After the floor has been laid, it shall be planned in both directions and made perfectly smooth. All depressions in the wood nail holes and all small defects of every kind, where permitted by the Engineer-In-charge to remain in the work, shall unless otherwise specified, be filled with "Beaumont age" or stopping out wax.

14.9 BASE FOR FLOORING

Unless otherwise specified, the base of all ground floors shall be constructed in accordance with the following specifications:

14.9.1 PREPARATION OF SUB-GRADE

Earth (clay) conforming to following Specifications shall be used for sub-grade:

Source:

Clay shall be obtained from good earth approved by the Engineer-in-Charge containing 20 % to 30% fine sand.

Quality:

Clay shall not contain more than 0.5 % soluble salts more than 0.2 % sulphate and more than 4% organic contents. It shall not contain any gravel, coarse sand, kanker, the grass and plant.

Earth filling shall be done up to the specified level in a layer of six inches and shall be properly watered and consolidated as specified hereunder:

Earth shall be placed in layers and shall be sprinkled with water and rammed to such an extent that a layer of 6 inches thick loose earth evenly spread is reduced to 4 inches in thickness. The consolidated surface shall be such that a very faint impression can be made on it with the heel of boot or the blow of hammer.

The sub-base shall be properly levelled before sand filling.

14.9.2 SUB-BASE / SAND FILLING

Sub-base or Sand filling shall be done as specified and shown on Drawings in layers not more than 3 Inches thick and shall be rammed after saturation to such an extent that a three-Inch layer is reduced to about two Inches after compaction.

Sub-base or Sand shall conform in all respects to the specifications for fine aggregate under Section 5 – Plain Reinforced Concrete except for its grading i.e. it shall pass through a sieve No.16 and not more than 30 per cent shall pass through a sieve No. 100.

14.9.3 BRICK BALLAST

Brick ballast to be used in the base of floors shall be obtained from well burnt or over-burnt bricks which are hard, durable and strong. Brick ballast shall be free from impurities, quarry sap, dust, dirt; and solubility characteristics. The size of brick ballast shall be specified or as directed by the Engineer-in-Charge.

14.9.4 CONCRETE

Concrete shall be cement concrete as specified and shown on drawings complying with the provisions of Section 5 – Plain and Reinforced Concrete.

14.9.5 CONCRETE LAYING

Concrete shall be laid in one operation in a uniform layer of specified thickness, absolutely true and parallel to the required level of the finished surface and to the entire satisfaction of the Engineer-in-charge.

14.9.6 SURFACING TO BOND WITH CONCRETE

Concrete shall be cured for at least 7 days before any topping is laid. The surface shall be kept wet and protected from earth, dirt or other foreign matter. Before laying the topping, 'the surface' shall be washed and scrubbed with wire brushes so that the concrete and the topping are well bonded.

14.9.7 LEVELS AND SLOPES

Unless otherwise specified, the base shall be perfectly level. A slope of 1:64 shall, however, be provided in verandah and bath rooms.

14.9.8 BASE FOR FIRST & SUBSEQUENT FLOORS

The top surface of the roof slabs shall be roughened with wire brushes while it is still green. The base shall be constructed with cement concrete complying with the provisions of Section 5 – Plain and reinforced concrete, as specified, shown on drawings and approved by the Engineer-in-Charge. The brickbats shall be placed under concrete where specified. Further operations shall comply with the requirements of preparation of base for ground floor.

14.10 CEMENT CONCRETE FLOORS

a) They comprise cement concrete (1:2:4) topping laid in panels over a base. Thickness of topping varies with requirement. The thickness of concrete layer will be 3 inches. Floor will be divided in panels of max. 16 sft. To avoid, cracks the area of a panel is restricted to 16 square feet unless otherwise approved by the Engineer-in-Charge

b) The concrete for flooring shall comply with the requirements of Section 5 – Plain & Reinforced Concrete, and will be paid accordingly.

c) Division strips shall be cut from 5mm thick glass plate in width as specified in drawings or as directed by the Engineer-in-Charge

14.11 TERRAZZO / MOSAIC / CONGLOMERATEFLOOR

14.11.1 SCOPE

The work under this section consists of making terrazzo floor in conformity with British Standard Code of Practice BS 8204-4 “Screeds, bases and in-situ floorings. Cementitious Terrazzo wearing surfaces”. The work shall include furnishing all labour material and equipment and performing all operations as required to lay the Terrazzo floors which include but is not limited to;

- Sub-base in sand and brick ballast and sub grade in accordance with Clause 14.9.1 (Separately Paid)
- Base in cement concrete in a thickness of 3 inches including Mosaic ¾ inch thick, Paid under this item.
- Grinding and polishing of mosaic as directed by the Engineer, Paid under this item.
- Skirting, Dado in Terrazzo, as directed by the Engineer, Including in this item.

14.11.2 MATERIALS

a) Cement, Sand, Aggregate for concrete and water shall conform to relevant specifications given in Section - 5, Concrete.

b) Sub-base / Base shall conform to the provisions of Clause 14.9.

c) Marble chips shall be crushed marble and shall be best quality white or coloured. It shall have an abrasive hardness of not less than 16 and the size shall vary from No. 4 to 8 as specified or as directed by the Engineer-in-Charge.

d) Dividing strips shall be of brass, aluminium (3mm thick) or glass (5mm thick) as specified and 38mm wide or as required in the Drawings.

e) Mineral Pigment for colouring the matrix of terrazzo / mosaic shall be of the best quality and purity and shall be alkali resistant, sun proof and lime proof with a specific gravity similar to that of Portland cement and as approved by the Engineer-in-Charge.

f) Terrazzo tiles shall be hydraulically pressed at 140 Kg per sq. cm (2,000 psi). Tiles shall be 12”x12” with 5/8” thick terrazzo topping and 5/8” thick base. The topping shall be in 1:2 white cement and marble chips by volume, in size & colour as approved by the Engineer and base shall be of 1:2 grey cement and sand mortar.

g) Where required to be used cement slurry shall contain an average of 4.10 Kg cement per square meter area.

h) Commercial products for polish shall be of the best quality available as approved by the Engineer-in-Charge.

14.11.3 BASE & WEARING SURFACE

The ground shall be prepared and sub - base laid as Shown in the Drawings in accordance with the requirements of sub-section 14.10. Concrete of 220 kg/cm^2 strength (1:2:4) shall then be mixed and laid in the manner specified for cement concrete floor, using a minimum quantity of water for workability. The net thickness specified for wearing surface shall be that obtained after grinding and polishing.

14.11.4 DIVIDING STRIPS

Floors shall be laid in panels of about 1.2 x 1.2 meters or of size and pattern as shown on the Drawings. Dividing strips of brass, aluminium or glass as specified shall be provided and fixed to exact levels making an allowance for grinding. Brass and Aluminium strips shall not be less than 3mm thick and Glass strips shall not be less than 5 mm thick. Strips shall be of width equal to the total thickness of cement concrete base and terrazzo topping or as specified or as directed by the Engineer-in-Charge.

14.11.5 PLACEMENT

The cement concrete base shall be levelled with a trowel and straight edge, consolidated and finished with steel trowels to an even but rough surface. The top layer of cement marble chips mixed in the proportion of 1:2 (1 cement and 2 marble chips) and pigment, if required, shall be laid over it within 24 hours. The cement and marble chips must be mixed dry in such quantities as are sufficient for a unit of specified shade. Water shall be added to only such quantities as can be mixed thoroughly and consumed in less than 30 minutes, the quantity of water being. the minimum for workability. Mixing must be done on water tight platform and any mix not used within 30 minutes shall be discarded .and removed from the site. A layer of cement and marble chipping mixture should be well trowelled into the surface of the

base concrete before filling to the top level of the screeds. The layer should be well compacted and all voids shall .be filled in. A layer of neat cement, of the specified colour shall then be well trowelled into the surface leaving a plain smooth surface.

14.11.6 SURFACE GRINDING & FINISHING

a) Plain Finish

Six days after laying, the top layer must be evenly and smoothly machine ground with carborandum blocks of coarse, medium and the fine grades so as to ensure that all marble chipping are evenly exposed all over the surface. If marble chips are not evenly exposed, the Contractor shall remove the surface and relay it at his own cost. After the first grinding, the floor shall be thoroughly grouted with the same cement and colour composition as specified for the mosaic' mix. The grout shall be of the consistency of thick cream and shall be brushed over the floor to eliminate all depressions and thoroughly fill the surface for final grinding. The surface after grinding shall be left undisturbed and cured for 2 or 3 weeks, after which it shall be cleaned of dirt and dust by rubbing gently with pumice stone or washing soda in sufficient water. Three days after the surface has been cleaned it shall be rubbed hard with 1:10 solution of oxalic acid using felt. The surface shall then be cleaned and washed with plenty of water. After the surface has dried a final gloss shall be given by polishing the surface to the satisfaction of the. Engineer-in-Charge. The walls and all surfaces of the finished works of other trades shall be properly protected from damage and spoiling during the process of grinding and washing of the mosaic. After the finish grinding has been completed and the surface treatment and polish applied, the mosaic work shall be covered and protected with material approved by the Engineer-in-Charge until completion of the work of all other trades.

b) Washed Mosaic - Rough Finish

Before the mosaic is hardened the top surface shall be brushed down. Plenty of water be used in this process. The brushing shall continue till the matrix is removed and each piece of marble chips is clearly exposed. If brushing of surface does not produce desired results tooling process shall be carried out by kango Hammer. After whole of the area is evenly exposed the surface shall be sprayed with water and lightly brushed down cleaning all the adhering mortar and revealing the true colour of the marble chips.

14.11.7 TERRAZZO DADO & SKIRTING

The plastered surface over which the dado/skirting is to be applied shall be well roughened and watered, cement mortar of specified ratio shall then be plastered over this well roughened surface to .the indicated thickness. Before the base course has set the layer of mosaic mixture shall be well trowelled into the surface of the base to a thickness which after grinding shall result in the finished thickness. A layer of neat cement of the specified colour shall then be well trowelled into the surface leaving a plain smooth surface. The Contractor shall start finishing as specified for floors above. Mosaic skirting shall be provided around all mosaic floors unless shown otherwise. Skirting and dado shall' be straight, level and in plumb. Intersections at floors shall be straight and flush.

14.12 PVC RUBBER TILE FLOORING

14.12.1 GENERAL

Such flooring shall consist of PVC flexible tiles or plain designed rubber tiles of approved size, colour and thickness. Tiles shall confirm to the relevant British Standard Specifications or of approved manufacturers. This item shall include, include 1” thick 1:2:4 concrete with proper trowel finish, also including adhesives for fixing PVC/Rubber Tiles.

14.12.2 BASE

Base for these tiles shall be according to cement concrete flooring as per specification, topped with ½" thick 1:3 cement sand mix or any other specified mix.

14.12.3 LAYING

After completing the curing of the base, it will be allowed to dry completely and cleaned thoroughly to make it free from contamination of dust, moisture, oil or grease. Any irregularity on the base shall be filled in and levelled before laying the tiles. The area of not exceeding 25 square foot at a time shall be coated with approved adhesive material. Sufficient number of tiles for this shall be treated with adhesive material. 10 to 15 minutes shall be spent for airing the adhesive. The tiles shall be laid starting from one side of the room. The tiles shall be pressed thoroughly with appropriate means so that complete adhesion takes place. The finished surface shall be washed with soap and water after 3 days.

14.12.4 CURING

The curing involves complete veratilization and 3 days shall be allowed for this purpose before the loading is applied to the floors.

14.13 MEASUREMENT AND PAYMENT

14.13.1 COMPOSITE RATE

The measurement and payment for the items of the work of Flooring hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified herein, including the site clearance as approved by the Engineer-in-Charge. Dado/ skirting shall be measured and paid at 50 percent rate of relevant floor item.

Pay Item No.	Description	Unit of Measurement
14.13 a	Providing, lying watering and compacting brick ballast 2" size, filled with 25% sand for ground floor and basement	CM
14.13b	Earth flooring 6" thick as described in specifications or as directed by the Engineer	SM
14.13c	Mud flooring 6" thick as described in specifications or as directed by the Engineer	SM
14.13d	Brick Tile (9x4.5x1.5 inch) flooring as described in specifications or as directed by the Engineer	SM
14.13e	Providing and laying super white 12x12 inch marble tile over 1" thick CS mortar (1:2 ratio) with slurry grouting, including curing, rubbing and polishing for ground floor (including 3"x1/2" skirting/dado)	
	i. ½" thick	SM
	ii. ¾" thick	SM
	iii. 1" thick	SM
14.13f	Providing and laying Lasbella marble 12x12 inch marble tile over 1" thick CS mortar (1:2 ratio) with slurry grouting, including curing, rubbing and polishing for ground floor (including 3"x1/2" skirting/dado)	
	i. ½" thick	SM
	ii. ¾" thick	SM
	iii. 1" thick	SM

14.13g	Providing and laying Badal marble 12x12 inch marble tile over 1" thick CS mortar (1:2 ratio) with slurry grouting, including curing, rubbing and polishing for ground floor (including 3"x1/2" skirting/dado)	
	i. ½" thick	SM
	ii. ¾" thick	SM
	iii. 1" thick	SM
14.13h	Providing and laying ceramic tile on prepared surface size 12"x18" in floor, non skid/matt finish, set in ¾" thick mortar (1:2), ground floor, with grouting/finishing	SM
14.13i	Providing and laying ceramic tile on prepared surface size 12"x18" in walls, glazed, fix in 3/8" thick mortar (1:2), ground floor, with grouting/finishing	SM
14.13j	Providing and laying porcelain tile size 16"x16" in floor,non skid/matt finish, set in ¾" thick mortar (1:2), ground floor, with grouting/finishing	SM
14.13k	Mosaic floor 1-1/2" thick over 2" thick concrete as described in specification (Ref. 14.11) or as directed by the Engineer including glass/ aluminium/ marble strips as required complete in all respect	SM
14.13l	Mosaic tile (12"x12"x1.25") flooring including 2" thick concrete laid over brick ballast and other items, (including 3"x1/2" skirting/dado) complete in all respect	SM
14.13m	Providing and laying Sheesham wood (completely seasoned) strip flooring ¾" thick, tonged and grooved or splayed, in size as approved by the Engineer, rebated including hardware and two coats of hot bitumen grade 10/20 laid on the concrete base and fixed using concrete nail complete in all respect	SM
14.13n	Cement concrete/ screading floor any thickness 1:2:4 as described in specifications or as directed by the Engineer	SM
14.13o	Providing and laying of PVC/ Rubber tiles 305x305x2 mm as described in Specifications or as directed by the Engineer	SM
14.13p	Providing and laying of PVC/ Rubber tiles 305x305x3 mm as described in Specifications or as directed by the Engineer	SM
14.13q	Providing and laying slab for steps, reception and kitchen counter, over 3/8" thick (1:3) mortar base, including nosing, hardware, grinding and polishing etc.	
	i. Super white	SM
	ii. Lasbella marble	SM
	iii. Badal marble	SM
	iv. Granite marble	SM
14.13r	Providing and laying Granite tiles 12"x12"x¾" thick of approved colour/quality, over 1" thick (1:3) CS mortar ground floor, including finishing complete in all respect	SM
14.13s	Providing and laying Granito tiles 12"x12"x¾" thick of approved colour/quality, over 3/4" thick (1:3) CS mortar ground floor, including finishing complete in all respect	SM

14.13 t	Supply and filling sand under floor or plugging in wells as per design or direction of the Engineer in-charge	CM
14.13 u	Providing and laying Taveera 12x12 inch marble tile over 1” thick CS mortar (1:2 ratio) with slurry grouting, including curing, rubbing and polishing for ground floor (including 3”x1/2” skirting/dado)	SM
	i. ½” thick	SM
	ii. ¾” thick	SM
	iii. 1” thick	SM
14.13 v	Providing and laying Parlino 12x12 inch marble tile over 1” thick CS mortar (1:2 ratio) with slurry grouting, including curing, rubbing and polishing for ground floor (including 3”x1/2” skirting/dado)	
	i. ½” thick	SM
	ii. ¾” thick	SM
	iii. 1” thick	SM
14.13 w	Providing and laying Boticena 12x12 inch marble tile over 1” thick CS mortar (1:2 ratio) with slurry grouting, including curing, rubbing and polishing for ground floor (including 3”x1/2” skirting/dado)	
	iv. ½” thick	SM
	v. ¾” thick	SM
	vi. 1” thick	SM
14.13 x	Provide & laying 2” thick conglomerate floor with top layer of 1/2" thick wearing surface of one part of cement 2 parts of aggregate over bottom layer of cement concrete (1:3:6) including surface finishing & dividing in panels complete in all respect as per drawing	SM

SECTION 15 FINISHES

15.1 PLASTER

Plaster is a material used in a plastic state, which can be troweled to form a hard covering for interior or exterior surfaces, walls, ceilings, etc., in any building or structure.

The work carried under this section shall conform to the requirements of the following British Standards / American Standards as applicable:

BS 8481 “Design, preparation and application of internal gypsum, cement, cement and lime plastering systems. Specification.”

BS EN 13914-1 “Design, preparation and application of external rendering and internal plastering. External rendering.”

BS EN 13914-2 “Design, preparation and application of external rendering and internal plastering. Design considerations and essential principles for internal plastering.”

ASTM C926 “Standard Specification for Application of Portland Cement-Based Plaster.”

Except as may be otherwise shown or specified, all plaster shall be cement sand plaster, except the plastered surfaces of Operation Theatres and X-Ray rooms, which shall be barium plaster. Plastered ceilings and walls shall include partitions, piers, columns, pilasters, plastered jambs and other returns, reveals and backs of recesses, alcoves, and jambs and heads of windows and doors, unless otherwise specified or shown on Drawings. Plaster on walls shall be carried down to Dado, Skirting and projection bases. Plasterwork shall also include all plasterwork on and under all concrete surfaces to be left exposed and concrete not required Fair Faced, until and unless specified otherwise. It would be the Contractor's responsibility to ensure that all electrical conduits, hidden or items to be embedded, ducts, pipes, brackets, doors, windows, ventilators and all other fixtures on walls, ceiling, columns or required elsewhere have been fixed in place before the plastering is started.

15.1.1 BASE

Plasters are applied to bases of bricks, stones, hollow tiles, or concrete masonry and to wood laths, metal laths and gypsum laths or similar materials finished in sheets.

15.1.2 SURFACE PREPARATION

A stiff wire brush is used to remove all loose dust from joints, and the surface is then thoroughly washed with water. Plastering should not be done' on too much wet walls, because the results will not be satisfactory.

A good key is essential to a successful rendering and to avoid cracking and crazing. All joints in masonry are raked to a depth of at least half an inch with a hooked tool specially made for the purpose and not with trowel or hammer. This is to be done while the mortar is still green and not later than 48 hours of the time of laying. After raking, the brickwork is brushed to remove all loose dust from the joints and thoroughly washed with water. (In case of old walls, it may sometimes be advisable to ensure a good key for the new rendering by destroying the smooth surface, of the brickwork with some tool.) If the walls are washed with a solution of 1 part hydrochloric acid to 10 parts water, it will bring the grains in brickwork to the surface. This solution is left on for about quarter of an hour and then washed off with water.

15.1.3 COATS

Plaster may be applied in one, two or three coats; two are usually sufficient, but three should be applied only on wood or metal lathing or on a very rough, uneven background. The thickness of the first coat has to be just sufficient to fill up all un-evenness in the surface. The second and subsequent coats are thinner than the first, and no single coat has more than half an inch of thickness, because thick coats shrink more and crack. Under-coats of coarse stuff are allowed to dry and shrink properly before subsequent coats are applied; otherwise cracking and crazing is bound to occur. A good key for all stages of, plastering is essential. The freshly plastered surface is scratched or roughened before it has fully hardened, to form a mechanical key for the second coat. The method of application of the mix influences the adhesion; the mix sticks better if thrown on than if applied by trowel.

15.1.4 MATERIALS

Various materials employed for plastering have been described here below. A rich mortar mix tends to develop large cracks; a weaker one develops finer and distributed cracks. A strong coat is never applied over a weaker one since the latter would be unable to restrain its movement.

Mortar is defined as a material composed of fine aggregate and cementing material which forms a hardened mass when mixed with a suitable proportion of water. It is used for plaster work and for bonding bricks and masonry solidly together so that stresses from super-Imposed loads are evenly distributed. The cementing materials are clay and Portland cement for mud mortar and cement mortar respectively. Sand is the aggregate used for cement mortars. The constituents of all mortars should be mixed thoroughly to ensure a uniformity of composition.

Mortars are usually defined by their composition rather than properties, and the proportions of ingredients are generally taken by volume. The following are the different types of mortars commonly used.

15.1.4.1 MUD MORTARS

Mud mortar is used in brickwork, masonry and plaster work, provided these works are not likely to remain under water. The mud mortar shall comply with the provisions of clause 11.7.2(i), Mud Mortar, Section11 – Brickwork.

15.1.4.2 CEMENT MORTAR

Cement mortar is used in brickwork, masonry plaster work and concrete work. Its Ingredients are cement and sand whose proportions may be 1:2, 1:3, 1:4, 1:5, 1:6, 1:7,1:8 and so on by volume as specified, and shall comply with the provisions of clause 11.7.2(ii), Cement Mortar, Section 11 - Brickwork.

15.1.4.3 MORTAR OF FIRE CLAY BRICK WORK

Fire-clay or alternatively fire-cement is suitable for setting firebricks. Generally the joints are the most vulnerable part of fire brickwork and when they crumble away, the arises of these bricks become vulnerable to heat. Fire-clay can be used just as it comes out of hearth but it tends to contract on cooling and again on exposure to heat; so the best way is to use tire-cement that is especially prepared to resist construction under heat. Burnt clay, made by crushing ordinary fire bricks does not expand or contract markedly and therefore constitute a suitable aggregate for fire brick mortar mixed with high alumina or other bauxite cement.

The proportion of alumina cement to crushed fire brick is 1:1. The mortar is prepared in the same manner as described for cement mortars.

15.1.4.4 METAL LATHING

Metal lathing used as back ground for plastering should not weigh less than five (5) lbs/sq. yard for sanded plaster and three (3) lbs/sq. yard for light weight gypsum plasters and shall comply with BS EN 13658-1 “Metal lath and beads. Definitions, requirements and test methods. Internal plastering” and BS EN 13658-2 “Metal lath and beads. Definitions, requirements and test methods. External Rendering”

15.1.4.5 GALVANIZED WIRE NET

Galvanized wire netting where required to provide a mechanical key, 22 SWG galvanized wire netting of mesh not greater than 2" and complying with BS EN 10223-2 “Steel wire and wire products for fences. Hexagonal steel wire netting for agricultural, insulation and fencing purposes” shall be used.

15.1.4.6 BEADS & STOPS

Beads and stops shall be manufactured from tight coat galvanized steel to B.S. 3989 Grade Z2, coating type ‘C’ profiled to suite the depth of plaster or render to be applied.

15.1.4.7 NAILS, SCREWS & WASHERS

Nails, screws and washers shall be galvanized or stainless steel. Pins for short-firing shall be of steel with a tight coating of cadmium or zinc to comply with BS 1706.

Clout nails shall be galvanized steel and shall comply with BS 1494, Part 2.

15.1.4.8 MOVEMENT JOINT FILLER & SEALANT

i. Movement joint filler shall be approved impregnated fibre board or cellular polyethylene which is compatible with the sealant being used and which does not give up bituminous or oily products.
ii. Sealants shall be two-part polysulphide type as recommended by the manufacturer for the situation in which they will be used. Butyl mastics and other forms of mastics shall not be used without specific approval by the Engineer.

15.1.4.9 CEMENT MORTAR WITH PLASTICIZER/ADDITIVES

The proprietary plasticizer approved by the Engineer-in-Charge, shall be used with cement and sand to improve the workability and durability of cement mortar. The dosage and mixing of the plasticizer shall be in accordance with the recommendations of the manufacturer for plasticizer.

The other additives used could be pigments for the required color, water proofing agent and washing soda. The procurements shall be made and mixing done as approved by the Engineer-in-Charge.

15.1.4.10 BARITES:

For Barium Sulphate plaster, barium sulphate fines shall be used.

15.1.4.11 BRASS DIVIDING STRIP

Brass dividing strips shall comply with BS DD 19.

15.1.5 CEMENT PLASTERING

15.1.5.1 GENERAL

a) Plastering or pointing shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the Contractor to make sure that all such work is carried out at

site before starting of plaster or pointing work, chiseling and repairing of cement plaster or pointing shall not be permitted without the approval of the Engineer-in-Charge.

b) Sample of materials shall be submitted to the Engineer-in-Charge for his approval prior to use in the works.

c) Tolerances

Surfaces of plaster work shall be finished with a true plane to correct line and level with all angle and corners to a right angle unless otherwise specified and with walls and reveals plumb and square.

The maximum permitted tolerances shall not exceed 3 mm in 2m variation from plumb or level in any exposed line or surface and 1.5 mm variation between planes of abutting edges or ends.

d) Cleaning and Protection

Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer-in-Charge. As each room or space is completed, all rubbish, debris, scaffolding and tools shall be removed to leave the room clean.

15.1.5.2 PRECAUTIONS IN PLASTERING

Unless otherwise specified or directed by the Engineer-in-charge the following measures shall be adopted to remedy defects and faults incidental to plaster work.

i. Fine aggregate (sand) shall be clean and free from all impurities. It shall be washed before use.
ii. A proper key shall be provided between the plaster and the surface to be plastered.
iii. The background shall be kept moist but excessive moisture shall be avoided.
iv. Proper curing shall be done to eliminate excessive and rapid thermal changes.
v. Each coat shall be allowed to dry before the next is applied.

15.1.5.3 SCAFFOLDING

The scaffolding for plaster shall always be double.

15.1.5.4 INSPECTION OF PLASTERING

Plastering shall be inspected by the Engineer-In-charge or his authorized representative when the work is in progress and after its completion. The following points will be kept in view while making the inspection.

i. If wood skirting is specified, the plastering has been finished tight, on to them.
ii. The surface checked by means of straight edge and tips of the fingers are perfectly even.
iii. All intricate places like soffits, cupboard and their recesses, specified to be plastered, have been properly plastered.
iv. The work has been properly finished at the junction with other materials, such as woodwork at windows and door openings fireplaces and similar other places
v. If wood angle-beads are specified they are of proper section under cut for key. Securely fixed and the plaster has been finished up to them in a proper manner.

vi. Special care has been taken of cornices, and moulding sections. The templates shall be thoroughly checked and compared with the approved drawing.
vii. All ornamental work and other details as specified are true to design and securely fixed and bonded.
viii. In external stucco, rough cast, or pebble-dashing, the coats are of even thickness and are uniformly laid.
ix. The plastered surface struck with the knuckles does not give hollow sound. If it rings hollow, it is an indication of insufficient adhesion between various coats of plaster.

15.1.6 PLASTERING.

In case proportion is not indicated, following shall be adopted:

a) Walls Exterior face 1 : 4 (Cement/Sand Mortar)

b) Walls Interior face 1 : 5 (Cement/Sand Mortar)

c) Ceiling 1 : 4 (Cement/Sand Mortar)

Volume batching shall be done by proper gauge boxes and not by the shovelful.

i. Unless otherwise specified or directed by the Engineer-in-Charge or his authorized subordinate in writing, wooden screeds 8 cm wide and having a thickness equal to the plaster shall be fixed vertically 2.5 meter to 3 meter apart to act as gauges and guides in applying the plaster.

ii. The arises shall then be plastered for a space of 10 cm on each side and up to the ceiling, except in case of openings where it shall run around them. This plaster shall also serve as a guide for thickness etc. Unless otherwise specified or directed by the Engineer-in-Charge all corners and arises shall be rounded off to a radius of 20mm only and no more.

iii. The mortar shall be laid on the wall between the screeds, using a plasterer's float for the purpose and pressing mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight-edge reaching across the screeds. The straight-edge shall be worked on the screeds with an upward and sideways motion, 5.5 cm or 7.5 cm at a time. Finally the surface shall be finished off with a plasterer's wooden float. Metal floats shall not be used.

iv. The plaster shall be laid to a true and plumb surface and tested frequently with a straight - edge and plumb-bob. The straight - edge shall not be less than 3 meters in length. As the work proceeds, all horizontal lines and surfaces shall be tested with a level, and all jambs and corners with a plumb-bob.

v. All mouldings decorations details and finishes shall be worked true to template and shall be neat, clean, level, and parallel, or truly plumb, as the case may be.

vi. Unless otherwise specified, plaster shall not exceed 12 mm in thickness and shall not be less than 6 mm at the thinner part.

vii. Protection During Curing

After completion, plaster shall be kept wet for10 days and shall be protected during that period from extreme fluctuations of temperature and weather.

15.1.7 DEFECTS IN PLASTER

Various defects observed on plaster along with their causes are given below:

a) CRACKS

Cracks briefly occur on account of

(i) Structural defects in building and discontinuity of surface.

(ii) Plastering on very wet background.

(iii) Old surface not properly prepared.

(iv) Over-rapid drying.

(v) Excessive shrinkage of the plaster owing to thick coats and richer mixes.

b) PITTING AND BLOWING

These defects are noticed In case of faulty slaking -and hydration of the lime particles in the plaster.

c) FALLING OUT

Plaster falls out mainly on account of

(i) lack of adhesion for not having formed a proper "key" in the background

(ii) Excessive moisture in the background

(iii) Excessive thermal changes either in the background or in plaster itself.

(iv) Rapid drying.

(v) Insufficient drying between each coat of plaster.

15.1.8 REMEDIES OF DEFECTS

Hair-cracks on fresh plaster normally disappear after whitewashing. But wide cracks shall be filled in by forcing down mortar consisting of plaster of Paris, cement and sand in the proportion of 1:2:7 unless otherwise specified or directed by the Engineer-in-charge. Surface areas showing pitting, blowing, popping and blister shall be remedied by cutting out patches in rectangular shape, under cutting the edges to form a dovetail key and making good on a Portland cement ground.

All these remedial measures shall be carried out by the contractor at his own expense.

15.1.9 PLASTERING ON LATHING OR EXPANDED METAL

15.1.9.1 GENERAL

Lathing constitutes a convenient base in some form of construction for plastering on walls and ceilings. Metal lathing, the most commonly used, is fixed to timber support by galvanized wire, nails or staples at short distance. It is also often used to bridge the junction of two dissimilar backgrounds, or to provide a suitable key for plastering over a wooden beam. Metal lathing may be of expanded metal or woven wire etc., which should weigh not less than 18.5lbs per 100 square feet for sanded plaster and 11lbs per 100 square feet for light weight gypsum plaster, except when used to

provide the key. Lathing is stretched tight with the help of some tension device such as mild steel rods since plaster would crack on a loose lathing. After cleaning the rust, if any, the lathing is brushed with cement slurry. Most common defects in plaster on metal lathing are extensive cracking, particularly along the line of fixing of the lathing to its support or unevenness of the finished plastered surface.

All metal lathing shall be of 3/4" or 1" mesh and shall be fixed with the long way of the mesh across the supports. Metal lathing with stiffening ribs shall be fixed with the ribs uppermost towards and across the supports. If the supports are more than 14" apart, the gauge of metal shall be increased above that normally used to give sufficient stiffening.

The strands in various sheets shall all slope in one direction; in vertical work, they shall slope inwards and downwards from the plaster face.

Metal lathing minimum 12" wide extending 6 inch on each side of junction of RCC elements and block/brick work shall be fixed by galvanized nails or staples at 4" centres. End laps shall not be less than 1" when laps occur in the bearers and not less than 2" when the laps occur between bearers. They shall not occur at angles or grooves and shall preferably occur only at supports. The sheets shall be lapped and securely tied together with 18 SWG galvanized tie wire.

Side laps shall not be less than 1" and wired together with similar gauge tie wire at 16" centre. Metal lathing shall be as taut as possible, this is best achieved by nailing the sheet in the centre and then working towards each end. Ends of wiring for fastening shall be bent inwards and not towards the plaster coat.

After erection all cut edges and damaged metal lathing, staples or nail heads shall be given a protective coat of bitumen paint.

Wherever required Steel Wire Mesh of approved quality shall be used to avoid shrinkage cracks at the connection of brick and R.C.C. element, for this purpose overlap of minimum 6” (six inches) on both surfaces will be adopted. The payment for this item shall deemed to be included in the item of plastering.

When rendering on metal lathing or expanded metal, back rendering wherever it can be applied, shall be done when the first under coat on the face is hard enough to permit. The work shall then be allowed to dry as completely as possible before applying further coats, in order to prevent cracking.

15.1.9.2 PREPARATION OF SURFACE

i. Expanded metal or similar metal fabric or lathing shall be free from all rust, grease or other surface impurities, before plastering can be done.
ii. When wooden lathing is used the wood shall be cleaned, slightly roughened and two coats of (creosote) or other wood preservative shall be given. Lathing shall be erected to break joints.

15.1.9.3 MORTAR

Unless otherwise specified two coats of plaster shall be applied. The mortar for both the coats shall be cement mortar prepared as per Specifications No. 0 except that for the first coat ¾ lb of fine chopped jute or hemp shall be added and thoroughly mixed with each cubic foot of mortar.

The surface to be plastered shall be properly cleaned and watered for 24 hours before application of plaster. Concrete surfaces shall be properly roughened by wire brushes while the concrete is still green or by hacking if the surface has hardened so that 40% of the concrete surface is roughened. Masonry joints shall have been raked to 1/2” depth. Cement slurry shall be applied to concrete surface before plastering.

Cement and sand shall be thoroughly mixed in a dry state and then with gauged water for sufficient workability. Mortar shall be mixed in mechanical mixer. Any mortar, which has not been used within 30 minutes of the addition of water, shall be discarded. All tools should be examined and thoroughly cleaned before plastering is begun. All adjacent works, doors, windows, flooring etc. shall be properly covered and protected before commencement of plastering.

The thickness of plaster shall be as indicated in the item. Wherever a thickness of more than 3/4" is required due to masonry or concrete surface being not in one plane, it shall be applied in two coats, backing coat and final coat. The backing coat shall be roughened with waving lines drawn by wire brushes when wet, to provide adhesion for the final coat. The final coat shall be applied along with the plasterwork over rest of the area only after the backing coat has been properly cured and wetted.

Plaster shall be laid and finished to a true plane and plumb surface free from blow holes, trowel marks and other defects and shall be tested frequently with plumb-bob and straight edge about 10 feet long. All horizontal lines and surfaces shall be tested with levels and all corners and arises with a plumb bob as the work proceeds. All overhangs and the like shall be provided with drip course.

All putlog holes shall be filled up in advance of the plastering as the scaffolding is being taken down. The scaffolding shall be strong and secure to avoid accidents.

Plaster containing cracks, blisters, pits, blemishes, trowel marks etc. or discoloration shall be removed and replaced with plaster matching the rest of the work in color and texture.

Proper drip course shall be prepared in all the projected slabs, overhangs/ chhajjas etc. on the external areas or in the internal areas open to sky so that no rain water could travel inside at no extra cost.

All the grooves and fixing of Aluminium U channel of size shown in drawing or as instructed by the Engineer shall be provided as per approved sample or Mock-up.

All Plaster shall be finished smooth suitable for the type of painting of coating required to be applied over it. In clean areas / control rooms / operation theaters indicated in drawings or to be decided by the Engineer, all internal and external angles (corners) shall be rounded off having a radius of 20 mm. At other places, internal angles shall be squared or slightly rounded off.

Thickness of plaster and the mix ratio of grey cement to sand shall be as indicated in the item.

The plaster shall be kept wet for 10 days and protected from ambient temperature and weather.

Do not use materials that are caked lumpy, dirty or contaminated by foreign, materials.

Do not use excessive water in mixing & applying plaster materials.

Sequence plasters application with installation & protection of other works so that neither will be damaged by installation of other.

15.1.9.4 <u>FIRST COAT</u>

The first coat shall be applied in such a way as to enclose the fabric completely or in the case of wooden lathing, to form a secure key between the lathes. The coat shall be worked to an even surface half an inch behind the screeds.

The first coat shall be as uniformly thick as possible and in no case shall be more than 3/4" thick in any one-trowel laying. After it has been left long enough to set firm, the surface shall be combed or scratched, care being taken to leave the scratch marks sufficiently deep to provide a key for the following coat but not so deep as to penetrate the rendering.

It shall be applied with sufficient pressure to fill the raked out joints in block/brick work to prevent air pockets and to secure a good bond. It shall be kept moist with fog spray for seven (7) days and then be allowed to dry out. First coat shall be allowed to dry out for as long as possible before the subsequent coat is applied. It is desirable to wait at least twenty four (24) hours even in the hot dry weather. Before applying any subsequent coat, the preceding coat shall be brushed down to remove any dirt and loose particles and, if of a porous nature and very dry shall be wetted.

15.1.9.5 FINISHING COAT

Before the first coat has set the surface shall be scratched with a sharp tool both ways to give a key to the floated coat. All dust and loose plaster shall be washed off, the surface shall be cement-washed and floated coat shall then be applied and finished according to provisions of Clause 15.1.5 as approved by the Engineer-in-Charge.

Finishing coat shall not be applied until the undercoat has been cured for seven (7) days. Just before application of the finish coat, the under coat shall again be wetted evenly with a fog spray.

It shall not be less than 1/4" or more than 3/8" thick and shall be applied with a laying trowel and finished with steel trowel.

Over working shall be avoided. Water shall not be applied to the surface of the finishing coat whilst working up, but patches showing signs of premature drying may be patted with a damp float.

It shall be kept moist with a fog spray for at least ten (10) days and thereafter shall be protected against rapid drying until properly and thoroughly cured.

15.1.9.6 OTHER RESPECT

In all other respects, it shall conform to relevant portions of Clauses 15.1.5 and before.

15.1.10 MORTARS FOR PLASTERING

The mixing proportion (by volume) of dry material for preparation of mortar shall be corresponding to relevant CSR item.

15.1.11 NIRU PLASTER

The niru plaster is a cement wash comprising a solution of cement & water in proportions as specified. The solution is freely applied on prepared surfaces by simple spraying or by application with brush.

15.1.12 MUD PLASTER

15.1.12.1 PREPARATION

Mud mortar for plastering shall be prepared as per Specifications No. 0.

15.1.12.2 APPLICATION OF PLASTER

The plaster shall be spread evenly over the wall so as to be not more than 3/4 inch thick. In case of roofs and floors, its thickness shall be 1 inch. After spreading, the

plaster shall be floated with a straight-edge, till the surface is perfectly smooth, level and true. Any cracks that open out during drying shall be filled with liquid cow-dung.

15.1.12.3 FINISH

i. When the surface has dried, it shall be leeped over and finished off with a trowel or float in the case of walls and roofs. In the case of floors, it shall be applied and finished by hand.
ii. The leeping shall be done with a preparation described below:-

Cow-dung is steeped in water to render it free from grass, straw, seeds and other impurities. If considered necessary, it shall be passed through a fine sieve. An equal part of finely-powdered clay shall then be mixed with it thoroughly in the tub.

15.2 POINTING

15.2.1 GENERAL

The surface of the work is prepared as explained under "Plastering". When commencing masonry each day the first thing to be done if the surface is to be subsequently pointed, is to rake out the face joints of all masonry finished the previous day. The joints are properly wetted in old work before pointing; for the mortar will not stick to a dry surface. The work pointed is kept wet for at least three days.

15.2.2 MORTAR MIX

The mortar for pointing shall be cement sand mortar in proportion as specified and shall be prepared as per provisions of Clause 15.1.4.2.

15.2.3 PREPARATION OF SURFACE

i) Before pointing old brickwork or new brickwork in mud, the joints shall be raked out with a hook (not hammer) to a depth of half an inch. If, for any reason, the joints in new brickwork and stone masonry are not struck as the work proceeds they shall be raked out before the mortar sets.

ii) All earth and mortar dust coming out of the joints as a result of raking shall be washed off and the brickwork watered for 24 hours. The face shall once again be washed just before starting pointing.

iii) The surface prepared in the manner described above shall be inspected by the Engineer-in-charge or his authorized subordinate and shall be approved by one of them before actual pointing begins.

15.2.4 TYPES OF POINTING

Unless otherwise specified various types of pointing suitable for different situations shall be as follows:

a) DEEP OR STRUCK CEMENT POINTING

i) This type of pointing, shall be done to all un-plastered faces of brickwork in mud where the brickwork is liable to be affected by dampness and saltpetre such as in plinths of buildings.

ii) The mortar shall be prepared as per Specifications Cement Mortar, Section 11 - Brickwork.

iii) The mortar shall be filled in the joints flush with stone masonry or brickwork with a pointing trowel and then pressed in with proper pointing tools. Lining with a spike on a mass of mortar .shall not be allowed.

b) FLUSH CEMENT POINTING

i) This type of pointing shall be done to all brickwork and stone masonry with an exposed face when the finish of the face is not important or when a flush floor surface is required or when the floor or brickwork is subject to wear or to the effects of dampness and saltpetre.

ii) The mortar shall be prepared as per Specifications Cement Mortar, Section 11 - Brickwork.

iii) The mortar shall be filled and pressed into the joints with a pointing trowel and finished off level with the edges of the bricks to give the smoothest possible appearance to the work.

c) RULED POINTING

i) This type of pointing shall be done when specified to brickwork and stone masonry not liable to be flushed with Water.

ii) The cement mortar as actually specified shall be used. These mortars shall be prepared as per Specifications Cement Mortar, Section 11 - Brickwork.

iii) The mortar shall be filled and pressed into the joints with a pointing trowel and finished off level with the edges of the bricks and shall then be ruled along the centre of all joints with a half round tool 1/2" wide.

d) STRIKING JOINT

i) All new un-plastered faces of work in cement mortar shall be finished by striking joints as the work proceeds according to the relevant part of Section 11 contained under brickwork.

ii) In case of walls, joints shall be struck by raking out the green mortar after the brickwork has been laid and finished with a pointing tool.

No payment shall be made for pointing, except for rolled pointing were directed.

15.2.5 POINTING TOOLS

The pointing tools for horizontal joint shall be such as to form weathered and struck joints, and for vertical joint, triangles so as to make a (V) notch in the joints care shall be taken not to develop a cutting edge in the tools since the idea is to compress the green mortar into the joints and not to cut it away.

15.2.6 EDGES OF BRICK

The mortar shall not be spread irregularly over the edges and corners of the bricks, which shall be left clearly visible. The practice of smearing mortar, over defects in bricks, to hide them, shall not be allowed and shall render the whole brick work liable to be rejected.

15.2.7 WASHING AFTER POINTING

After pointing, the face of the work shall be cleared off all surplus mortar sticking to the face. No washing shall be done till the pointing has set.

15.2.8 CURING

The cement pointed work shall be kept wet for 10 'days after completion. The work shall be protected during that period from extreme fluctuations of weather.

15.3 WHITEWASH

15.3.1 PREPARATION

Whitewash, which is the cheapest water paint and has the desirable sanitary properties, is prepared from pure fat lime (white stone) or shell lime. Preferably, un-slaked lime is brought to the site of work and slaked there. After slaking it is kept in a tank of water for at least two days and then stirred up with a pole till it attains the consistency of a thin cream. Where necessary, gum or rice water (2 Oz. of gum for1Cu.ft of lime) is added. Sometimes flour, skimmed milk, glue, molasses or other substances are mixed in the slaked lime to increase its adhesion. Preservatives such as salt or formaldehyde are added to keep these substances from spoiling. White ash may be tinted by using pigments and should be strained through a coarse cloth or a fine wire gauze before use.

15.3.2 PREPARATION OF SURFACE

All loose material and dirt on the surface must be removed with a brush. Holes and, irregularities of surface are repaired with lime putty, and the surface is allowed to dry before applying whitewash or color-wash. Similarly dusting and repair are done, to walls which have been whitewashed several times before. All greasy spots are given a coat of rice, water and sand. Surfaces discolored by smoke are washed with a mixture of wood ashes and water or yellow earth before being whitewashed.

15.3.3 APPLICATION

Each coat of whitewash comprises four strokes applied vertically and horizontally. One stroke is given from the top downwards and the other from the bottom upwards over the first stroke before it dries up, and similarly one stroke from the right and another from the left over the first brush. Each coat is allowed to dry up before the next is applied. Normally three coats are applied on the new surface.

Keeping in view the various principles on which the hydration of quicklime depends, the following methods are employed for slaking different types of lime:

a) HAND SLAKING

i) By drowning: High calcium lime or fat lime is slaked by, drowning the particles in a tub containing enough quantity of water. The tub is covered to preserve the heat.

ii) By Immersion-Feeble hydraulic limes are slaked by immersion. They are put in a basket which is immersed in, a tub filled with water. The basket is withdrawn when the sound of the reaction becomes apparent. The exact period of immersion is a matter of experience.

iii) By sprinkling-Hydraulic limes are usually slaked by this manner. They are spread on a specially prepared non-ferrous platform and water is sprinkled by mean of a can with a rose. Simultaneously the limes are turned over with spades. The slaking operation is accelerated, if the limes are initially pulverized in grinding mills.

iv) Air Slaking-According to this method lime takes moisture from the air when kept in an exposed condition. This process of hydration is also accompanied by the formation of a certain proportion of calcium carbonate by taking carbon-dioxide from the air and in this way lime is spoiled. Besides, it is difficult to control this process.

b) MECHANICAL SLAKING OR HYDRATING:

Hydrated lime is produced on a large scale with the aid of various types of mechanical appliances. It may be produced in a specific quantity each time or the process kept continuous.

By whatever method, the hydration is done the following points must be observed:

- Only the necessary quantity of water should be added to the lime at a uniform rate.
- Lime and water must be thoroughly mixed. The temperature of hydration should be properly controlled by a suitable cooling method.

A hydrating plant essentially consists of a crusher and a hydrator with a suitable storage tank and silos, and contains devices for conveying the material from one unit to the other. Hydrated lime is then passed through a sieve of 20 to 30 meshes to an inch to yield a powder of the required fineness.

15.3.4 WHITE-WASHING CEMENT CONCRETE

Cement concrete surface requires treatment prior to whitewashing. Surface is scraped off with a wire brush to remove greasy patches if any and washed with soap-suds. A coat of sodium silicate and water in the ratio of 1:5 is given to avoid any future scaling or flaking off.

Half to one part (by weight) of tallow in small lumps is added to 16 parts of quick lime, slaking it with only just sufficient water to form a thick paste stirring occasionally to assist in dispersing the tallow, and allowing it to stand till it cools down. The resultant paste is thinned down to a required consistency, is strained and applied on the surface in the usual manner. In the absence of tallow other oils or fats (for example, linseed oil or castor oil or some common vegetable oil) about 10% of the weight of dry lime are added to serve this purpose. If oil does not incorporate with the lime, the mixture is boiled a little till the oil disappears. In this way it becomes an insoluble soap which when once dry cannot be washed off even with heavy rains.

15.3.5 CEMENT WASH

Cement wash is simply a thin grout made of Portland cement and water and of such a consistency that it can be applied with a brush. Fine sand is sometimes added. This wash may be colored, if desired, but with certain tints it is desirable to use white Portland cement. Paints consisting of two parts of Portland cement to one part of lime are usually used.

15.4 COLOR-WASHING

15.4.1 GENERAL

Color-washing is nothing more than a lime-wash colored with suitable pigments and treated to give a desired tint. It is applied exactly in the same fashion as the whitewash. The old paint is scraped off or a coat of whitewash is applied before the new color is given. Gum or rice water is added as in whitewashing.

15.4.2 PREPARATION

The surface to be color-washed shall be prepared according to the specifications No. 15.3.2 for Whitewashing.

15.4.3 PREPARATION OF COLOR-WASH

The color-wash shall be prepared by adding the necessary coloring pigment to the whitewash which has been strained. The mixture shall be stirred thoroughly and passed through a clean, fine cloth. Only such quantity of wash shall be prepared as can be consumed in a day's work.

15.4.4 APPLICATION

i) New or scraped surface shall be given a coat of whitewash, prior to color-wash.

ii) Old surface when the color-wash is satisfactory shall be given only one new coat of color-wash.

iii) When replacing one color with another of a lighter shade the old color - shall be thoroughly scraped and a coat of whitewash given before the new color is applied.

iv) Each coat color-wash shall be allowed to dry and shall be inspected by the Engineer-In-charge or his authorized subordinate. The next coat shall not be applied unless the previous one has been approved by either of them.

v) The completed wall shall be of a uniform color free from blots lines or cut shades and shall present a smooth regular surface which shall neither crack nor come off readily on figures when rubbed.

vi) Each room shall be finished in one operation and work shall not start in a room so late that it cannot be finished the same day.

15.4.5 OTHER RESPECTS

In all other respects not specified here, It shall strictly conform to Specifications No. 15.3 for Whitewashing.

15.5 DISTEMPERING

15.5.1 GENERAL

i) Unless otherwise specified or directed in writing, a newly plastered wall shall not be distempered earlier than 12 months after the plastering if distempered earlier the plaster shall be treated with damp proof compound.

ii) Distempering shall not be done in damp weather nor when the weather is excessively hot and dry.

15.5.2 PREPARATION OF SURFACE

i. Newly-plastered surface when absolutely dry shall be sand-papered to remove all irregularities, making good inequalities and holes with gypsum which shall be allowed to set hard. Unless the surface is perfectly clean and smooth, no pleasing effect shall result from distemper.

ii. Old plastered surfaces shall be thoroughly cleaned if it is whitewashed or color-washed, it shall be rubbed off with sand-paper or cocoanut fibre in case it is loose and then stopped and sized.

iii. After rubbing and cleaning, all plastered surface, old or new, shall be sized with a coat of equal parts of size and alum dissolved in hot water. Decomposed size shall not be used under any circumstances. Where the

makers of the distemper recommend a special priming coat only that coat shall be applied.

iv. If the existing surface is cleanly distempered all the distemper shall not necessarily be removed. The surface shall be smooth down with glass paper or any firm distemper on the wall after such rubbing shall be-left.

15.5.3 PREPARATION OF DISTEMPER

i) Unless otherwise specified ready-made distempers as specified and approved by the Engineer-in-Charge shall be obtained from the market as they are easily available.

ii) Distempers shall be mixed strictly in accordance with the maker's instructions or as directed by the Engineer-In-charge, and the quantity shall be just sufficient for the day's work.

15.5.4 APPLICATION

i. Distemper shall be applied only with proper brushes as supplied or recommended by the maker. The brushes shall be washed in hot water after work each day and hung up to dry. Old brushes caked with dry distemper shall not be allowed to be used on the work.

ii. Distemper shall be applied quickly and boldly leaving no dry edges. The brush shall be dipped in distemper and stroked cross-wise on the wall, then immediately stroked up and down and stopped.

iii. Unless otherwise specified or directed two men shall work on a wall together, one working from the ceiling, downwards as far as he can reach and the other following him applying, the distemper from below. No patchy overlap shall be allowed under any circumstance. .

iv. Unless otherwise specified, the following number of coats of distempers shall be applied:

a) On newly plastered walls two coats over one coat of priming. b) On old plastered walls covered with one or two coats of hard dry whitewash free from efflorescence or kalar, one coat without priming coat.

15.6 CEMENT RENDERING

15.6.1 PREPARATION OF SURFACE

i) The surface to be rendered shall be thoroughly cleaned and dust loose particles, grease and oil stains shall be removed by washing, using a wire brush, if necessary.

ii) Brickwork, stone masonry or concrete shall be prepared to receive the rendering by raking out joints to a small depth not more than ½", or in the case of hardened concrete by beating a thoroughly saturated surface by 1:6 solution of hydrochloric acid and water, washing down within six hours and wire brushing so as to expose the aggregate. If the Engineer-in-charge thinks that the surface so prepared provides a good key, a single coat of rendering 3/8" to ½ " thick shall suffice.

iii) If, however, a good key is not obtained, a base coat of coarse sand and cement in the proportion of 1-1/2" parts sharp sand 1/4" down to 1 part cement, mixed in sufficient water, shall be applied. The mixture shall be dashed on to the wall in an uneven manner.

15.6.2 PREPARATION OF MORTAR FOR RENDERING

i) Fine Aggregate, Cement and water shall conform to Specifications of Cement Mortar referred in Clause 15.1.4.2.

ii) The grading of aggregate shall be ½" down for key coat and 1/8" down for finishing coat.

iii) The proportions of cement and aggregate for key coat shall be 1:3 and for backing or finishing coat 1:1-1/2". A mortar of required consistency shall be prepared by adding water from 12 to 16 per cent of the total volume of aggregate and cement for backing coat and 14 to 18 per cent for finishing coat, unless otherwise specified or directed by the Engineer-In-Charge.

15.6.3 APPLICATION

i. **BACKING COAT**

It shall be laid to a uniform thickness of 3/8" and just, after the material has started to set, it shall be scored in wavy lines by a wire-nail comb to form a bond for the next coat, arid the work then allowed to set for at least 30 hours. It shall be kept damp for that period.

ii. **FINISHING COAT**

Unless otherwise specified or directed, the finishing coat shall be 1/8" thick. The backing coat (base coat) shall be washed clean and the finishing coat applied evenly with care.

15.6.4 CURING

The finishing coat shall be protected from the sun, hot winds or rain by wet screens till it has hardened sufficiently to remain unaffected by the external application of water. It shall then be watered and kept damp for a period of at least seven days and allowed to dry as slowly as possible.

15.6.5 PROTECTION AGAINST CRACKING AND CRAZING

The surface shall be divided by joints to prevent cracking, and these joints shall be placed horizontally at the sill and Lintel level of windows and vertically at opening In wall angles and corners.

15.7 EMULSION PAINTING

15.7.1 SCOPE

The work include the provision of all materials, labour, plant and equipment and completion of work as specified and approved by Engineer-in-Charge

15.7.2 MATERIALS

Emulsion paints shall be of make and type as specified and approved by the Engineer-in-Charge.

15.7.3 EMULSION PAINT APPLICATION

For emulsion paint application the specifications laid for distempering under clause 15.5 shall apply.

15.8 SYNTHETIC FINISH

Synthetic finishes consist of application of synthetic finishes like Rockwall, Durock Graphic, Cemec or equivalent as specified and approved by the Engineer-in-Charge. The work shall be carried out according to supplier's instructions.

15.9 STUCCO CEMENT PLASTER

15.9.1 SCOPE

It shall cover placing 1:2:4 (Cement, Sand and Shingle) mix, 51 mm thick, as a plaster including furnishing of all labour, materials, plant, equipment, accessories and services as required to complete the plastering item as shown on the Drawings, specified herein and/or as directed by the Engineer-in-Charge. The materials herein specified shall be proportioned, mixed, formed and placed in accordance with the herein stated requirements. The stipulations and requirements herein set forth shall apply except when such stipulations and requirements are specifically modified by the Engineer for this particular item of work.

15.9.2 MATERIALS

a) Cement

Portland cement shall conform to ASTM C 150-94 Type 1 or BSS – 12.

b) Sand

All sand required under these specifications shall be composed of particles with a maximum size of 5 mm. Sand shall be processed from natural deposits or manufactured from quarried rock.

The grading of sand for this item of work shall be as under:

100 % shall pass through sieve NO.4

2 to 10% shall pass through sieve NO.1 00

c) Aggregate

The aggregate shall comprise shingle having grading as shown on the Drawings and or as directed by the Engineer. Generally reasonable grading is as under:

5mm to 9mm size	up to 25%
9mm to 10mm size	up to 75%
Above 18mm	NIL

d) Water

Water required to be used shall conform to the stipulations and requirements set-forth Section 11 – Brickwork mortar.

15.9.3 MIX PREPARATION

The mix shall conform to the mix design specified in the Drawings. Mix used in Stucco Cement Plastering, as a general principle, shall be so mixed that it is firm enough to stay in place when plastered. The net water-cement ratio of the concrete (exclusive of water within or absorbed by the aggregates) shall range from 0.53 to 0.58 based on the climatic temperature. Temperature of mix when it is placed, shall not be more than 32 degree C and not less than 5 degree C. Tests of the mix shall be made by the Engineer-in-Charge and the mix proportions shall be changed,

whenever necessary, for the purpose of securing the required workability, density, impermeability, durability or strength.

15.9.4 THICKNESS

Unless otherwise specified, the thickness of the plaster shall conform to the approved design / drawings. Generally, the thickness of Stucco cement plaster is taken as 51 mm. The plaster having thickness less than the specified thickness shall be rejected.

15.9.5 APPLICATION OF PLASTER

The plaster shall be done in two coats. The surface of first coat shall be made rough before the second coat is applied

15.10 GYPSUM PLASTER

Gypsum Plaster shall be provided wherever shown on the Drawings or as directed by the Engineer-in-Charge. The work shall be carried out strictly in accordance with the manufacturer's instructions.

Gypsum is naturally occurring material which is quarried or mined. When it is heated to a comparatively low temperature (150-170^{o}C), it is called plaster of Paris or calcium sulphate hemihydrates. When it is mixed with water it sets quickly to form a hard mass. This setting period is too short to permit the material to be used as plastering material. The setting time may be lengthened by adding retarders and the amount of retarders is adjusted by manufacturer's instructions to suit the purpose of plaster.

Simple precaution which should be taken includes storing before use in a dry place. Calcium sulphate plasters in general are not suitable for use under persistently damp conditions because they will slowly dissolve in water. Plaster of Paris should not be applied to backgrounds containing large amounts of water, should not be used with clayey sand which tends to retain water and should be given adequate drying conditions once they have hardened.

15.10.1 GYPSUM PLASTER BOARD

Gypsum plaster board consists of a core of set gypsum enclosed between and firmly bonded to two stout lining papers. It is covered by British Standard, 1230:1955. This includes the following main type;

- Gypsum base board
- Gypsum wall board
- Gypsum lath
- Gypsum plank

Gypsum base board, Gypsum lath and Gypsum plank are used as a base for plaster. Gypsum wall board is designed to receive a direct decorative finish, but it may be plastered on its reverse side.

15.10.1.1 UNDERCOAT:

The undercoat of specified thickness and proportion shall be applied strictly in accordance with the specification of plaster as described in 15.1.5. The surface, however, needs not to be smooth.

15.10.1.2 APPLICATION

Gypsum plaster board of specified thickness shall be fixed by nailing to wood joists or studs at 14" to 18" centre or as directed by Engineer-In-charge.

15.11 TILE FACING

The tile facing shall be as shown on drawings and approved by the Engineer-in-Charge. The work shall be carried in accordance with the applicable provisions of tile laying in Section 14.

15.12 ORNAMENTAL PLASTER

Ornamental plaster shall be provided wherever shown on the Drawings or as directed by the Engineer-in-Charge. It could be either original imported cement, or colored cement or cement mixed with coloring pigment as provided in the item of work. The work shall be carried out strictly in accordance with 15.1.5.

15.13 MEASUREMENT AND PAYMENT

15.13.1 COMPOSITE RATE

The measurement and payment for the items of the work of Finishes hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified herein including the site clearance as approved by the Engineer-in-Charge.

Pay Item No.	Description	Unit of Measurement
15.13a	Cement sand plaster up to 12ft (3.65m) height (1:5) ratio and thickness ½", using approved sand, on ceilings, beams, columns, stair soffit, making the edges/ corners etc. with sand of approved quality/ specification complete in all respects including floating coat (neru)	SM
15.13 b	Cement sand plaster on stair steps and brick masonry up to 12ft (3.65m) height (1:5) ratio using approved sand, for internal surfaces complete in all respects including floating coat (neru), with cornice in roof i. ½" thickness ii. ¾" thickness	SM
15.13 c	Cement sand plaster on brick masonry up to 12ft (3.65m) height (1:4) ratio and thickness ½" using approved sand, on external surface of walls etc. complete in all respects including floating coat (neru), with drip course	SM
15.13 d	Cement sand plaster on stair steps and block masonry up to 12ft (3.65m) height (1:5) ratio and thickness ½", using approved sand, for internal surfaces complete in all respects including floating coat (neru), with cornice in roof	SM
15.13 e	Cement sand plaster on block masonry up to 12ft (3.65m) height (1:4) ratio and thickness ½" using approved sand, on external surface of walls etc. complete in all respects including floating coat (neru), with drip course	SM
15.13f	Rough texture plaster ¼" thick up to 12ft (3.65m) height, hand machine sprayed using cement with marble powder (1:1) complete in all respect	SM
15.13g	Rolled pointing up to 12ft (3.65m) height on outside brick masonry wall CS (1:2) mortar 1/2" thick	SM
15.13h	Rolled pointing up to 12ft (3.65m) height on outside block masonry wall CS (1:2) mortar 1/2" thick	SM
15.13i	Rolled pointing up to 12ft (3.65m) height on outside stone masonry wall CS (1:2) mortar 3/4" thick	SM

15.13j	Applying architectural coating of emulsion acrylic resin, rock wall, durock, pigments, and additives (Graffiato) on prepared surface up to 12ft (3.65m) height as recommended by manufacturer complete in all respect	SM
15.13 k	Marble tiles on columns up to 12ft (3.65m) height in any colour in sizes 4x8x1/2 inch fixed with 3/8" thick CS mortar (1:3)	SM
15.13l	Marble tiles on walls up to 12ft (3.65m) height in any colour in sizes 6x12x1/2 inch fixed with 3/8" thick CS mortar (1:3)	SM

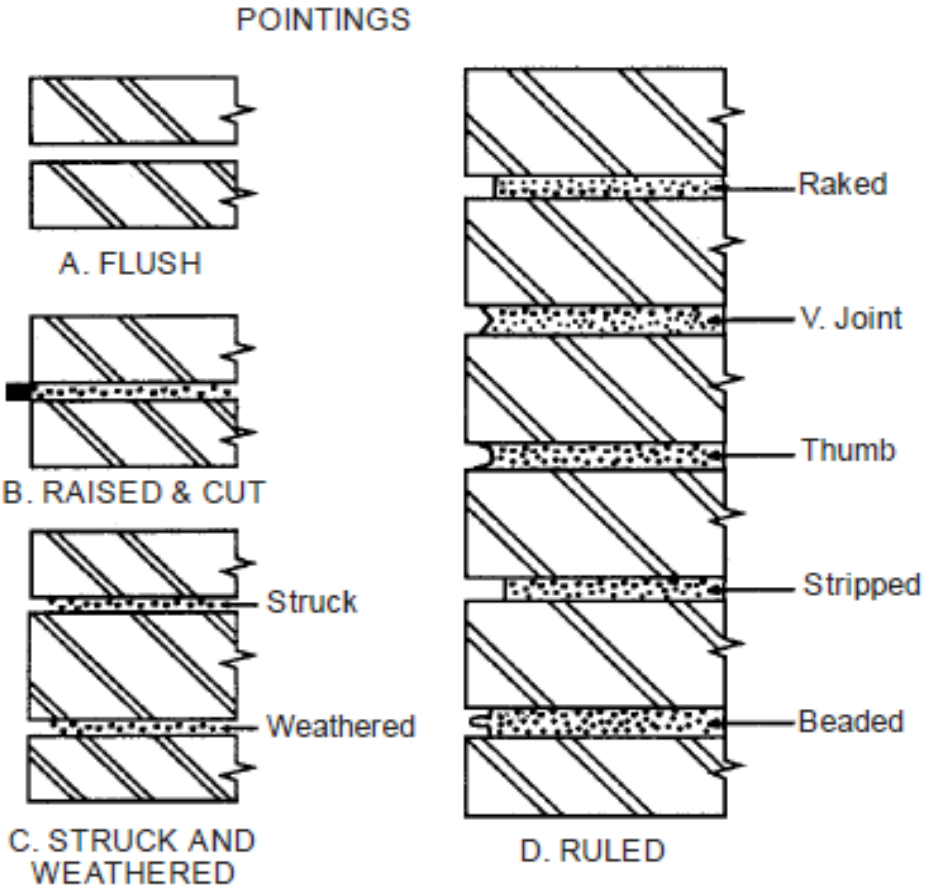


Fig 15.1 Types of Pointing

SECTION 16 WOOD WORK AND JOINERY

16.1 INTRODUCTION

16.1.1 DEFINITION

Woodwork is the process of converting timber into a desired shape and erecting it into Its final position. It is mostly carpenter's and joiner's work.

16.1.2 CARPENTER'S WORK

Carpenter's work includes all work on timber used in roofs, floors, verandas, staircases, doors and windows, frames, bridges, centering, shores, struts, large gates, and generally all wood work of which the scantling exceeds three-quarters of an inch, except in case of battens used in roof trellis-works which is specially mould or carved. When the thickness of carpenter's work does not exceed two inches but its width exceeds twice the thickness, it is called "planking".

16.1.3 JOINER'S WORK

Joiner's work includes furniture, doors and windows, turned and carved, on moulded work of all kinds.

16.2 SCOPE

The scope of work includes providing all labor materials, plants, equipment, accessories and services to complete the fabrication and installation of wood work consisting of but no limited to doors, windows, ventilators, gates, trusses stairs and all related work as specified and shown on drawings as approved by the Engineer-in-Charge.

16.3 MATERIAL

16.3.1 TIMBER

16.3.1.1 SOURCE:

Timber to be used for woodwork shall consist of deodar wood, shisham and kail wood as specified and shall be procured from an approved source. Brief description in their respect is as under.

Description	Uses
SHISHAM *Weighs about 49 lbs, per cubic foot. It is a large tree of* plain areas as well as the Sub-Himalayas forests growing at the altitude of about 3000 feet or less. Its sapwood is pale brownish white and heartwood is golden brown to dark brown with deeper brown streaks. The wood is dull with interlocked grain and medium coarse texture. It is easy to season but hard to work. It keeps its shape well if properly seasoned and takes on fine finish	It is chiefly used for flooring paneling furniture, sports goods, turnery and wheel-work; when peeled it can be made into beautifully grained plywood panels.
DEODAR Weight about 35 lbs per cubic foot. It is the most important soft wood of Pakistan found in the Himalyan ranges between 4000 to 7000 elevations. It is yellowish brown in colour. Its heartwood is strong and durable due to natural preservatives in it. It is easy to season and work and retains its shape well.	Being light and moderately strong, it is used for structure work, railway carriage wagons, planking, shingles, pattern making and cheap furniture etc.

KAIL An evergreen tree, moderately hard, durable and close-grained. It is found is the Himalayas. Weights about 32 lbs per cubic foot.	It is used for furniture house building are railway sleepers, etc.
FIR, PALUDAR, PARTAL An evergreen tree having light and soft wood with an average weight of 30 lbs per cubic foot (air dry) occurs naturally in North Western hilly areas from 2000 to 3000m elevation.	It is used for railway sleepers, planking for floors, ceiling, cheap type door and windows, house construction and paper pulp etc.
CHIR, CHILL An evergreen tree having durability when placed under cover but non-durable in exposed conditions. An average weight of 38 lbs per cubic foot (air dry) occurs naturally in North Western hilly areas from 450 to 2400 meter elevation.	It is used in building construction, roofing and flooring, furniture making and also used for fuel wood.

16.3.1.2 QUALITY:

General

i) Timber shall be of good quality in accordance with the requirements of BS:1186, felled not less than two years before use for carpentry and four years for joinery and shall be properly seasoned.
ii) Timber shall be uniform in texture, straight in fiber, free from open shakes, bore holes, fungus attack rots, dots, decay, warp, twist spring or crook and all other defects and blemishes.

Sapwood

iii) Sapwood shall not be permissible in hard wood thresholds and projecting window sills.

iv) Sapwood shall not be permissible in hard wood joinery unless properly treated with a suitable preservative as approved by the Engineer-in-Charge.

v) In soft wood joinery which is ordered as 'selected for staining' discolored sap wood shall not be permissible in surfaces which are intended to receive the final decoration.

vi) In all other uses sap wood including discolored sap wood if sound shall be permitted.

Knots:

vii) Exposed surfaces of hard wood sills shall be free from knots other than isolated sound tight knots not exceeding ¾ inches in diameter.

viii) In joinery which is ordered as 'Selected for staining' all surfaces intended to receive final decoration shall be free from knots.

ix) Glazing bars shall be free from all knots other than sound knots appearing on one surface only and not exceeding ¾" diameter in the web and ½" diameter elsewhere.

x) Loose or decayed dead knots shall not be permissible in any joinery and shall be cut out and plugged properly.

xi) In all other cases sound and tight knots including knot clusters which appear on any surface shall be permitted subject, to a maximum of:

a) One live knot measuring 1 ½" to 2" across the major diameter per 2 feet length, i.e. a Max of four 2" knots per 8 feet length and five such knots in 10 feet length. (Smaller live knots shall be tolerated provided they are not so numerous or on ground as to affect unduly the strength of the sawn out turn there-from).

b) One dead knot measuring ½" to 1"across the major diameter per 3 feet length, i.e. three such knots per nine feet length and four such knots in twelve feet length (Dead knots below ½" diameter shall, however, be considered as negligible).

Shakes

xii) Straight splits or shakes shall be permissible upto a total for both ends of ½ inch per foot of length at the time of passing.
xiii) Timber shall not be spongy or in brittle condition.

Storage

Timber shall be stacked on a raised wooden or paved platform to eliminate chances of white ant attack. It shall be stacked under a proper shelter where maximum aeration is possible without subjecting it to the direct sun, rain or other weathering agents.

16.3.1.3 LOGS END SQUARES

Source

Logs or Squares shall be obtained from an approved source.

Size

i) Round logs shall not be of size less than 10 feet in length and 60 inches in girth.
ii) Logs shall not be longer than 35 feet in length. Tapered logs shall not be less than 54 inches in girth at the small end.
iii) Squares shall be of the size not less than 10feet in length and 15"x15" in cross section.

Quality

Logs or squares shall conform to the specifications for Timber, Clause 16.3.1.

16.3.1.4 SEASONING

i) General

The object of seasoning timber is either to expel or to dry up the sap remaining in it, which otherwise putrefies and causes decay. The seasoned timber does not decay, or warp or bend due to temperature variations as in case of moist timber. The seasoned timber works easily under the saw and its shape and dimensions do not change with variations in temperature or with age. The seasoning also increases the strength of timber. The timber for carpentry is well seasoned when it has lost its weight by 1/5th. Timber for joinery is fit when it loses about 1/3rd of its weight after felling.

ii) Method of Seasoning

Wood can be seasoned in drying kilns or by air seasoning. Kiln seasoning though very helpful in our country, where the high humidity during certain part of the year, precludes effective air seasoning.

iii) Air Seasoning

For air seasoning there are two important points to be attended to. First is the proper pilling and stacking of timber and the second is the protection of wood from rain, sun and hot wind. The wood pile should be on proper foundation of wood, masonry or concrete. Concrete of brickwork foundations are the best. One square foot pillars at 4 to 5 feet intervals and rising 1 foot above the level of the ground will do. The distance between the two rows of pillars forming the two sides of the stack should also be 4 to 5 feet. For protection against termites, termite guards are provided near the top of the pillars, with a bend down edges protruding all rounds.

The orientation of the stack foundation is also a matter of considerable importance. Generally, the length of the pile should be in the same direction as the prevailing dry wind. The main force of the hot dry wind is then met by the sides of the crossers and only one end of the planks is exposed to heat. Piling of timber is to be done in a systematic manner. Lack of care in proper piling results in wastage of timber through crack warp, rot, stain and termite attack. All these can be avoided with a little extra expense or trouble. Other important factor is protection of the stack from hot wind, sun and rain. The direct rays of the scorching sun can cause very rapid drying of wood on the exposed surfaces and consequent splitting and cracking. Timber can be classified into six categories based on the seasoning behavior. They are;

1) Very easy to season but require quick seasoning,

2) Easy to season,

3) Season well with care,

4) Crack in seasoning and so difficult to season,

5) Season well but take a long time to season and

6) Crack badly in seasoning. In the para 16.3.1.1 giving individual description of wood of the seasoning behavior has been stated based on the above classification.

Timbers which crack in seasoning and so are difficult to season or crack badly in seasoning, should be dried so as to prevent rapid drying. Timbers which season well with care, or season well but take a long time to season, should be seasoned in shades open on the north with a sufficient overhang so that the pile is protected from the rain. In case of timbers which are easy to season or very easy to season but require quick seasoning, it is necessary, that the timber should be piled under a good weather-proof roof but the sides should be always exposed to air and the sun. In the cases of timbers which require quick seasoning it is a good practice to stand the planks up on the ends against a horizontal support for a week or two after conversion to prevent formation of mould and staining. After a short period of vertical stacking the plans should be pilled horizontally as described.

16.3.2 PLYWOOD AND VENEER

a) Plywood

Plywood shall be an assembled product made up of plies and adhesives, the chief characteristic being the crossed plies which distribute the longitudinal wood strength. The term plywood in general sense shall include similar products such as laminated board, block board and batten board. Plywood shall conform to BS1455 whereas laminated, block and batten boards to BS 3444.

Three ply constructions shall include a “face” a “back” and a core or inner ply. Multi-ply shall include a face, a back and a core of three or more inner plies. With very few exceptions the grain of each veneer in the core shall run at right angles to that of the veneers on either side of it.
The construction of plywood may be balanced with an odd number of veneers arranged symmetrically or unbalanced. The tendency of the finished board to distort shall be reduced by adopting a balanced construction.
Plywood according to BS1455 shall be classified into two main types, viz interior and resin bonded.
Interior type plywood shall be suitable for most interior work including wall paneling, subflooring, kitchen filaments, and any location where resistance to moisture is not required. Adhesive used shall include casein, soya, blood albumen and animal glues as well as synthetic resin extended with other substances.
Synthetic resin bonded plywood shall have a much greater resistance to moisture. The more resistant types shall be suitable for external wall sheathing, shop front fascias, sign boards, shuttering and form work for concrete and for any purpose where it may be exposed to moisture. Adhesives used shall include urea, melamine phenol and resorcinol formaldehyde (arranged in order of increasing moisture resistance).

b) Veneers

Grade I Veneer shall be of one piece of firm smoothly cut veneer. The veneers shall be free from knots, worm and beetle holes, splits, dots, glue-stains, filling or In laying of any kind or other defects. No end joints shall be permissible.
Grade II Veneer shall present a solid surface free from open defects. Veneer may be in one or two pieces.
Veneers when jointed need not necessarily be matched for color or be of equal width. A few sound knots shall be permitted with occasional minor discoloration and slight glue stains, isolated pin holes not along the plane of the veneer.
Grade I veneered plywood shall only be used if not specified otherwise.
Grade II shall be used if specified and where subsequent painting and/or veneering is intended.

c) Laminated Veneered Board

It shall be built-up board, with narrow strip 3 to 7 mm wide, faced both sides with either one or two veneers from 1.2 mm to 3.7 mm thick. Where single or double face veneers are used, the grain shall usually run at right angles to the grain of the core strip. This type of board, conforming to B.S. 3444 and of a thickness between 13 mm to 25 mm, shall be the base for the highest class of veneered wood.

d) Block Veneered Board

Block board conforming to B.S. 3444 shall be of similar construction as of laminated board but the core shall be built-up of blocks up-to 25 mm wide. It shall be used as a base for veneering and for painted work.

e) Fiber Building & Chip Board

The term “board” in general sense shall include fiber building boards and the chip boards (or particle boards). The fiber building boards shall include hard boards, insulation boards and straw boards.

A. FIBER-BUILDING BOARDS

i) Hard Board

Mass per unit volume of hard boards shall range from 480 to 800 Kg per cubic meter and shall be classified according to this density (mass per unit volume). Tempered hard board/standard hard board shall be treated to increase hardness and resistance to water.

ii) Insulation Board

Insulation board shall have maximum density of 400 Kg/Cu meter, minimum thickness of 11 mm and maximum thermal conductivity (K) of 0.45. Insulation boards classified as homogeneous laminated, bitumen bonded, bitumen impregnated and acoustic shall have good qualities of thermal insulation and sound absorption. Acoustic boards shall be of low density and specially designed (Often with perforated surface) to increase sound absorption.

iii) Straw Board

Straw boards shall be made of straw compressed and formed into slabs 50 mm thick by heat and pressure and with proprietary paper glued to the sides. Edges too shall be bound with paper. The slabs shall be fairly stiff and shall have thermal conductivity (k) of 0.6.

B. CHIP BOARD (Particle Board)

Chip boards shall be made of wood particles in the form of chips or shavings of a controlled size combined with a thermo setting synthetic resin glue binder and formed into panels under the influence of mechanical pressure and heat. The process of adhesion shall be controlled resulting in a variety of boards with different but predictable physical properties. Chip Board, if specified, shall be used in sheathing, flooring and sub-flooring, wall paneling, partitions, shelves, furniture and veneered boards. It should not be affected dimensionally by changes in atmospheric humidity, though in wet conditions it shall have a limited resistance to moisture. The surface finish of standard boards shall be comparatively rough and to support a good quality paint or varnish finish it shall require sanding and filling. Special grade of the board which have a paper surface permanently bonded to the board during manufacture shall be used for painting. Chip boards shall be classified in grades of high, medium and low density mainly in thickness of 13 mm and 19 mm. The density range of this board is from 480 to 800 Kg per cubic meter as under:

High Density (HDF)	:	Above 800 kg/m^3
Light (LDF)	:	Below 650 kg/m^3
Ultra-Light (ULDF)	:	Below 550 kg/m^3

Due to variation between brands, the weight of chipboard is not constantly proportional to thickness. Typical weights, based on standard chipboard with average density 750 kg/m3, are:'

Chipboard is available in an extensive range of thicknesses, i.e. 1.8mm to 60mm. The most common sheet sizes are: widths 1220mm, 1525mm and 1850mm and in lengths up to 3660mm.

16.3.3 ADHESIVES

For joinery work, animal glues complying with B.S:745 or synthetic resin adhesive complying with B.S:1204 shall be used. For flush doors and other forms of construction that rely mainly upon the adhesive, and particularly where exposure conditions are severe and prolonged dampness is likely to occur, one of the more moisture resistant adhesive shall be employed, the choice depending upon the severity of the conditions to which the work will be exposed.

16.3.4 HARDWARE

a) Nails and Screws

For joining work, wire nails oval, chequered head, lost head round or panel-pins complying with BS:1202, or wood screws in accordance with BS: 1210 shall be used. The gauge of nail or screw used shall be suited to the woods being fixed and to which a fixing is being made, and the length shall be such as will give a

sufficiently strong and secure fixing. CP: 112 shall be followed which gives relationship between gauge amount of penetration and strength. All nails and screws used with reactive timber (becoming stained and disfigured by reaction with ferrous metals) shall be of non-ferrous metals or shall be given protective coating before use if the woodwork is likely to be subjected to moist conditions, e.g. external doors.

b) Finish Hardware

Hinges, tower bolts, handles, locks catchers, stoppers, railings, supports, appurtenances, fixings, fittings and all other items metallic, plastic or wooden considered as finish hardware shall be as shown on the Drawings or required in the Specifications and approved by the Engineer-in-Change for the specific job.

16.4 WORKMANSHIP

A. GENERAL

i) All workmanship shall be of the best type and all joints shall fit accurately without wedging or filling. After the wood work has been erected, the contractor shall, if any undue shrinkage or bad workmanship is discovered, forthwith correct the defect without any extra charge.

ii) All Woodwork shall be fitted, hung and trimmed as indicated on the Drawings. One sample of each fitting to be used, shall be deposited by the contractor in the office of the Engineer-in-Charge. Hinges shall be counter sunk into the frames. The recess to be cut to the exact size and depth of the hinge. No subsequent packing shall be allowed. Brass screws shall be used with brass fittings unless otherwise specified. Hardware shall be fixed as specified in the Drawings. Locks and other hardware items shall be fixed at heights as shown on the Drawings or as directed by the Engineer-in-Charge.

iii) Items of hardware specified in the Drawings shall be carefully fitted and securely attached on completion of the work. Hardware shall be demonstrated to work freely, keys shall be fitted into their respective locks, and upon acceptance of the work, keys shall be tagged and delivered in duplicate to the Engineer-in-Charge.

iv) All wood work shall be neatly and truly finished to the exact dimensions specified.

B. JOINTS

Unless otherwise specified all joints shall be simple ten on and mortise joints with the end of the ten-ons exposed to view. All mortise and ten-on joints or scarf's shall fit truly and fully without filling. Where specified in the case of special 'high class joinery the end of the ten-on shall not show. Joints shall be painted with specified lead paint before the frames are put together. Glue shall not be used in joints which are exposed to weather and in such exposed work any hard stopping shall be done with tight driven plugs.

C. SCREWS AND NAILS

All nails and screws shall be of an approved type. Holes of correct size shall be drilled before inserting screws. Hammer shall not be used at all for driving in or starting the screws. All screws shall be dipped in oil before they are inserted in the wood. The heads of nails or screws shall be sunk and puttied or dealt with as directed by the Engineer-In-charge.

D. WOOD TO BE COVERED IN GROUNDS OR WALL

The contractor shall give at least 7 days' notice to the Engineer-in-charge in writing, when any timber is to be covered in the ground, or in the walls of a building, or otherwise. Failing this the Engineer-in-charge may order it to be uncovered at the contractor's expense, or measure and pay for only so much as is uncovered.

E. FIXING

All wood work shall be fixed in accordance with the drawings or the instructions of the Engineer-in-charge.

F. BEARING

All beams and girders shall be bedded on plates with not less than 9 inches bearing. All joists shall bear not less than 4-1/2 " inches on wall plates, and every purlin or batten supported on a wall shall have a bearing in the direction of its length equal to its own depth subject to a minimum of 4" inches.

G. AIR SPACE

An air space of quarter of an inch shall be left along sides of battens and other wood work buried in masonry or brickwork.

H. PRESERVATIVES

All portions of timber built into or against or close to masonry or concrete, and all junctions or rafters, purlins, beams and wall plates shall be given two coats of hot solignum, creosote or other wood preservative approved by the Engineer-In-Charge.

I. PLANKS

All scantling planks etc. shall be sawn straight and shall have uniform thickness. They shall be sawn in the direction of the grain and shall have full measurement from end to end. All planks and scantlings shall be sawn 1/16 inch in excess of actual measurement to allow planning. They shall be supplied with straight square edge, or rebated, ploughed, tongued or dwelled, as may be directed.

J. CHIMNEY FLUE

As a precaution against fire no wood work shall be fixed within 2 feet of the interior face of a chimney flue.

K. WOOD FOR USE

Unless otherwise specified the wood used in construction or joinery work shall be conform with the applicable provisions of Sub-Section 16.3.

L. RESPONSIBILITY OF CONTRACTOR AFTER FIXING

The contractor shall be responsible for the easing or otherwise of all doors etc. and the closing down of all open joints which may occur within six months of the completion of the work or as specified in the contract and which in the opinion of Engineer-in-charge required attention. Should any shrinkage or warping occur or any other defects appear in the joiner's work before the end of the specified period, such defective work shall be taken down and replaced to the Engineer-in-Charge satisfaction and any other work disturbed shall be made good at the Contractor's expense.

16.5 DOORS AND WINDOWS (GENERAL)

16.5.1 QUALITY

Unless otherwise specified timber shall conform to specifications as mentioned under 16.3.1

16.5.2 WORKMANSHIP

Unless otherwise specified the workmanship for doors and windows shall conform to the provisions under clause 16.4 – Woodwork (General) in all respects, except those specified hereunder.

16.5.3 SIZE OF DOOR AND WINDOWS

The size of doors and windows shall be as specified.

16.5.4 SECTION FITTING

Unless otherwise specified or directed the particulars and dimensions of chowkats for doors and windows together with their fittings and furniture shall be as specified on drawings or as existing at site for repair works.

16.5.5 CHOWKAT FRAMING AND CORNERS

Chowkats shall be properly framed and mortised together. Door and Window chowkats shall have 4-1/2 inches wide horns left on the heads (also on sills where these are provided) or the corners of the chowkats bound with 2-1/4 inches by 1/10 inch Iron straps bent into a right angle having legs of a length equal to the depth of the chowkat and fixed with four screws of 2 inches each. The cost of horns or straps is included in the rate. Unless otherwise specified, the latter method shall be adopted. Door and Window chowkats shall have 2.5 inch wide wooden beading made of Deodar wood or specified in BOQ and drawings.

16.5.6 REBATES

Chowkats shall have a rebate cut to receive the leaves. The rebate shall be 1/2 inch deep and its width shall be equal to the thickness of the leaf. The other side shall be finished with a bead and quirk; or other simple moulding, unless wire gauze is to be fitted. Where the plaster butts against the chowkat1/2 inch deep rebate with a slight cut back shall be given, to serve, as key to the plaster

16.5.7 POSITION OF CHOWKATS IN JAMBS

Unless otherwise specified, doors and windows opening to another room, to a corridor or verandah shall have the chowkats so fixed that they project 3/8 of an inch from the plastered face of the wall.

The plaster shall stop against the chowkat which shall have the rebate mentioned in the above paragraph as key for the plaster.

Other doors and windows shall be set back 4-1/2 inches from the face of the wall.

16.5.8 CHOWKAT TO BE READY BEFORE STARTING SUPERSTRUCTURE

No chowkat shall be painted or fixed before the Engineer-In-charge has inspected and approved it. All chowkats shall be ready before the work reaches the sill level so that they can be built in as brickwork or masonry proceeds.

16.5.9 CHOWKAT PAINTING WITH PRESERVATIVES

Before fixing, chowkat shall have the side in contact with the brickwork or masonry painted with two coats of hot solignum, creosote, coal tar or other wood preservatives approved by the Engineer-in-Charge. If doors and windows are to be subsequently painted, the priming coat shall be painted on the chowkats before they are fixed.

16.5.10 HOLD FAST

Chowkats shall be secured to the brickwork or masonry by hold fasts which shall be built into the wall with specified mortar. Hold fasts shall be made 1 ½ x ¼ inches flat steel patti bent over at both ends leaving 13 ¾ inches clear length between bends one bend shall have two screwed holes to which the chowkat is secured by bolt ½inch in diameter. The head of the bolt shall be sunk into the chowkats and the hole plugged with wood. Where the chowkatis fixed at the extreme edges of the Jambs, the hold fasts shall be worked or bent as directed by the Engineer-in-charge. The

number of hold fasts to each chowkat shall be as indicated on drawings. The feet of the chowkat shall, in this case, rest on the damp-proof course or floor as the case may be.

16.5.11 SEASONING

All door and window leaves shall be cut out and framed together, as soon as possible after the commencement of the work, and stacked in the shade to season. They shall not be wedged and glued for four months where possible and where the contract time permits. If it is not possible, they shall be wedged and glued just prior to being hung. Before final gluing, all portions in which defects appear shall be replaced.

16.5.12 METHODS OF FRAMING LEAVES

All stiles and rails shall be properly and accurately mortised and tenoned. The thickness of the tenon shall not exceed one-fourth the thickness of the plank and the width shall not exceed five times the thickness. All rails over 7 inches in depth shall have double tenons. All tenons shall pass completely rough stiles and shall be secured by 3/8 inch hard wood or bamboo pins. All rails shall be haunched to the depth of groove for panels.

16.5.13 GLUING

All tenons at the final assembly of the doors shall be glued and wedged at top and bottom of the tenon with glued wedges. Immediately after gluing, the frames shall be tightly clamped and so left till the glue has set.

16.5.14 HINGES

Unless otherwise specified, leaves shall be hung on hinges of the size and the number specified. These hinges are to be of an approved type and quality. They shall be counter sunk into the chowkat as well as to the leaf the recesses being cut to the exact size and depth of the hinge, no subsequent packing shall be allowed. Two inch screws shall be used with 5 inches to 6 inches hinges and 1 ½ inches for smaller sizes.

16.5.15 FITTING

The Contractor shall deposit in the office of the Engineer-in-Charge one sample of each fitting to be used in the work. Unless otherwise specified, fittings shall be of the number size and type as specified.

16.5.16 SPECIAL DOOR FURNITURE

Where special ironmongery or door furniture is required, it shall be supplied by the department, or provided by the contractor at an extra cost. The cost of fixing or mounting such special furniture shall, however, be included in the rate.

16.5.17 SCREWS

Screws of such diameter shall be used as to fill completely the holes and cups in the fittings which they secure, and shall be oiled before being inserted. Unless the head can be counter-sunk flush with the fittings, round headed screws shall be used. Brass fittings of specified type shall be secured with brass screws.

16.5.18 CHOCKS

Hinged chocks shall invariably be fitted to all doors and windows to keep them open. Chocks shall be of hardwood and swung on 3 inches butt hinges and shall act on a sheet metal protector fixed to the door stile.

16.5.19 STOPS

Wooden stops of a size suitable for the leaf concerned shall be fixed to the door or window chowkats to prevent the leaf from damaging the plaster of the jamb when fully opened.

16.5.20 MISCELLANEOUS

The miscellaneous items for the woodwork consist of but not limited to:

- Curtain rods rails and accessories
- Window stays
- Door Holders, Door locks, Door springs, Finger Plates
- Sliding bolts, Tower bolts, Door handles Brass plates

All procurements and installations shall be made as specified and as approved by the Engineer-in-Charge.

16.6 <u>PANELED AND GLAZED DOORS AND WINDOWS</u>

16.6.1 DESIGN

Unless otherwise specified the paneled and glazed doors shall conform to the drawings.

16.6.2 QUALITY OF TIMBER

Unless otherwise specified or directed by the Engineer-in-Charge the wood shall conform to specifications as mentioned above in 16.3.1.

16.6.3 DOOR FRAME

a) The members shall be joined with close fitting mortise and tenon joints which shall be further pinned with corrosion resisting metal pins of not less than 8 mm (5/16”inch) diameter or with hard wood pins whose diameter shall not be less than 10 mm(3/8” inch). The framing shall be such as to ensure complete rigidity throughout.

b) The entire surface of frame coming in contact with masonry shall be treated with a preservative of an approved type and quality.

c) The frame shall be fixed to the masonry with at least four hold fasts. Two additional hold fasts shall be used if the chowkat is without a sill.

16.6.4 SHUTTER FRAME

The stiles and rails of the frame shall be mortised and tenoned together. The thickness of each tenon shall be approximately 1/3 rd the thickness of the rail and the width of each tenon shall not exceed 5 times its own thickness.

16.6.5 PANEL

a) Panels shall be made of solid wood or hard board or water resistant plywood or veneer having both sides properly finished. They shall be truly cut and framed into rebates to a depth not less than 3/8 inch. Their thickness shall not be less than 7.5 mm (5/16 inch) panels shall be in one piece up to 12 inches clear in case of deodar and 18 inches clear in case of teak. In the larger sizes they shall be jointed, but the joints shall be glued and dowelled together to prevent all possibilities of its opening out afterwards.

b) Panels shall be absolutely smooth so that no marks are visible. Unless otherwise specified, panels shall be splayed and fielded on both sides and the arrises of the frame receiving the panels finished with a simple mould.

16.6.6 SASH BARS

Sash bars shall be of the same thickness on the leaf and shall be 1 inch to 1-1/4 inch wide, according to the size of the doors, and shall be twice moulded and twice rebated and mitred on the outside. The size of the rebate shall be 3/8 inch x1/2 inch to receive the glass and its fixing.

16.6.7 GLAZING

All glazing shall be done in accordance with the provision of clause 16.14 for glazing. If specified, the doors and windows of bedrooms shall be glazed with blind glass up to full eye level. The glass panels of appropriate sizes shall be fitted into (3/8 inch) rebates and shall be retained in position with a thin layer of putty which shall be covered with wood beading.

16.7 <u>FRAMED AND BRACED DOORS AND WINDOWS</u>

16.7.1 FRAME OF LEAF

Framed and braced doors shall consist of two stiles, three rails and two braces forming the frame of each leaf to which the battens (planks) shall be fixed. In case of doors opening outside, where it is necessary to admit light, the Engineer-in-Charge may direct the addition of a frieze rail. In this case the space between the frieze rail and the top rail shall be glazed by the contractor without any extra charge.

16.7.2 FRAMING AND BRACING

The framing shall be made with mortise and tenon joints as per Specification No. 16.4. The top rail (or frieze rail when the door has been glazed) and bottom rails shall be chamfered or stop chamfered. The exposed edges of stiles and rails shall be chamfered or stop chamfered. Unless otherwise specified framing and batten shall be of the sizes as shown on drawings.

16.7.3 BATTEN

Batten shall butt into rebates in the top (or frieze) rail and the bottom rail and shall pass over the braces and the lock rail. Batten shall not be more than 5 inches wide and shall all be parallel and uniform in width. The joints shall be ploughed and tongued and finished with a bead and quirk on the outside. Battens shall be secured with two screws at each end and with one screw over each brace and the lock rail.

16.7.4 OTHER RESPECT

A framed and braced door/window shall conform to the provisions of Clause 16.5 In all respects.

16.8 <u>LEDGED AND BRACED DOOR AND WINDOWS</u>

16.8.1 FRAME OF LEAF

Ledged and braced door leaf shall be formed with battens secured to three ledges, with two braces between the ledges. Windows shall have only two ledges and one brace. The top edges and ends of ledges and braces shall be chamfered. Battens (planks) shall have rebated joints finished with a “V” on one side and shall be of uniform width of not more than 5 inches. The battens shall be screwed, with two screws at each end and one over each brace and the middle ledge. The size of ledges, braces and battens shall be as shown on drawings.

16.8.2 DOUBLE LEAVES

In the case of double doors a 3” x 1” cover bar shall be screwed on to the edge of one leaf so as to make it a master leaf.

16.8.3 HANGING

The chowkat shall be rebated to a depth equal to the full thickness of the door, i.e the batten plus ledges. The doors shall be hung with the battens inside and the ledges outside. Hinges shall be fixed to the ledges.

16.8.4 OTHER RESPECT

In all other respect it shall conform to provisions of clause 16.5 for Doors and Windows (General).

16.9 LEDGED DOORS AND WINDOWS

16.9.1 FRAME OF LEAF

Ledged type also called country doors and windows, shall be formed by fixing battens on to three ledges. The battens shall be of uniform width, not more than 9 inches, and shall have rebated joints. The thickness of battens and the size of ledges shall be as specified on drawings.

16.9.2 ERECTION

Country doors shall be hung on pivot with the battens outside and ledges inside

16.9.3 OTHER RESPECTS

In all other respect the ledged doors and windows shall conform to the Specifications No.16.8 for Ledged, Braced and Battened Doors

16.10 WIRE GAUZED DOORS

16.10.1 MATERIAL

Unless otherwise specified leaves of wire gauze doors shall be made from deodar, irrespective of the wood used in making the chowkat or the other leaves hung from the same chowkat.

16.10.2 CHOWKAT

Wire gauzed door shall normally be hung on the same chowkat as other doors, and the rate shall include the provision of extra depth in the chowkat to take the rebate for the wire gauze leaf. Where wire gauze doors are hung on a separate chowkat a special rate shall be settled.

16.10.3 WIRE GAUZE

Unless otherwise specified, wire gauze shall be of best quality and uniformly woven wire webbing 12 x 12 meshes to the square inch made from 22 gauge galvanized iron wire. All wire gauze panels shall be in one piece, on joints being allowed in the gauze. Whereas specified expanded metal or plastic or aluminum wire mesh could be used.

16.10.4 FIXING

Wire gauze shall be fixed to the frame of the leaf after being stretched from out to out of rebate and nailed down taut by nails spaced at not more than 2 inches and then fixed that by a fillet of ¾ inch x ¾ inch screwed into a rebate of that size. The screws shall not be less than 1-1/4 inches in length, nor spaced further than 9 inches. All exposed arises of the fillet shall be finished with a small neat mould.

16.10.5 SPRING HINGES

Unless otherwise specified all wire gauze doors shall be hung on self-closing spring hinges which shall be of an approved quality.

16.10.6 DOUBLE DOORS TO PROJECT

All double leaf wire gauze doors shall close with the meeting stiles butting, against each other, a felt being fixed to one leaf to close the joint. The leaves shall close to such an extent that the junction projects from the face of the chowkat, the protection being one inch for each foot width of leaf. The top of the chowkat (and sill when it has been provided) shall be enlarged to a corresponding wedge shape, the cost of this being included in the rate.

16.10.7 MATCHING INNER LEAVES

Unless otherwise specified the width and position of lock and bottom rails on wire gauze doors shall be the same type as those of the other leaves hung on the same chowkat.

16.11 WIRE GAUZED WINDOWS

Where moveable wire gauze flaps or leaves are provided to windows, the provisions of Clause 16.10 for wire gauzed doors shall be followed with the following modifications. Wire gauze windows shall not be provided with springs or spring hinges. Double hung wire gauze windows shall close flush with the chowkat without the meeting stiles projecting in any way. Unless otherwise specified wire gauzed windows shall open outwards and shall be provided with hinged chocks to keep them in the open position, and with stops to prevent damage to plaster.

16.12 CLERESTORY WINDOWS

6.12.1 CHOWKAT

Unless otherwise specified the chowkat of clerestory windows shall be so fixed as to project 3/8" inch from the inner face of the wall.

16.12.2 CLEAT

Unless otherwise specified brass cleats of the slanting single button type approved by the Engineer-in-Charge shall be fixed by two brass screws to the polished wooden teak blocks with chamfered edges. The wooden blocks shall 2" x 3-½"x ¾" and shall be firmly fixed to the wall by means of plugs and screws of an approved type.

16.12.3 LEAVES

The leaves shall be hung 1 inch off centre so as to make them self-closing. In order to open them, a cord (stout, non-twisting picture cord) shall be provided with a hard wood weight at one end (to keep the cord in position over the cleat).

16.12.4 OTHER RESPECT

In all other respects it shall conform to the provisions of Clause 16.6.

16.13 FIXED WIRE GAUZE

16.13.1 WIRE GAUZE

Unless otherwise specified, the wire gauze shall be of an approved quality, uniformly woven, wire webbing of 12x12 meshes to a square inch made from 22 gauge galvanized Iron wire. All panels shall be in one piece and no joints shall be allowed in the gauze. Where specified aluminium or expanded metal wire gauze shall be used.

16.13.2 METHODS OF FIXING

Wire gauze shall be fixed to the outside of the chowkat. This shall be drawn taut to the full width of the chowkat and nailed down by nails spaced not more than 2 inches and a cover strip, 3/4 inch in thickness and of the same width as the chowkat so at to seem a part of the chowkat, bed all round with 1-1/4 inches screws fixed not more than 9”inches apart.

16.13.3 ALTERNATE FINISHING

If specially required by the Engineer-In-charge, the wire gauze shall be fixed to the chowkat by a fillet, ¾ inch x ¾ inch, screwed into a rebate of the same size. The wire gauze shall be stretched taut and nailed down by nails spaced not more than 2 inches to the chowkat, and then the fillet screwed down with one-inch screws spaced not more than 9” inches apart.

16.13.4 FINISHING RATE

Exposed arises shall be finished with a small but neat mould in each case. The rate shall be the same for either method of fixing.

16.14 GLAZING

16.14.1 GLASS THICKNESS AND QUALITY

Unless otherwise specified, all glass shall be flat sheet glass of fine quality known as "seconds". Glass shall be of the following weights per square foot for the various sizes mentioned below:-

Not exceeding 12"x14" - 16 oz (about 1/14" thick)

Exceeding 12"x14" but not exceeding 24”x24”-21 oz (1/10” thick)

Exceeding 24"x24" but not exceeding 30”x30" -26 oz (1/9" thick) Exceeding 30”x30” but not exceeding 36”x36”-32 oz (1/7" thick) Exceeding 36”x36” plate glass- (1/4" thick)

Glass shall be free from specks, bubbles, distortion and flaws of every kind, and shall be properly cut to fit the rebates, so as to leave a uniform space of 1/16 inch all-round the panes between the edge of the glass and the rebate.

16.14.2 PUTTY (METHOD OF PREPARING)

Putty shall be prepared from pure raw linseed oil and best whiting, specially dry and ground fine to pass a sieve of 45x45 meshes to a square inch. The two shall be well mixed by hand and kneaded into a stiff paste. It shall then be left for 12 hours and worked up in small pieces till it becomes quite smooth. If the putty becomes dry; it shall be restored by heating and working it up again while hot. Where the rebate is small a little white lead shall be added in making the putty. Putty required for glazing large panes or for bedding plate glass shall be made with a mixture of linseed oil and tallow with whiting so as to make it pliable and capable of standing expansion of the panes. Where required, putty shall be coloured to match the wood work.

16.14.3 PAINTING OR PRIMING REBATES

If rebates have not been painted, they shall be well primed with boiled linseed oil to prevent the wood from drawing oil out of the putty. Putty shall be painted at the same time and the same number of coats as wood work.

16.14.4 FIXING GLASS WITH PUTTY

Each pane of glass shall be bedded on a thin layer of putty called "back putty" and secured into position with proper glazing springs or nail. "Front Putty" shall then be applied chamfered and finished off neatly so as to ensure that the depth of the putty is exactly equal to the rebate.

16.14.5 FIXING GLASS WITH WOOD FILLETS

In the case of all panes exceeding 12 inches in width, front putty shall not be used but the glass secured with fillets of wood, without extra charge. The fillets shall be plain or moulded and of a size depending on the type of door being glazed. The glass shall be protected from contact with the wood by putty made with tallow to act as a cushion.

16.14.6 BLIND GLASS

Where blind glass is fixed the frosted face shall be away from the putty.

16.14.7 PUTTY (COMING OFF)

All glass that has been fixed by the contractor shall if it becomes loose during the period specified in the contract, be re-fixed and puttied by him at his own expense.

16.14.8 CLEANING AND FINISHING

No glazing shall be considered complete until all paint and other stains have been removed from the surface of the glass. Glass shall be cleaned and polished with pads of damp newspaper, and then with a clean dry soft cloth. Cleaning shall be done by two men working on opposite sides of the same pane at the same time. The contractor shall make good all glass broken by his workers while cleaning the glass. On completion of the work all doors and windows shall be cleaned, damaged putty or glazing repaired and the whole work left perfect with a workmanlike finish.

16.15 TIMBER STRUCTURES AND TIMBER PARTS OF COMPOSITE STRUCTURES

a) Scope

The work shall consist of the construction of timber structures and timber parts of composite structures.

b) Material

Structural timber and lumber shall conform to the requirements of Material Specification mentioned in 16.3.1. Treated timber and lumber shall be impregnated with the specified type and quantity of preservative and in the manner specified.

Hardware, except cast iron, shall be galvanized as specified for iron and steel hardware in Material Specification. Unless otherwise specified, structural steel shapes, plates, and rods shall not be galvanized. Nuts, drift bolts, dowels, and screws shall be either wrought iron or steel.

Steel bolts shall conform to the requirements of ASTM A 307. When galvanized or zinc-coated bolts are specified, the zinc coating shall conform to the requirements of Material Specification.

c) Workmanship

All framing shall be true and exact. Timber and lumber shall be accurately cut and assembled to a close fit and shall have even bearing over the entire contact surface. No open or shimmed joints will be accepted. Nails and spikes shall be driven with

just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and may be sufficient cause for rejection of the work.

Holes for round drift pins and dowels shall be bored with a bit 1/16 inch smaller in diameter than that of the drift pin or dowel to be installed. The diameter of holes for square drift pins or dowels shall be equal to one side of the drift pin or dowel. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

Unless otherwise specified, surfacing, cutting, and boring of timber and lumber shall be completed before treatment. If field cutting or field repair of treated timber and lumber is approved, all cuts and abrasions shall be carefully trimmed and coated with copper naphthenate preservative containing a minimum of 2.0 percent copper metal or any other approved preservative. The treatment preservative shall be applied according to the product label. Any excess preservative not absorbed by the wood member shall be cleaned from the surface prior to the use of the member. Bored holes for connectors or bolts may be treated by pumping coal-tar roofing cement meeting ASTM D5643 into the holes using a caulking gun or similar device. After timber assembly, any unfilled holes shall be plugged with tightly fitting wooden plugs that have been treated with preservative as specified.

16.16 WOODEN STAIRS

16.16.1 GENERAL

The wooden stairs shall be constructed where specified according to drawings with deodar wood complying with the provisions of Clause 16.3.1.

16.16.2 WORKMANSHIP

The quality of materials and workmanship shall conform with the provision of Clauses 16.3 & 16.4 or as specified.
The glazing where specified shall conform with the provisions of Clause 16.14.
The stairs shall be firmly anchored at floor and with walls as specified.

16.17 WOODEN ROOF

The wooden roofs shall be constructed according to Drawings and as specified. The timber and materials shall conform to the provisions of Clause 16.3. The work shall be carried out in accordance with Clause 16.4. The roofing work shall comply with applicable provisions of Section 13 – Roofing.

16.18 SOUND PROOFING

i) Where specified shutter and frames of the doors, windows shall be affixed with sound proofing material sheets. The sound proofing sheets shall include cork sheet, rubber sheet and namdaas specified.

ii) The sheets shall be cut precisely for the size of panels and frames on which they are to be affixed. The cut sheets shall be neatly fixed on the surface by means of screws/adhesive specified in Clause 16.3 as approved by Engineer-in-Charge.

16.19 WALL LINING

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patching or plugging of, any kind shall not be permitted except as provided.

16.19.1 GROUNDS

Grounds shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 × 50 mm and top 35 × 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement: 3 fine sand) and batten of first class hard wood or as specified of size 50 × 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimeters centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

16.19.2 PANELLING

16.19.2.1 MATERIAL

This paneling shall be decorative or non-decorative (Paintable) type as per design and thickness specified by the Engineer-in-Charge, of 2nd class teak wood, or graded wood pre-laminated particle board or as specified in item.

PVC Panel thickness shall range from 7mm to 12 mm as specified, and shall comply with the following specifications:

Property	Test Method	Typical Value	Unit
Physical			
Density	ISO 1183	0.72	g/cm^2
Water Absorption (24 hrs at 73° F)		< 0.2	%
Weather Resistance		No visible change after 4,000 hours	
Mechanical			
Yield Stress	ISO 527	20	MPa
Elongation at Yield	ISO 527	2.5	%
Elongation at Break	ISO 527	20	%
Tensile modulus of elasticity	ISO 527	1300	MPa
Impact Strength (Charpy unnotched)	ISO 179	11	KJ/m^2
Thermal			
Temperature range		0 to +60 32 to +140	°C °F
Coefficient of linear thermal expansion		0.8 x 10^-4	K^{-1}
Thermal conductivity		0.087	W/mK
Electrical			
Surface resistivity		>10^15	ohm
Others			
Fire behavior		B1 flame retardant	

16.19.2.2 ORNAMENTAL WORK

The ornamental wood work shall be painted on the back with priming coat of approved wood primer before fixing the same to the grounds with screws, which shall be sunk into the wood work and their tops covered with putty. The ornamental work shall be made true and accurate to the dimensions shown in the working drawings. The fixing shall be done true to lines and levels. The planks for wall lining shall be tongued and grooved, unless otherwise specified.

16.20 <u>WARDROBE (ALMIRAH)</u>

Wardrobes will have minimum depth of 22 inches and shall be fabricated with 3/4" thick chipboard box all around, 3/4" thick chipboard partitions and 1/8" thick

commercial ply at the back of the wardrobe box. 3/4" thick veneer board shutters with teak or shisham veneer (outside) and commercial veneer (inside) mounted on Fir or Kail wood frame with Fir wood lipping 3/4" x 1/2" all around shutters, Fir or Kail wood Drawers with 3 mm ply base, 3/4" dia. chromium plated hanging rod, lock, mongery fillings, including 3 coats of approved enamel paint (inside) and spirit polish (outside) including surface preparation and filling complete as per approved shop drawing and quality of hardware as approved by the Engineer.

16.21 CABINET

Kitchen Cabinet shall have a depth of minimum 15 inches and shall be fabricated with 3/4" thick chipboard box all around, 3/4" thick chipboard partitions and 1/8" thick commercial ply at the back of the cabinet. 3/4" thick veneer board shutters with teak or shisham veneer (outside) and commercial veneer (inside) or as directed in BOQ. Including lock, mongery fillings, including 3 coats of approved enamel paint (inside) and spirit polish (outside) including surface preparation and filling complete as per approved shop drawing and quality of hardware as approved by the Engineer.

16.22 MEASUREMENT AND PAYMENT

The measurement of various items of work shall be made as under:-

i. Hollow or Solid Door frame, payment on “each” basis for completed work.

ii. Hollow or Solid Doors, payment per SM for completed work

iii. Wardrobe or Cabinet, payment per SM for completed work.

16.22.1 RATE AND PAYMENT

All wood door, wardrobes and cabinet work shall be paid at the rate as per complete item entered in the Bill of Quantities and all features described in the relevant BOQ item. Such payment shall constitute full compensation for all materials, labour, equipment including all incidentals, necessary to complete the work including iron mongery, push plates, kicking plates, door locks etc.

Pay Item No.	Description	Unit of Measurement
16.22 a	Providing and fixing Dowlly chowkat of 2"x2 1/2" batten on both ends with bracers and kail wood plank of 3/4" thick over it as per width of dowlly chowkat fixed with glue and nails including hold fast, chowkat may be installed during and after masonry	SM
16.22 b	Providing and fixing solid kail wood chowkat of 2" thick batten as per width of wall including hold fast, chowkat may be installed during and after masonry	CM
16.22 c	Providing and fixing solid deodar wood chowkat of 2" thick batten as per width of wall including hold fast, chowkat may be installed during and after masonry	CM
16.22 d	Providing and fixing in position doors consisting of door leaf (single shutter/double shutter), consisting of 1-1/2” thick solid door of first class Deodar wood panels (door size 3.5’x7’) with approved quality hardware i.e door lock, tower/sliding bolts, steel hinges etc. Including one prime coat, complete in all respects	SM
16.22 e	Providing and fixing in position doors consisting of door leaf (single shutter/double shutter), consisting of 1-1/2” thick solid door of first class Kail wood panels (door size 3.5’x7’) with approved quality hardware i.e door lock, tower/sliding bolts, steel hinges etc. Including one prime coat, complete in all respects	SM

16.22 f	Providing and fixing in position doors consisting of door leaf (single shutter/double shutter), consisting of 1-1/2" thick hollow core flush doors mechanically pressed with 1/8" thick commercial ply on both sides of kail wood shutter frame size (door size 3.5'x7'), 3"x1-1/4" and in fill (3" gap) of Kaill wood 1-1/2"x1-1/4", with Kail wood 6"x1-1/4" lock rail, ½" thick wood lipping around shutter, with approved quality hardware i.e door lock, tower/sliding bolts, handle steel hinges etc. Including one prime coat, complete in all respects	SM
16.22 g	Providing and fixing in position doors consisting of door leaf (single shutter/double shutter), consisting of 1-1/2" thick hollow core flush doors mechanically pressed with 1/8" thick teak veneer ply on both sides of kail wood shutter frame size (door size 3.5'x7'), 3"x1-1/4" and in fill (3" gap) of Kail wood 1-1/2"x1-1/4", with Kail wood 6"x1-1/4" lock rail, ½" thick wood lipping around shutter, with approved quality hardware i.e door lock, tower/sliding bolts, handle steel hinges etc. Including one prime coat, complete in all respects	SM
16.22 h	Wardrobes with 22" depth as mentioned in specifications including all hardware complete in all respect	SM
16.22 i	Kitchen cabinet, reception desk etc. with 15" depth as mentioned in specifications including all hardware complete in all respect	SM
16.22 j	Godown/Garage double shutter door with (door size 10'x7') hollow internal frame of kail wood, with covering by GI plain sheet 24 gauge including all hardware as per drawing including locking arrangement	SM
16.22 k	Providing and fixing solid kail wood chowkat of 2" thick batten as per width of wall including hold fast, chowkat may be installed during and after masonry for godown or garages door	CM
16.22 l	Providing and fixing of window or ventilators of two shutters of kail wood 1.5" thick, one for 6mm glass other for wire gauze of 12x24 including necessary hardware, complete in all respect but excluding the cost of wooden or steel chowkat	SM
16.22 m	Wooden truss of chir wood for CGI roofing of cross section of purlin 2"x2", rafter 4"x4", cleat 1.5"x1.5" and king post 4"x4" or design approved by The Engineer incharge, including small iron work at all joints complete in all respect	CM
16.22 n	Providing and fixing in position doors consisting of door leaf (single shutter/double shutter), consisting of 1-1/2" thick partly panelled with first class Kail wood and partly glazed with plain glass of 6mm (door size 3.5'x7') with approved quality hardware i.e door lock, tower/sliding bolts, steel hinges etc. Including one prime coat, complete in all respects	SM
16.22 o	Providing and fixing of curtain rails with double roller, runner, clamps including cost of CP ends	LM
16.22 p	Providing and fixing of first class Kail wood for stair railing of approved design and section in staircases, balcony or parapet with same wood balusters, fixed into stringers, steps or walls having hand railing etc. complete in all respect	LM

16.22 q	Providing and fixing of 6mm clear glass with hardware at position, complete in all respect	SM
16.22 r	Providing and fixing of GI gauze (12x24) of 24 gauge with hardware at position, with doors, windows and ventilator complete in all respect, as directed by the Engineer.	SM
16.22 s	Providing and fixing of Aluminium gauze (14x14) mesh per square inch of 28 gauge with beading of deodar 1.5"x0.5" over frame of door, windows, ventilators complete in all respect, as directed by the Engineer.	SM
16.22 t	Providing and fixing of ridge gola of 24 SWG plain GI sheet of 18" wide of required shape and design with wood both sides and circular batten at crown portion including hardware, complete in all respect	LM
16.22 u	Providing and fixing of PVC wall panelling of required design and colour of 25cm width, 2.9m length, 7mm thickness, fixing in position, including hardware etc. complete in all respect	SM

SECTION 17 PAINTING & POLISHING

17.1 DESCRIPTION

The work covered by this section of Specifications consists of furnishing all labour, painting and polishing equipment, scaffolding, surface preparation, protective covering and materials, including that classified in particular as "Paint" hereinafter; and painting in performing as such, all plastered wall and ceiling surfaces, including soffits, sides of beams, etc. and the painting and polishing of all exposed interior metal work; miscellaneous and ornamental iron, steel and sheet metal and all wood work. Painting includes field painting of exposed bare and covered pipes & ducts (including colour coding), hangers, exposed steel & iron works, and primed metal surfaces of mechanical/plumbing and electrical equipments.

The work under this section shall further conform to the requirements of British Standard Code of Practice BS 6150 "Painting of Building" and all the British Standards relied therein or bearing relevance.

Do not paint pre-finished items, concealed surfaces, finished metal surfaces, operating parts and labels.

17.2 GENERAL

1. Where the word or term Paint and Polish is used or referred to 'as such' throughout the Specifications, it shall be interpreted to mean and include the surface finish treatment consisting of any, all or some of the following items:

   Sealers, primers, fillers, body and final coats, emulsions, varnish, shellac, stain or enamels, as more specifically defined hereinafter as to kind and quality and function for various surfaces and finishes.

2. All paint, polish and accessory material incorporated in or forming a part thereof shall be subject to the Approval and selection for colour, tint, finish etc. by the Engineer. A copy of the printed instruction of the manufacturer shall be supplied to the Engineer. Contractor shall prepare “Mock up” for the Engineer’s approval if so required.

3. The determination of colour or tint of any particular surface, the depth of any colour or tint selected or required shall in no instance be a subject for an additional cost or charge.

4. Painting of wood, except if specified otherwise and for plaster surfaces shall be three (3) coat works in addition to the shop protection coats.

5. All material shall be delivered to the site of work in manufacturer's original unopened containers with manufacturer's label bearing name, type, shade and quality marked thereon. A copy of the printed instruction of the manufacturer shall be supplied to the Engineer. Only approved type of materials shall be used throughout the work and rejected materials shall be removed from the site of work immediately. Mock up shall be prepared by the contractor for selection of shade and quality of workmanship and whole work shall conform to the approved samples.

17.3 MATERIAL REQUIREMENTS

1. The basic materials entering into the compounding and/or manufacture of all paints, varnishes, shellac and other finish treatments shall be of the best grade and quality of their respective kinds for the intended purposes. They shall be the products or formulas of recognized and reputable Manufacturers of known reliability and integrity as approved.

2. All materials shall be delivered in their original unbroken containers or packages and bear the Manufacturer's name, label and brand, and formula and be mixed and applied in accordance with his directions and/or instructions. The mixing of all paint or other covering finish treatments shall be done in the premises when required and as Approved.

3. Paints shall be well-ground, shall not settle badly, cake or thicken in the container, shall be readily broken up with a paddle to a smooth consistency and shall show easy brushing properties. The paint shall be suitable for spraying when thinned with not more than twelve (12) percent by volume of mineral spirits.

4. Paints shall be lime-proof where used on concrete blocks, concrete or plaster.

5. Unless materials of specific brands and makes are indicated in the pay items, or drawings, material of Paintex, ICI and Berger shall be used. Other equal material shall be used only if approved by the Engineer.

17.4 PROTECTIVE PAINTS

1. Unless otherwise specified all exterior and interior ferrous metal except reinforcing steel, bolts, rough hardware and metals with nonferrous coatings shall be given a shop coat of protective paint of Approved quality. Surface to be painted shall be thoroughly cleaned of scale, dirt and rust by the use of steel scrapers, wire brushes and blast or other equally suitable tools or methods. Oil and grease shall be removed with benzene or other suitable solvent. Paint shall be kept well stirred whilst it is being applied.

2. No paint shall be used after it has caked or hardened. Paint shall be well worked into all joints and corners; paint shall not be applied to damp surfaces or when the temperature is below 40 degree F (5 ^{0}C).

3. Coating for Fire Protection shall be applied according to British Standard BS 8202

17.5 SAMPLE AND TEST

Samples of each type of paint and each colour proposed for use shall be submitted for Approval thereof before the material is used. Samples shall consist of one pint (0.568 liter) and three displays of each type and colour of paint applied to the surface, identical to the surface on which paint is to be ultimately applied. In addition to the submission of samples, the contractor shall submit authenticated reports of tests of the materials proposed for use as may be required.

17.6 PREPARATION OF SURFACE AND APPLICATION OF PAINT

17.6.1 General

Hardware, accessories, plates, lighting fixtures and similar items in place shall be removed prior to painting operations or shall be otherwise protected. All surfaces to be painted shall be clean, smooth, dry and free from dust, grit and other objectionable materials. All work shall be done in a workmanlike manner, leaving the finished surfaces free from drips, ridges, waves, laps and brush marks. Except if specified or required, cement water paints shall be applied under dry and dust free conditions and shall not be applied when the temperature is below 40 degree F or when a temperature drop of 20 degree F or more is forecast. All primer and intermediate coats of paint shall be unscrapped and completely integral at the time of application of each succeeding coat. Each coat of paint shall have a slight variation of colour to distinguish it from the preceding coat. Sufficient time shall be allowed between coats to en sure proper drying. Paints shall be thoroughly stirred and kept at a uniform consistency during the application and shall not be timed in

excess of the printed directions of the Manufacturer. Paint containers shall not be opened until required for use. Paint shall preferably be applied by the spray/brush/ roller or as directed. Floors, roofs and other adjacent work shall be properly protected by drop cloths or other coverings.

17.6.2 Concrete and Masonry

Concrete and masonry surfaces to be painted shall be prepared by removing all dirt, dust, oil and grease for good adhesion.

The method of surface preparation may be left to the discretion of the contractor, provided the results are satisfactory and acceptable as required.

Surfaces to be painted with cement water paint, shall be thoroughly dampened with a fine spray of water before application of the paint. The interval between coats of cement-water paint shall not be less than twenty four (24) hours, and the first coat of cement-water paint shall be slightly dampened before application of the second coat. The paint shall be applied with a stiff brush, and thoroughly worked into the surface to seal all pores, cracks and voids. The paint shall be cured by wetting the surface between coats, and at intervals for a period of not less than two (2) days after the application of the finish coat. Nails and similar exposed metal occurring in concrete or masonry surfaces shall be coated with shell or oil paint before the cement water paint is applied. Masonry surface to be painted with oil base paint shall be free from alkali and shall be thoroughly dry before paint is applied.

17.6.3 Metal Work

Shop primed metal work shall be kept clean and free from corrosion following installation. Surfaces shall be retouched prior to finish painting, using the same type of paint as the priming coat.

17.6.4 Plaster Work

Plaster shall be at least two (2) months old (or less if allowed in writing and shall be thoroughly dry, clean, and free from grit, loose plaster, and surface irregularities before paint is applied. Cracks and holes shall be repaired with patching plaster such as plaster of Paris properly keyed to the existing plaster. All plaster surfaces shall be tested for the presence of Alkali, which if present, shall be removed with a solution of Zinc Sulphate mixed in the proportion of 2-1/2 to 3 pounds to a gallon of water. After drying, the precipitate shall be removed by brushing. Plaster patches shall be worked to match the appearance of the adjoining plaster.

17.6.5 Wood Work

Small dry seasoned knots shall be thoroughly cleaned and scraped and shall be given a thin coat of orange shellac varnish before the priming coat is applied. Large, open, unseasoned knots and all beads or streaks of pitch shall be heated by a blowtorch and then scrapped off, or if the pitch is still soft, it shall be removed with mineral or denatured alcohol.

Resulting voids, if any, shall be filled with putty. Nails shall be set. Painting shall proceed only when the wood is satisfactorily dry.

1. Priming

All millwork specified to be painted, shall be primed on all sides in the shop before delivery to the job.

2. Puttying and Glazing

After the priming coat has been applied, nail holes, cracks, and other depressions shall be filled flush with putty, coloured to match the finish coat and sand papered smooth. Putty shall be dry before subsequent painting.

Glazing, rebates and bends in exterior glazed doors shall be given one coat of exterior primer before glazing. All exposed putty shall be painted. A minimum of two subsequent coats of paint shall be applied and the surface finished satisfactory as specified.

17.7 SCHEDULE OF PAINT FINISHES

17.7.1 Chalk/Colour Wash

Three coats of Approved quality shall be applied to all ceilings and other places as directed.

17.7.2 Distemper

Two coats of Approved washable oil bound distemper shall be applied to internal wall or at locations as directed as per Manufacturer's instructions and direction. The distemper shall be of required shade and shall be the product of reputable Manufacturer, subject to the Approval.

17.7.3 Emulsion Paint to Plastered Surfaces

Plastic Emulsion Paint or vinyl Emulsion Paint shall be used as indicated in the Bill of Quantities.

The plastered surfaces required to be painted with emulsion paint shall be painted with ready made Approved paint of the kind. The paint shall be applied in three coats strictly according to Manufacturer's instructions including preparing base coat. The paint may preferably be applied by spray or roller method of application unless permitted otherwise.

17.7.4 Enamel Paint to Plastered Surfaces/Wood Work/Steel Work

The plastered surfaces required to be painted with enamel paint shall be painted with ready-made Approved paint of the kind. The paint shall be applied in three coats strictly according to Manufacturer's instructions including preparing 'base coat'. The painted surface shall finally exhibit a glossy finish as Approved. This will also apply to hard woodwork or wherever required.

17.7.5 White Wash /Colour Wash

Concrete, concrete block and plaster shall be painted with three (3) coats or white/colour wash.

The lime should be slaked at Site with an excess of water to the consistency of paste/cream and should remain under water for forty eight (48) hours. The mixture shall then be strained through coarse cloth and gum water added (having 60 gram gum to one (1) pint of water).

Colour washing shall be prepared as for white wash and colour added. The colouring matter is to be boiled and gum added to it and strained into white wash.

17.7.6 Painting to Wood Work

Wood work required to be painted shall be painted with Approved oil paints as follows:

After surface preparation as specified apply one coat of wood primer.

After wood primer has thoroughly dried, apply two (2) coats of oil paint of Approved manufacturer directly from containers strictly according to the Manufacturer's instructions.

17.7.7 Painting on Metal Work

Except if specified otherwise all metal work shall have, in addition to shop primer coats, one coat of enamel under-coat and one coat of semi gloss (dull) enamel, as well as two coats of anticorrosive red oxide paint.

17.7.8 Cement-Water Paint

Preparation of surfaces: Before the application of the cement water paint, all holes in joints or masonry surfaces shall be filled with mortar and suitably tooled. Caulking installed around wood or metal frames built into masonry, shall be thoroughly checked. Masonry shall be clean and free from dust, dirt, grease or any other material, which might affect the proper adhesion of paint.

Application of cement-water paint: Paint shall be mixed in accordance with the Manufacturer's directions and allowed to stand thirty (30) to forty five (45) minutes. Before application, the paint shall be mixed to uniform consistency and stirred frequently during application. The surface shall be uniformly dampened by spraying several minutes between coats for the moisture to penetrate.

Paint shall be applied with a brush having relatively short, stiff, fiber bristles, scrubbing the paint into the surface voids. The first coat shall be cured by keeping the surface damp for at least twenty four (24) hours; the surface shall be sprayed as soon as the paint has hardened sufficiently to resist injury and the spraying repeated as often as necessary to keep the surface damp before applying the second coat. The second coat shall be applied in such a manner as to completely cover the first coat as specified above, except that curing shall be continued as long as practicable, and for not less than forty (40) hours. Paint shall be applied in shade rather than in bright sun light, especially during warm windy weather. In applying the finish coat an entire wall surface shall be completed in one operation. If this is impracticable, painting shall be carried out to some expedient stopping point.

17.7.9 Interior Painting

Interior painting shall include the finishing of all ferrous metal work, wood work, concrete, concrete block, and plaster. Exposed pipes, pipe coverings, ducts, conduits, panel boxes, and other exposed ferrous metal work, for plumbing and electric work, shall be painted with wall or ceiling surface on or near which they occur, except where such surfaces are painted with resin emulsion paint, in which case the pipes, conduits, etc. shall be finished with three (3) coats of exterior oil paint. Pipe coverings, shall be sized with glue before being painted. Motors and other equipment for plumbing and electric work shall be painted as specified. Galvanized work shall be prepared in an Approved manner before being painted.

Interior wood work shall be finished as specified for exterior wood work except that the varnish shall be an interior varnish instead of a spar varnish. Wherever indicated on the Drawings, interior wood work shall be either painted or polished with sufficient coats of Approved paint or polish. Concrete, concrete block and plaster shall be given three (3) coats of PAINTEX Vinyl Emulsion distemper including primer coat, wherever indicated on the Drawings.

Concrete, concrete block and plaster shall be painted with one coat of primer and two coats (or as specified) of DULUX Paint including finishing coat wherever indicated on the Drawings.

17.7.10 Weather Shield Paint

Weather shield paint shall be of ICI Dulux or approved equivalent and shall be as per manufacturer's specifications. It shall be used on exposed surfaces wherever indicated on the drawings. It is a water thinnable emulsion, pigmented with light fast, alkali resistant non-lead pigments and contains a mould control additive. It is suitable where alkali resistance and exterior durability are the prime requirements. It shall be applied by Brush, roller or conventional spray.

17.7.11 All Rounder Paint

VIP all rounder interior supermatt paint shall be of Berger Robbialac or approved equivalent. It shall be applied by brush, roller or spray Thin where necessary with mineral turpentine. It is re-coatable in 6-8 hours under normal conditions. All-rounder paint shall be applied to surfaces wherever indicated on the drawings.

17.7.12 Texture Paint

The quality of the paint shall be approved by the Engineer. The rate of application and other features of application shall be same as recommended by the manufacturer. It shall be applied over one coat of primer.

17.7.13 Marblex Paint

Marblex is composed of special acrylic binders in aqueous solution, inorganic pigments, fine fillers, additives and specific bactericides. The quality of the paint shall be approved by the Engineer. The rate of application and other features of application shall be same as recommended by the manufacturer. It shall be applied over two coats of primer. Marblex paint shall be applied in two or more coats. It shall be ensured that during the application and in the following 24 hours the temperature shall not fall below + 5 °C and the relative humidity shall not exceed 80%.

17.7.14 Deco Paint

The quality of the paint shall be approved by the Engineer. The rate of application and other features of application shall be same as recommended by the manufacturer. Deco paint shall be applied over two coats of deco paint grey primer. For matt finish 2 coats of lacquer shall be applied, while for gloss finish 4 costs of lacquer shall be applied over deco paint.

17.7.15 Aluminium Paint

The quality of the paint shall be approved by the Engineer. This is a one component styrene modified oxidative drying alkyd coating. It must be heat resistant up to 250 ℃. It may be used as an exterior aluminium finish usually within an alkyd system. It may be used as primer, mid coat or finish coat in atmospheric environments. Suitable for properly prepared carbon steel and aluminium substrates.

Film thickness per coat;

Typical recommended specification range

Dry film thickness	20- 30 µm
Wet film thickness	45- 65 µm
Theoretical spreading rate	22.5 - 15 m²/l

Other features of application shall be same as recommended by the manufacturer.

17.7.16 Special Paints, Coating and Finishes

Where special paints, coatings and finishes like those for chemical (acids, alkalis etc) resistance are required to be applied, these shall be applied as per printed instructions of the manufacturer's as described in the relevant pay items in the Bill of Quantities including preparation and cleaning of surfaces.

17.8 BURIED PIPING

All steel piping and all exposed threads of galvanized piping, where run in or through concrete or masonry, or buried under ground, shall be given one (1) coat of Approved asphalt varnish where specified.

17.9 SAMPLES

Prior to the start of the application of any paint and/or finish treatment otherwise, the contractor shall apply samples of the required finish treatments to specific representative wall and ceiling surfaces or other areas or surfaces where indicated. The sizes of the sample paint finishes shall be as specified.

17.10 PROTECTION

Contractor shall protect all the work against damage or injury by his employees, or by the materials tools or untensils used in connection with the work of this contract. Any and all work damaged as a result of the execution of this contract shall be repaired at the contractor's expense, or if it cannot be properly repaired it shall be replaced with new work by the contractor without additional compensation beyond the contract amount. At all times, the general and liberal use of drop cloths shall be a primary requirement for protection purposes.

17.11 TOUCHING-UP

At the completion of all Work specified herein all painted work shall be touched up and restored where damaged or defaced and the entire Work left free from blemishes.

17.12 CLEANING

The contractor shall clean all paint, spots, daubs, oil and stains, entirely from all floors, woodwork, glass, hardware, metal work and all similar items upon completion and level the work in perfectly clean condition in every respect.

All cloth and cotton waste, which might constitute a fire hazard shall be placed in metal containers or destroyed at the end of each workday. Upon completion of all work all staging, scaffolding, and containers shall be removed from the Site or destroyed in a satisfactory manner.

17.13 MEASUREMENT AND PAYMENT

The painting and finishing on all surfaces, other than timber and steel works, which shall be deemed to be inclusive of painting and finishing in their own items of work, shall be measured and paid for at the unit rates entered in the Bill of Quantities. Where separate quantities for paintwork are not shown in the Bill of Quantities, they shall be taken to have been already included in the rate of items to be finished and painted.

17.13.1 RATE AND PAYMENT

The payment shall be made at the unit rates as stated in the Bill of Quantities. Such payment shall constitute full compensation for all materials, equipment, labour scaffolding including all incidentals, necessary to complete the work.

Pay Item No.	Description	Unit of Measurement
17.13 a	Application of two coats of approved quality of paint over properly prepared surface of concrete, masonry or plaster up to 12ft (3.65m) height, complete in all respects	
	i. White wash/colour wash	SM
	ii. Water bound distemper	SM
	iii. Oil bound distemper	SM
	iv. Emulsion paint	SM
	v. Enamel paint	SM
	vi. Black japan paint	SM
	vii. Black bitumen paint	SM
	viii. Anticorrosive paint	SM
	ix. Acid/Alkali resistant paint	SM
17.13 b	Application of two coats of approved quality enamel paint over properly prepared wood surface up to 12ft (3.65m) height, complete in all respect	SM
17.13 c	Application of two coats of approved quality of enamel paint over properly prepared shop primed metal surfaces up to 12ft (3.65m) height, complete in all respect	SM
17.13 d	Application of two coats of approved quality aluminium paint over sand papered and cleaned surface of metal pipe after application of one coat of primer complete in all respect	
	i. Pipe ½" size	LM
	ii. Pipe ¾" size	LM
	iii. Pipe 1" size	LM
	iv. Pipe 1.5" size	LM
	v. Pipe 2" size	LM
	vi. Pipe 2.5" size	LM
	vii. Pipe 3" size	LM
	viii. Pipe 4" size	LM
	ix. Pipe 5" size	LM
	x. Pipe 6" size	LM
17.13 e	Application of two coats of approved quality weather shield paint over properly prepared plaster surface up to 12ft (3.65m) height, complete in all respect	SM
17.13 f	Application of two coats of hot bitumen grade 10/20, over dried concrete or plastered surface to act as vapour barrier up to 12ft (3.65m) height	SM
17.13 g	Application of two coats of snowcem or equivalent over properly prepared external surface up to 12ft (3.65m) height	SM
17.13 h	Application of bee wax-polish over doors, frames and any wood work after preparation of surface as described in specifications up to 12ft (3.65m) height	SM
17.13 i	Application of spirit-polish over doors, frames and any wood work after preparation of surface as described in specifications up to 12ft (3.65m) height	SM
17.13 j	Application of copal varnish polish over doors, frames and any wood work after preparation of surface as described in specifications up to 12ft (3.65m) height	SM
17.13 k	Application of synthetic clear varnish polish over doors, frames and any wood work after preparation of surface as described in specifications up to 12ft (3.65m) height	SM

17.13 l	Application of one coat of approved quality of primer over surface of concrete, masonry or plaster up to 12ft (3.65m) height. Including puttying where required after sand papering and dusting, complete in all respects	SM
17.13 m	Application of one coat of approved quality of primer coat with preservative over wood surface up to 12ft (3.65m) height, complete in all respect	SM
17.13 n	Application of one coat of approved quality of red oxide primer over shop primed metal surfaces up to 12ft (3.65m) height, complete in all respect	SM
17.13 o	Application of lacquer (mate/clear) polish over doors, frames and any wood work single coat, after preparation of surface as per instructions of manufacturer and directed by the Engineer in charge up to 12ft (3.65m) height	SM

SECTION 18 ALUMINIUM DOOR, WINDOWS AND MISC. WORKS

18.1 DESCRIPTION

The work covered under this section comprises of the following:

1. Fixing in position Aluminium doors, windows and curtain walls etc. complete with top /bottom hinges, handles, locks, nylon wheels, vinyl weather strips etc. as shown on the drawings and specified hereunder.

2. Fixing glass of specified quality and thickness to windows and doors, including all fillers or fasteners.

18.2 GENERAL COMPLIANCE

1. Design Requirements

All doors, windows, railings, Handrails, etc. to comply with BS 4873 “Aluminium alloy windows” or equivalent in respect of materials, work sizes and manufacture. All sectional dimensions shown on drawings are only indicative. The contractor, shall be responsible to determine the adequacy of these with respect to actual structural and performance requirements. All extrusions shall be of adequate strength, not only to meet the structural performance, but also to minimize the risk of distortion in the finished surfaces.

2. Work Sizes

“All dimensions given on drawings are between structural openings and/or between finished surface and allowances shall be made for variation due to constructional tolerances. The contractor, shall be responsible to measure actual final dimensions from the Site before fabrication of doors, windows and other assemblies/units.

3. Weather Tightness

Weather tightness and operations shall suit the weather conditions prevailing in the area of installation. All doors and windows will be fabricated as completely air and water tight units including gaskets for glazing, weather stripping, latches, locks, bolts for fixing etc.

4. Air Tightness

The fixed glazed windows shall be as far as possible reasonably air tight under all weather conditions.

5. Acoustic Performance

Windows when installed shall provide an average sound reduction of 28 dB.

18.3 MATERIAL REQUIREMENTS

Aluminium Sections

All aluminum sections shall be extruded Aluminum Alloy 6063 T-5 or T-6, conforming to International Standard for alloy quality and extrusion, Temper T-5 or T-6 as specified. Some of the properties of these alloys are as follows:

Property	T-5 Alloy	T-6 Alloy
Aluminium	max. 97.5%	max. 97.5%
Magnesium	0.45-0.9%	0.45-0.9%
Silicon	0.2-0.6%	0.2-0.6%
Iron	max. 0.35%	max. 0.35%
Copper	max. 0.1%	max. 0.1%
Zinc	max. 0.1%	max. 0.1%
Ultimate Tensile Strength	27,000 psi (186 MPa)	35,000 psi (241 MPa)
Yield Tensile Strength	21,000 psi (145 MPa)	31,000 psi (214 MPa)
Hardness, Brinell (500Kg load, 10mm ball)	60	73
Elongation (In 5cm sample 1.6mm thick)	12%	12%
Fatigue Strength (500 million cycles)	10,000 psi (68.9 MPa)	10,000 psi (68.9 MPa)
Electrical Resistivity at 68 ^{0}F	$3.16x10^{-6}$ Ohm-cm	$3.32x10^{-6}$ Ohm-cm

Wall thickness of frames shall be minimum 2.5 mm for curtain wall, 2 mm for Doors & 1.6 mm for Windows and Ventilators, unless otherwise specified in BOQ and drawings.

Provide Aluminium systems capable of withstanding loads and thermal and structural movement requirements indicated without failure, based on testing manufacturer's standard units. Failure includes the following:

a) Air infiltration and water penetration exceeding specified limits.

b) Framing members transferring stresses, including those caused by thermal and structural movement to glazing units.

All aluminium doors and windows as shown on the drawings shall be fabricated with heavy duty high strength aluminium extruded sections of aluminium alloy 6063-T5 or T-6 conforming to BS EN 573 "Aluminium and aluminium alloys, Chemical composition and form of wrought products" or ASTM B-221 "Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes". Aluminium extrusions shall be hard colour anodized in specified colour, with an average anodic film. The anodic treatment shall conform to AAMA 611 (Class-1) Specifications, or B.S. 3987 "Specification for anodic oxidation coatings on wrought aluminium for external architectural applications". Anodization shall not be less than average 25 microns thickness, or as specified in the BOQ. Average thickness shall be calculated by taking average of at least five readings for a section length, with a tolerance of (-)10% of specified thickness for individual readings. Hence, for a specified average thickness of 25 microns, no individual reading shall be less than 22.5 microns.

Aluminium sections for slidable / openable segments, fixed segments and frame shall be as approved by the Engineer. Tolerance in aluminium section wall thickness shall be ±10% of specified wall thickness. All other tolerances shall be as specified in EN 12020-2.

Bolts and Nuts shall conform to BS 4190 “Black hexagon bolts, screws and nuts. Specifications”. Bolts shall be oil protected on the threaded parts.

Washers shall conform to BS 4320 “Specification for metal washers for general engineering purposes”.

Glass of required thickness shall conform to BS 952-1 “Glass for glazing. Classification” and shall perfectly flat or parallel surfaces, free from distortion specks bubbles and flaws of every kind. Glass shall be of Safety Glass (SG) quality.

Clear glass shall also be free from tints and shall transmit 85% of the diffused light falling on it.

Tinted glass shall be of approved colour and shade.

The quality, kind, thickness and size of the glass shall be as shown on the drawings or called for in the Bill of Quantities.

Wire gauze shall be 24 AWG, 12x12 meshes per square inch, for open able panels of doors and windows.

Glazing bead and detail shall be as shown in drawings.

Hardware Iron-mongery and Fixtures Iron mongery, fittings, handles and locks shall be of bronze, stainless steel and aluminium as shown on the drawings or as stated in the Bill of Quantities. Where specific makes or type are not given, these shall be of best quality available in the market and as approved by the Engineer.

Structural Silicon-Sealant Joints Provide systems with structural silicon-sealant joints complying with ASTM C1184 “Standard Specification for Structural Silicon Sealants” and the following requirements.

a) Structural sealant withstands tensile & shear stresses imposed by the system without failing adhesively or cohesively. When tested for adhesive compatibility with each substrate and condition required, provide sealant that fails cohesively before it fails adhesively. Adhesive and cohesive failure are defined as follows:

   i. Adhesive failure occurs when sealant pulls away from a substrate cleanly, leaving no sealant material behind.

   ii. Cohesive failure occurs when sealant breaks or tears within a joint but does not separate form each substrate because sealant to substrate bond strength exceeds sealant’s internal strength.

b) Colour: As selected by the Engineer form the full range of colours.

c) Provide sealant with modules of elasticity that will not allow movement of more than 25 percent of joint width, unless less movement is required by structural-sealant glazed system design.

Weather Stripping:

All opening section must be weather stripped with Neoprene glazing gaskets or similar approved and polypropylene pile weather stripping around doors to ensure adequate weatherproofing. Aluminium glazing beads are to snap on type without visible fixing and must be adjustable to allow for varying thickness of glass. No PVC weather stripping is acceptable.

Thermally Broken Construction Provide systems that isolate Metal exposed to exterior from Metal exposed to interior with a material of low thermal conduction.

Wind Loads Provide systems including anchorage, capable of withstanding wind load design pressure calculated according to requirements of authorities having jurisdiction or the "American Society of Civil Engineers". Minimum Design Loads for Buildings and other Structures, whichever are more stringent but not less than 120 km/hr.

a) Deflection of framing members in direction normal to wall plane is limited to 1/175 of clean span or 3/4 inch, whichever is smaller unless otherwise indicated.

b) Static-Pressure Test Performance: Provide system that does not evidence material failures, structural distress, failure of operating components to function normally, or permanent deformation of main framing members exceeding 0.2 percent of clear span when tested according to ASTM E330 “Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference”.

   i. **Test pressure** 150 percent of inward and outward wind load design pressure.

   ii. **Duration** As required by design wind load velocity, fastest 1 mile of wind for relevant exposure category.

Hurricane Resistance Test Performance Provide systems that pass large and small missile-impact tests, as required by systems location above grade, and cyclic pressure Tests according to following testing requirements:

ASTM E1233 Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Cyclic Air Pressure Differential.

ASTM E1886 Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

ASTM E1996 Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Windborne Debris in Hurricanes

Seismic Loads Provide systems, including anchorage capable of withstanding the effects of earthquake motions calculated according to requirements or “Min Design Loads for Buildings and Other Structures"

Dead Loads Provide system members that do not deflect an amount which will reduce glazing line below 75 percent of design dimensions when carrying full dead load.

a) Provide a min 1/8 inch clearance between members below and top of glazing or other fixed part immediately.

b) Provide a min 1/16 inch clearance between members and open able windows and doors.

Live Loads Provide systems including anchorage, that accommodate the supporting structure’s deflection from uniformly distributed and concentrated live loads indicated, without failure of material or permanent deformation.

Air Infiltration Provide system with permanent resistant to air leakage through fixed glazing and frame areas of not more than 0.06 Cfm/sft (1.09 $m^3/h\ m^2$) of fixed wall area when tested according to ASTM E283 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen” at a static air pressure difference of 1.57 psf (75 Pa).

Water Penetration Provide system that do not evidence water leakage through fixed glazing and frame areas when tested according to ASTM E331 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference” at min differential pressure of 20 percent of inward-acting design pressure but not less than 6.24psf.

Water leakage is defined as follows

Uncontrolled water infiltrating systems or appearing in systems normally exposed, and interior surfaces, from sources other than condensation. Water controlled by flashings and gutters that are drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.

Thermal Movements Provide system that accommodates structural movements including, but not limited to sway and deflections.

Condensation Resistance Provide systems with condensation resistance factor (CRE) of not less than 45 when tested according to AAMA 1503.1.

Average Thermal Conductance Provide system with average U-values of not more than 0.63 Btu/sq.ft x h x degree F when tested according to AAMA 1503.1.

Field Measurements Verify dimension by field measurements before fabrication. Co-ordinate fabrication schedule with construction progress to avoid delaying the works.

Glazing Gaskets Manufacturer’s standard press-glazing system of black, resilient glazing gaskets, setting to block and shims or spacers from an elastrometer of type and in hardness recommended by system and gasket manufacturer to comply with system performance requirements. Provide gasket assemblies that have corner sealed with sealant recommended by the gasket manufacturer.

Spacers, Setting blocks, Gaskets, and Bond Breakers

Manufacturing standard permanent, non-migrating types in hardness recommended by manufacturer, compatible with sealants and suitable for system performance requirement.

Secondary Sealant For use as weather seal, compatible with structural silicone sealant and other system components with which it comes in contact, and that accommodates a 50 percent increase or decrease in joint width at the time of application, when measured according to ASTM C719 “Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)”.

Miscellaneous Items

Framing system gaskets, sealants, and joint fillers as recommended by manufacturer for joint type.

PVC weather strip shall be used to render joints between the wall and outer frame, and between the moving panel frame and the receiving limb of the fixed frame etc.

Frame sections shall be joined by appropriate manufacturer's standard details.

Special nylon rollers for friction free operation of sliding windows shall be provided.

Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading and impact load (where applicable), without failure including loss or glass breakage attributed to the following:

Manufacturer, fabrication and installation, failure of sealants or gaskets to remain water tight & air tight; deterioration of glazing materials; & other defects in construction.

Door leaf shall be removable from the inner side of the frame for ease of maintenance and cleaning.

Aluminum Louvers shall conform to the construction details shown in drawings but anodic film shall conform to that for aluminum windows.

18.4 SAMPLES

1. The Contractor shall submit, for approval, samples of each type of door and window showing the quality of materials, workmanship and finish. The samples of iron mongery, fittings and fixtures shall also be got approved before purchases are made by the Contractor.

2. The samples of glass for each type of glazing alongwith specifications of the manufacturer of special quality shall be submitted for approval before firm orders are placed for supplies.

18.5 CONSTRUCTION REQUIREMENTS

The aluminium doors and windows shall be manufactured by an approved manufacturer in this trade. They shall be fabricated as complete unit, fully airtight and watertight including rubber gasket for glazing and necessary holes for fixing.

If required, the Contractor shall provide shop drawings based on Architectural drawings for the approval before orders are placed with the manufacturers.

The manufacturer shall use the latest and approved method of jointing employed in the manufacture of high class work viz. mechanical jointing, reinforced with concealed welding shall be used in the manufacture of doors and windows.

a) FIXING

The fixing of doors and windows to concrete openings shall be carried out in an approved method as indicated in the drawings or as directed. Provision of necessary groove or rebate and holdfasts in the concrete shall be made in the formwork and no holing or drilling shall be allowed in the exposed concrete finishes. These shall be erected in position after the building structure is completed and by using proper holdfasts as shown on drawings or counter sunk bolts and screws as directed in accordance with site requirements.

b) HANDLING

Care shall be taken in handling metal doors, windows, etc., during transportation and site. These shall be stored under cover and shall be installed only by skilled mechanics, set plumb, level, in alignment and properly braced to prevent distoration.

Protection

a) The joint between window and doorframes and the building should be caulked with approved building mastic for total weatherproofing.

b) After installation, doors, and windows shall be protected from construction hazards that will interfere with their operation or damage their appearance or finish. They shall be cleaned on inside and outside of all mortar, plaster, paint of other foreign matter to present a neat appearance. Hardware and moving parts shall be lubricated.

18.6 GLAZING

The work of fixing glazing to doors, windows shall be carried out with the type and quality of glass specified for each door and window and as indicated in the drawings or as directed.

The glazing of glass should be in accordance with the recommendations of BS 6262 “Code of practice for glazing for buildings.”

The sizes of glass indicated on the drawings are approximate only, and the actual sizes required shall be determined by measuring the frames to receive the glass. All glass shall be factory labelled on each pane and the label shall not be removed until finally approved. Glass will be fixed with best quality mastic compound of approved make suitable for the type of glass or with special bead or moulding as shown on the drawing or as directed. Special rubber lining and weather proof brush joints for sliding surfaces shall be provided where indicated.

Glass shall be fixed using flexible compounds, sealents, preformed strips or gaskets as per recommendation of the door/window manufacturer. The design shall allow for an edge clearance of at least 3mm (1/8") all around unless any dimension exceeds 1500mm (60") when the clearance shall be at least 5mm (3/16") edge cover shall be adequate to retain the glass in position under the design wind loading. The rebate depth edge clearance plus edge cover shall not be less than 11mm (7/16") for 6mm glass. The width of the rebate platform must accommodate the glass, the front and back compound, and glazing bead. The bead depth should not be less than the rebate depth. Setting blocks, distance pieces, and location blocks shall be used as appropriate.

Glass shall be protected against damage. After inspection, any labels, and paint spots shall be removed and glass shall be washed clean. Damages or broken glass shall be removed and replaced before acceptance at no extra expense. After the installation of glass it shall be cleaned using a soft cloth with water and mild soap or liquid detergent, followed by rinsing with clean water and drying.

18.7 ALUMINUM DOORS

Aluminium doors shall be open able / Luster Gold / Brown / Silver or any other approved shade anodized/powder quoted, of heavy duty deluxe size section of 120 x 64 x 2.5 mm wall thickness extruded by 6063-T-5 Alloy, having 25 micron anodic film thickness manufactured by the approved manufacturer, glazed with 6 mm thick distortion free tempered plain imported glass of best approved quality complete using all required approved accessories viz. door locks, door handles, floor hinges for doors, gasket for glass fixing, sealant, synthetic rubber for doors, screws and rowel plugs for fixing etc. of the best approved quality complete in all respects as shown in drawings and specifications and approval of the Engineer. (Shop drawing to be got approved by the Engineer before starting fabrication work). Door corners shall be able to withstand a minimum of 14 MPa (2000 psi) tension without noticeable deformation. Welded corners without structural assembly shall not be permitted.

18.8 ALUMINUM CURTAIN WALLS

Aluminium Curtain Wall shall be of Luster gold / brown / silver or any other approved shade anodized/powder quoted (as approved by the Engineer) Heavy Duty Deluxe Size Section of 120 mm x 64 mm x 2.5 mm (Wall Thickness), extruded by 6063-T-5-Alloy having 25 micron anodic film thickness manufactured by the approved manufacturer, glazed with 12 mm thick distortion free tempered plain imported glass of best approved quality to be installed / fixed with Galvanized Steel Brackets, steel clamps, steel bracings (as per approved shop drawings requirement) of at least 6 mm thickness fixed at slab, sill, and head to tie up Curtain Wall Section with specialized Hilti/Fischer bolts of 50 mm length 12 mm dia. (or as specified by the

manufacturer) with galvanized steel washers of 5 mm thickness complete with all required accessories viz. Gasket for Glass fixing,

Sealant for covering gaps and for rain protection and screws etc. complete in all respects as shown in the approved shop drawings and specifications. (Shop drawings and calculations catering for dead load, live load, hurricane resistance performance, seismic load, air infiltration, water penetration, movements and structural support movements etc. to be submitted for approval of the Engineer before start of the fabrication work).

18.9 ALUMINUM PANELS

Panels shall be exterior grade, 4mm thick composed of a low density Polyethylene Core sandwiched between two sheets of Aluminum of 0.5mm thickness. The outer top skin shall be coated with either PVDF KYNAR 500 (more than 70% PVDF resin) or Fluoropolymer coating. Paint approved suppliers shall be Akzo Nobel, Australia, Monopol Switzerland and P.P.G, U.S.A. There shall be a protective coating on the back skin. Aluminium Panels shall comply with the following performance standards.

Sr.	Properties	Result	Test
1	Tensile Strength	5408psi (37.3Mpa)	ASTM D638
2	Yield Strength	3737psi (25.8 Mpa)	ASTM D639
3	Elongation	6.10%	ASTM D638
4	Flexural Elastcity	4060Kg/mm^2	ASTM E393
5	Thermal Expansion Co-efficient	2.02 x 10^{-5} mm/mm ^{O}c 1.12 x 10^{-5}in/in^{O}F	ASTM D696
6	Apparent Thermal Conductivity	32.9w/m^{2o}K as per ASTM C518	ASTM D976
7	Deflection Temperature	211^{o}C	ASTM D648
8	Color Retention	Max. Rating of 5 unites after 4000 Hrs	ASTM D2244-89
9	Gloss Retention	70% after 4000Hrs	ASTM D523-89
10	Chalk Resistance	Max. Rating of 8 unites after 4000 Hrs	ASTM D4214-89
11	Pencil hardness	2H	ASTM D3363-92
12	Yield Strength of the Aluminium	17 ksi	ASTM E8
13	Flexural Elastcity of the Aluminium Skin	7000/kg/mm^2	ASTM C393
14	Sound Transmission Class	25Db	ASTM E413

Deviation Tolerances:
Thickness: 0.2mm
Width: 2.0mm
Length: 3.0mm
Diagonal < 3.0mm (length 2500mm) < 5.0mm (length 2500mm)
Side straightness: < 0.5% of the length

18.10 MEASUREMENT AND PAYMENT

The measurement for doors, windows, ventilators, curtain walls and Aluminium Panels shall be made in Sq. Ft. / M. from sill to bottom of lintel after plastering and Jam to Jam.

18.10.1 RATE AND PAYMENT

Rates for all the items under this Section shall cover the cost of furnishing all the materials labour, scaffoldings and appliances at Site and performing all operations in

connection with their installation in accordance with instructions. It is particularly mentioned that the rates for fixing doors and windows etc. shall include fixing of all finished hardware iron mongery fittings, such as locks, peg stays, handles, push plates, kicking plates, door closers, glazing, flexible compounds, rubber lining and appliances at site and performing all operations in accordance with the drawings and BOQ.

Pay Item No.	Description	Unit of Measurement
18.10 a	Providing and fixing aluminium Doors, windows and ventilators (fixed or sliding) with sheet thickness of 2 mm powder coated with 60-70 micron thick, partly glazed and partly gauzed hinged/ sliding including all hardware except glazing as per sizes shown in the drawing making good damages to wall etc.	SM
18.10 b	Providing and fixing aluminium curtain walls and panels using wall thickness of 2.5mm powder coated with 60-70 micron thick including all hardware and glazing (12mm thick clear glass) as per sizes shown in the drawing complete in all respect	SM
18.10 c	Providing and fixing glazing of doors, windows and ventilators as size shown on the drawings with 6mm thickness clear glass including all packing for joint filling work with neoprene, PVC or silicon joints complete in all respect	SM

SECTION 19 STEEL DOORS, WINDOWS AND MISC. WORKS

19.1 DESCRIPTION

Providing making and fixing steel doors, windows and ventilators single or double leaf, single shutter or double shutter, fully panelled or partly panelled including frame and providing and fixing of wire gauze, glazing, all mongery fittings or fixtures if required and shown on drawings or as directed by Engineer and conforming to British Standard BS 6510 “Steel-framed windows and glazed doors” and other referenced standards therein.

19.2 MATERIAL REQUIREMENTS

In addition to British Standard BS 6510 and its referenced standards, material shall comply with the following, as well as the drawings and as directed by the Engineer:

Structural Steel (channels, angles, flats, bars, plates of rolled sections) shall conform to including BS 7668 “Weld able structural steels. Hot finished structural hollow sections in weather resistant steels. Specification”, or Cold rolled into various profiles, are also included as Structural Steel.

Steel Sections for casement doors and windows and railing pipes shall be hot rolled low carbon steel on piece section with flanges rolled integrally flanges forming the weathering contacts at both inside and outside points of closure.

Galvanizing shall be hot dip as per ASTM A123 “Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products” or BS EN ISO 1461 “Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods”. Steel shall be further treated, if required, in Zinc Phosphate solution as a second shield against rust.

Powder Coating Steel shall be powder coated (if mentioned in BOQ) with Electric Static Powder coating polyester façade paint of 60-70 micron thickness U.V. resistant to prevent fading.

Bolts and Nuts shall conform to BS 4190 “Black hexagon bolts, screws and nuts. Specification”. Bolts shall be oil protected on the threaded parts.

Washers shall conform to BS 4320 “Specification for metal washers for general engineering purposes”.

M.S. Hold Fasts and Lugs shall be of approved size with split end for embedding.

Steel Pipes shall be black steel pipes medium quality conforming to BS EN 10255 “Non-alloy steel tubes suitable for welding and threading”.

Glass shall conform to BS 952-1 “Glass for glazing. Classification” and shall have perfectly flat or parallel surfaces, free from distortion specks bubbles and flaws of every kind.

Clear glass shall also be free from tints and shall transmit 85% of the diffused light falling on it. Glass shall be of Tempered Safety Glass (SG) quality.

Wire gauze shall be 22 AWG, 12x12 meshes per square inch, for open able panels of doors and windows.

Glazing bead. Glazing beads, or stops as they are sometimes called, shall be removable strips that allow the glass to be held in place, and shall also be

removable if the glass needs to be replaced. Glazing bead may be made from extruded aluminum to allow a better fit, and offer more different shapes.

Hardware Iron-mongery and Fixtures shall be of quantity and of specific types and makes as listed in Hardware schedules/drawings. Where specific makes or type are not given, these shall be of best quality available in the market and as approved by the Engineer.

Miscellaneous Items (Designer Choice) Framing system gaskets, sealants, and joint fillers as recommended by manufacturer for joint type, shall be used.

PVC weather strip shall be used to render joints between the wall and outer frame, and between the moving panel frame and the receiving limb of the fixed frame etc.

Frame sections shall be joined by appropriate steel rivets or to manufacturer's standard details.

Special nylon rollers for friction free operation of sliding windows shall be provided.

Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading and impact load (where applicable), without failure including loss or glass breakage attributed to the following:

Manufacturer, fabrication and installation, failure of sealants or gaskets to remain water tight & air tight; deterioration of glazing materials; & other defects in construction.

Door leaf shall be removable from the inner side of the frame for ease of maintenance and cleaning.

Steel Doors and windows shall conform to the construction details and shop drawings as approved by the Engineer. The door outer frame shall be 1.2mm thick and will have suitable PVC gasket for air tightness. Door leaf shall be of G.I. sheet (0.6mm thickness) filled with medium density polystyrene. Thickness of leaf shall be 38 mm.

Rolling Shutter shall conform to the construction details and shop drawings as approved by the Engineer.

Razor Wire: Razor wire shall be made from galvanized or stainless steel with following dimensions or shown in the drawings and approved by the Engineer:

- Surface: Hot Dipped Galvanized / Stainless Steel
- Wire diameter: 2.5 mm.
- Razor thickness: 0.5.
- Razor length: 12 mm - 65 mm.
- Razor width: 15 mm - 32 mm.
- Razor spacing: 26 mm - 100 mm.

Barbed Wire: Barbed wire shall be made from galvanized steel with following dimensions or shown in the drawings and approved by the Engineer:

- Surface: Hot Dipped Galvanized.
- Twist wire diameter: 4 mm.
- Round barb wire diameter: 2 mm.
- Space between barbs: 7 cm.
- Barb length: 12 mm with 4 heads.
- Roll length: 100 meter.

19.3 CONSTRUCTION REQUIREMENTS

Samples of all materials shall be submitted by the contractor for testing at contractor's cost, where so required by the Engineer and for approval. Only approved type of material shall be used throughout the works and rejected materials shall be removed from the site of works immediately. Shop drawings shall be furnished by the contractor to the Engineer for his approval along with detailed calculations for curtain wall and other relevant items as desired by the Engineer before starting fabrication.

All work shall be shop fabricated of required sizes and profiles, true to shapes. Fabricated and fitted accurately with hairline joints at corners, surface free of wrap, wave, buckle and other defects. Welds shall be best grade commercial work with all exposed beads ground smooth.

All units shall be erected plumb and true and shall be braced where necessary to avoid distortion.

19.3.1 Cutting & Forming

All members shall be so cut and formed that they can be accurately assembled without being unduly cracked strained or forced into position.

19.3.2 Jointing

The jointing of different parts of the members of mild steel shall be carried out by welding process with the help of electric/hydroxy flame. Welding points shall be made quite smooth by filing them and shall conform to the width stipulated in the relevant drawings.

19.3.3 Fittings Fixtures Etc.

All mongery fittings fixtures shall be of approved quality and shall be fixed as per standard practice or as per drawings. All the welding points shall be smoothened by filling and the heads of bolts sunken in the frame.

19.3.4 Fixing

All the frames of windows shall be fixed at site with the hold fasts of specified size and number and as shown on drawings.

All finished members must be free from twists bends or open joints and shall strictly be in accordance with drawings.

19.4 PRECAUTION/ PROTECTION

Unless otherwise permitted in writing or if shown otherwise on drawings the steel windows shall be placed in position before the work reaches the sill level so that they can be built in as brick work as masonry proceeds. The Contractor shall take care to protect the work from any damage of whatsoever nature during the construction period. In case of any such damage done to the work the Contractor shall remove replace or rectify such work at his own cost.

Unless galvanized or powder coated steel is used, the doors and windows shall be painted with primary coat of red oxide and three coats of synthetic enamel paint of approved make. No extra payment shall be made for such work.

19.5 LOUVERED DOORS

Louvered double leaf doors shall be of 8 SWG M.S. with 16 gauge M.S. Box (tube) sections including rough and finish hardware as shown in hardware schedule or as

directed by Engineer, one coat of red oxide paint and 3 coats of enamel paint of approved make or approved equivalent, embedded lugs/holdfasts embedded in concrete 1:2:4, locking arrangement complete as per approved shop drawings.

19.6 ROLLING SHUTTERS

M.S sheet rolling shutter shall be of 20 SWG, consisting of steel frame of M.S. channel 2" x 1-¼" x 1/8", angle iron, 1-½" x1-½" x 3/16" M.S. flat 1" x 1/8", G.I. pipe 1-½" dia. spring 2 c/c rollers, 20 SWG G.I. covering 12" x 12", handles, holdfasts embedded in concrete 1:2:4, locking arrangements etc. including one coat of red oxide paint and three coats of matt enamel paint of ICI/Berger or approved equivalent to all surface (inside/outside) as per shop drawings, as approved by the Engineer.

19.7 DOOR FRAMES

M.S. Frames shall be of 16 SWG installed in position pressed with PCC 1:4:8, including hold fasts, embedded in concrete 1:2:4, hinges, one coat of red oxide, 3 coats of enamel paint of best approved quality & shade, Deodar wood architraves of approved design & size, polishing, fixing complete in all respect as per drawing & as per instructions of the Engineer.

19.8 MEASUREMENT AND PAYMENT

The measurement for doors, windows, curtain walls or shutters shall be made in SM from sill to bottom of lintel after plastering and Jam to Jam, for any item fabricated and installed as per drawings or as directed by Engineer. Door/ Window frames shall be included in measurement and payment.

19.8.1 RATE AND PAYMENT

The payment shall be made at the unit rates per SM as stated in the Bill of Quantities. Such payment shall constitute full compensation for all materials, equipment, and labour including all incidentals, necessary to complete the work. The rate quoted shall deem to be inclusive of frames, glazing, painting, fly proofing, iron mongery, outside security grill for windows (wherever mentioned in BOQ) and other hardware etc. No extra payment shall be made for such work.

Pay Item No.	Description	Unit of Measurement
19.8 a	Providing and fixing molded steel door with frame of approved profile, manufactured from zinc-coated mild steel sheets 16 gauge, thickness 2" (50mm), made of standards conforming to BSS 1245, treated with special primer base paint all round, fitted with six fixing lugs, three steel hinges for fixing door shutters standard lock-strike plate, one sliding bolt/eye, and three rubber buffers, including cutting holes and making good damages to walls and filling the door frame cavity as directed by the Engineer	SM
19.8 b	Providing & fixing steel windows/ sky lights with 50% open able glazed panels using beam section for frame 1.5"x1"x5/8"x1/8" z-section for leave 3/4"x1"x3/4"x1/8" T-section sashes 1"x1"x1/8" 5mm thick glass panes, wooden strip and screws for glazing embedded over a thin layer of putty dully screwed with leave with fittings of locking arrangement of approved make including cost of primer, hold fast, fabrication, cutting holes, as per approved design/ drawings	SM

19.8 c	Providing and fixing of steel grating of round or square bar (including solid and hollow) gauge as per design, angle iron or strip iron bar as per design and specification with one coat of primer and two coats of enamel paint, according to standard drawings and design complete in all respect	KG
19.8 d	Providing and fixing of MS railing with stair of round, square, angle iron, posts etc. including all hardware and accessories, according to standard drawings and design complete in all respect	KG
19.8 e	Providing and fixing of MS railing with terrace of round, square, angle iron, posts etc. including all hardware and accessories, according to standard drawings and design complete in all respect	KG
19.8 f	Providing and fixing rolling shutter of 24 SWG channels/ strip including other accessories and hardware with two coats of enamel paint, according to standard drawings and design complete in all respect	SM
19.8 g	Providing and fixing collapsible steel shutter with vertical channels, flat iron diagonal 1.5" top and bottom rail T-iron 1/4" thick with steel roller of required size riveting and jointing, one coat of primer and two coats of enamel paint, according to standard drawings and design complete in all respect	SM
19.8 h	Providing and fixing of barbed wire fencing with 4 horizontal and 2 cross wires fixed with GI pipe medium quality of 2.5" dia. as a post having welded hooks for barbed wire holding 6ft height above the ground and 2ft in PCC block, excavation and concrete should be paid separately.	
	i. 2-ply, 14 gauge	LM
	ii. 3-ply, 12 gauge	LM
19.8 i	Providing and fixing razor wire of 10 SWG in spiral form of any size	LM
19.8 j	Providing and fixing of rolling shutters of ¼" dia. MS bars mesh 4"x4" size with all accessories and fittings encased in GI box with brackets, arrangement of inside and outside locking with operating handles, with red oxide, painting two coats and making good the damages to wall, according to standard drawings and design complete in all respect	SM

SECTION 20 STEEL STRUCTURES

20.1 DESCRIPTION

20.1.1 General

This work shall consist of steel structures and the steel structure portions of composite structures, constructed in conformity with the lines, grades and dimensions shown on the drawings or as established by the Engineer. Members and connections shall be as per ANSI/AISC 360-05 and ANSI/AISC 341-05.

The work will include all labour, materials and equipment required to furnish, fabricate, erect and paint structural metals called for in these Specifications or as shown on the plans. Structural metals will include rivet, welding, special and alloy steels, metallic electrodes, steel forging, and castings, and iron castings. This work will also include any incidental metal construction not otherwise provided for, all in accordance with these Specifications, Drawings or as directed by the Engineer.

20.1.2 Drawings

The Contractor shall submit to the Engineer shop Drawings for steel structures for approval prior to use in construction. Such shop Drawings shall be submitted sufficiently in advance of the start of the related work to allow time for review by the Engineer and correction by the Contractor of the Drawings without delaying the work. Such time shall be proportional to the complexity of the work, but in no case shall such time be less than six (6) weeks.

The shop Drawings shall show details of any permitted options proposed in the work, details for connections not dimensioned on the plans, the direction of rolling the plates where specific orientation is required, the sequence of shop and field assembly and erection, welding sequences and procedures, the location of all butt welded splices on a layout Drawing of the entire structure, the location of any temporary supports that are to be used and the vertical alignment of the girder at each stage of the erection. Substantiating camber calculations shall be submitted with the shop Drawings.

20.1.3 Inspection

Structural steel will be inspected at the fabrication site. The Contractor shall notify the Engineer when materials have been delivered to the fabrication site and shall give the Engineer at least ten (10) days notice before commencing the fabrication of any structural steel.

The Contractor shall furnish to the Engineer a copy of all mill orders, certified mill test reports and a Certificate of Compliance for all structural steel to be used in the work other than steel which is to be used under the provisions in Item 20.2.6, "Unidentified Stock Material". Certified mill test reports for steel with specific impact values shall include, in addition to other test results, the results of Charpy V-notch impact tests. When fine grain steel is specified, the test report shall include the grain size. Copies of mill orders shall be furnished at the time, orders are placed with the manufacturer. Certified mill test reports and “Certificates of Compliance” shall be furnished prior to start of fabrication of material covered by these reports. The Certificates of Compliance shall be signed by the manufacturer and shall certify to the Engineer the specifications from which the material has been manufactured and tested, and that the material is in conformance with said specifications and test requirements.

Material to be used shall be made available to the Engineer so that each piece can be examined. The Engineer shall have free access at all times to any portion of the fabrication site where said material is stored or where work on said material is being performed.

20.1.4 Shipping, Handling and Storing Materials

Structural steel shall be given prime coat, before leaving the fabrication shop, as per clause 20.2.10.

Members weighing more than two and one half (2.5) metric tons shall have the weight marked thereon.

In handling and shipping of the steel work, every care shall be taken to avoid bending, scraping, or overstressing the pieces. All pieces bent or otherwise injured will be rejected.

The loading, transporting, and unloading of structural material shall be so conducted that the metal will be kept clean. Material to be stored shall be placed above the ground upon platforms, skids, or other supports, and shall be kept free from dirt, grease, and other foreign material and properly drained and protected from corrosion. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent damage from deflection.

20.1.5 Falsework

Falsework used for the erection of structural steel shall conform to the provisions in Item 5.12, "Forms", except that dead loads shall consist of the weight of the structural steel and any other portions of the structures which are supported by the falsework.

Falsework and forms supporting the concrete work on steel structures shall be constructed so that any loads applied to girder webs shall be applied within fifteen (15) cm of a flange or stiffener and shall be distributed in a manner that will not produce local distortion of the web. Temporary struts and ties shall be provided as necessary to resist lateral loads applied to the girder flanges and to prevent appreciable relative vertical movement between the edge of deck form and the adjacent steel girders.

Loads imposed on existing, new or partially completed structures by the Contractor's construction methods and equipment shall not exceed the load carrying capacity of the structure, or portions thereof, as determined by the Pakistan Building Code 2007 or as specified by the Engineer.

20.1.6 Continuous Members

Unless otherwise noted on the plans, structural steel girders have been designed for continuity in supporting girder dead load. The Contractor may at his option erect the girders in such a manner that the girder continuity for dead load is or is not as assumed in design. Furnishing and erecting the girders shall be subject to the requirements in this Item.

If erection procedures are to be used which will provide the designed girder continuity for dead load, members with field joints shall be pre-assembled in a no-load condition in a horizontal or an upright positions.

If erection procedures are to be used which will result in steel girders not attaining the continuity for dead load assumed in design, the Contractor shall furnish to the Engineer for review a statement of steel erection procedures with calculations, in sufficient detail to substantiate that girder capacity and geometry will be correct.

If erection procedures are to be used which will result in steel girders not attaining the continuity for dead load assumed in design, the structure shall, after erection, have a load carrying capacity at least equal to the designed structure shown on the plans. The Contractor may increase the cross-sectional area or change the steel grades to provide the specified load carrying capacity subject to approval by the Engineer. Any additional steel or higher strength steels required to accommodate the method of erection selected shall be considered to be made for the convenience of the Contractor and no additional payment will be made therefor.

20.2 MATERIAL REQUIREMENTS

20.2.1 Description

Various materials shall conform to the specifications of ASTM as listed in the following tabulation with certain modifications and additions as specified.

Table 20.2 (a)

Material	ASTM Designation
Structural Steel	A 36
Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	A 53
Cold-Formed Welded and Seamless Carbon Steel	A 500 (Grade B or C)
Hot-Formed Welded and Seamless Carbon Steel	A 501
High-Strength Carbon-Manganese Steel	A 529
High strength low alloy columbium vanadium steel	A 572, Grade 42, 50, 55
High strength low alloy structural steel	A 588
High strength low alloy steel shapes of structural quality	A 913 Grade 50, 60, 65
Steel for Structural Shapes For Use in Building Framing	A 992
High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength Steel	A 1011 Grade 55
Steel Column Base Plates	Any of the preceding steel or A 283 (Grade D)
High strength structural steel bolts, nuts and washers	A 325
Bolts and nuts	A 307
Carbon steel for forging, pins and rollers	A 668, Class G
Alloy steel for forging	A 668, Class G
Pin nuts	A 36
Carbon-steel castings	A 27, Grade 65-35
Gray iron castings	A 48, Class 30B
Malleable iron castings	A 47, Grade 32510
Carbon steel structural tubing	A 500, Grade B or A 501
Steel pile (Hydrostatic testing will not apply)	A 53, Type E or S, Grade B; A 106, Grade B; or A 139, Grade B
Stud Connectors	A 108, grades 1010 through 1020 either semi or fully killed

All structural steel conforming to ASTM Designations: A 36, and A 572 shall be other than rimmed or capped steel.

Coiled steel plate shall not be used for the fabrication of flanges, eye bars and hanger plates nor for flanges and eye bars.

All structural steel precut prior to arrival at the fabrication site shall be cut so that the plate orientation complies with the requirements of Item 20.3.3, "Orientation of Plates".

All structural steel plate used for the fabrication of tension flanges, eye bars and hanger plates and for splice plates of tension flanges and eye bars shall meet the longitudinal Charpy V-notch impact value requirements specified herein. Sampling procedures shall conform to the provisions in ASTM Designation; A 673. Charpy V-notch impact values shall be determined in accordance with ASTM Designation E 23.

Charpy V-notch (CVN) impact values shall conform to the following minimum values: (Note: all metric values in this test are rounded to closest decimal).

Table 20.20(b)

Material	Impact Value Ft. Lbs. at Temp. (Kg-m at Temp.)
A 36	15 at 40 deg. F. (2.07 at 4.45 deg. C)
A 572*	15 at 40 deg. F. (2.07 at 4.45 deg. C)
A 588* 2" and under in thickness ..... (50.8mm & under in thickness).....	15 at 40 deg. F. (2.07 at 4.45 deg. C)
A 588* Over 2" to 4" in thickness ..... (Over 50.8mm to 101.6mm in thickness)	20 at 40 deg. F. (2.77 at 4.45 deg. C)

*If the yield point of the material exceeds 65,000 psi (4569.5 Kg/Sq.cm), the temperature for the CVN impact value for acceptability shall be reduced to 15 deg. F. (-9.45 deg. C) for each increment of 10,000 psi (703 Kg/Sq.cm) above 65,000 psi (4569.5 Kg/Sq.cm).

Stud connectors shall be produced by cold heading, cold rolling or cold machining. Finished stud connectors shall be of uniform quality and free of injurious laps, fins, seams, cracks, twists, bends or other defects. Studs shall not have cracks or bursts deeper than one half (1/2) the thickness from the periphery of the head to the shaft. Tensile strength of stud connectors shall be determined by test of bar stock after drawing or of full diameter finished studs at the option of the Contractor. Strength requirements shall conform to the following

Tensile Strength	Elongation	Reduction of Area (Min.)
(Min.) 60,000 psi (4218 Kg/Sq.cm)	(Min.) 20% in 2 inches (50.8 mm)	50%

Stud connectors shall be furnished with arc shields (ferrules) of heat-resistant ceramic or other suitable material for welding.

20.2.2 Structural Steel

Unless otherwise specified or shown on the drawings, all structural steel plates, shapes and bars shall conform to ASTM Designation: A-36.

At the option of the Contractor, girder flange plates shown on the drawings may be increased in thickness, and may be increased in length provided that the change does not involve a decrease in detailed thickness of any portion of said plates. For continuous girders, increases in length of girder flange plates, which involve changes in locations of butt welds between different thicknesses of flange plates, shall be approved in writing by the Engineer prior to fabrication.

When stud type shear connectors longer than twenty (20) cm are to be used, they may consist of two (2) or more shorter studs of the type shown on the plans connected together with full penetration welds.

Rolled shapes may be substituted for the welded sections, and welded sections may be substituted for the rolled shapes shown on the plans, provided that the shapes and sections to be substituted comply with the following provisions:

a) The depth, width and average thickness shall be at least equal to those for the shape or section shown on the plans.

b) For welded sections, the flanges shall be welded to the web with continuous fillet welds on each side of the web. All welding shall conform to the provisions in Item 20.2.7, "Welding".

c) The strength classification of the material shall not be reduced.

20.2.3 Castings

Steel, gray iron, and malleable iron castings shall be provided with adequate continuous fillets cast in place in all re-entrant angles. The radius of curvature of the exposed surface of a fillet shall define the size of the fillet. The size of fillets shall not be less than one-half (1/2) of the thickness of the thinnest adjoined member nor less than one and one quarter (1.25) cms.

The dimensions of the finished casting shall not be less than the specified. Castings shall not be more than seven and half (7.5) percent overweight. Large castings shall be suspended and hammered over their entire area. No cracks, flaws or other defects shall appear after such hammering.

20.2.4 Bearing Pads

a) Metal Bearing Devices

Unless otherwise directed by the Engineer, the materials for metal bearing shall conform to the following requirements:

AASHTO M 107 for bronze bearings.

AASHTO M 108 for rolled copper alloy bearings.

ASTM B 438 for sintered metal power bearings.

AASHTO M 160 for galvanized steel bearings.

b) Preformed Fabric Pads

The preformed fabric pads shall be composed of multiple layers of two hundred and seventy (270) gms/SM (8-ounce) cotton duck impregnated and bound with high-quality natural rubber, or of equivalent suitable materials compressed into resilient pads of uniform thickness. The number of ply shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall with-stand compression loads perpendicular to the plane of the laminations of not less than seven hundred (700) Kg/sq.cm without detrimental reduction in thickness or extrusion.

20.2.5 Asbestos Sheet Packing (Concrete Joints)

Asbestos sheet packing shall be approximately fifteen (15) mm thick unless otherwise shown on the plans, and shall be composed essentially of compressed white chrysotile asbestos fibres bound together with a synthetic rubber binder and fillers.

The deformation of the sheet packing under a load of three hundred and fifty (350) Kg/sq.cm shall be not more than fifteen (15) percent. When tested between planed steel plates under a load of fifty five (55) Kg/sq.cm, the sheet packing shall show a static coefficient of friction less than 0.4 after 1.00-1.25 cm. movements.

Where asbestos sheet packing is shown on the plans to be placed in joints in the concrete, the bottom layer of the packing shall be firmly attached to the concrete using water-proof cement.

20.2.6 Unidentified Stock Material

Unidentified stock material, consisting of material which cannot be identified with certified mill test reports, may be used subject to the requirements in this item.

When unidentified stock material is proposed for use the Engineer may, at his discretion, select random test specimens from each piece. The number of such test specimens shall be entirely at the discretion of the Engineer. Test specimens shall be cut and machined in accordance with ASTM requirements. Test specimens from unidentified stock material, including those required for retest, shall be furnished, machined and got tested by the Contractor from approved laboratory at his expense.

Fabrication shall not be commenced until the materials involved have been approved by the Engineer.

Not more than fourteen (14) metric tons of unidentified stock material may be used on one contract.

Unidentified stock material shall be segregated from all other materials to be used in the work.

20.2.7 Welding

Welding materials, welding, welder qualification, and inspection of welding shall conform to the requirements of the American Welding Society Structural Welding Code or other accepted codes as shown on the plans or as approved by the Engineer. Correction of weld faults shall be carried out in the presence of the Engineer. If required by Engineer, the contractor will produce a certificate of X-Ray/Radiography for all welds in structures/steel from a recognized agency.

20.2.8 Galvanizing

When galvanizing is shown on the Drawings, such galvanizing of products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips three (3) mm thick or thicker, shall conform to the specifications of AASHTO M 111 (ASTM A 123), except that complete seal welding of tightly contacting surfaces of such products prior to galvanizing is required only where seal welding is shown on the drawings. Except for pre-galvanized standard pipe, galvanizing of material three (3) mm thick or thicker shall be performed after fabrication into the largest practical sections.

Galvanizing will not be required for stainless steel, mono metal and similar corrosion resistant parts.

All welded areas shall be thoroughly cleaned prior to galvanizing to remove all slag and other material that would interfere with the adherence of the zinc. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.

Components of bolted assemblies shall be galvanized separately before assembly. Galvanizing of tapped holes will not be required. Galvanized surfaces, which are specified to be painted, shall not be chemically treated after galvanizing and prior to cleaning and painting.

20.2.9 Cleaning

All steel works shall be blast cleaned after fabrication in accordance with the Drawings and to the satisfaction of the Engineer. Steel work which is to be in contact with concrete shall be, after fabrication, wire brushed and cleaned to remove all loose rust, dirt and grease.

20.2.10 Painting

a) Shop Coat (Prime Coat)

The shop or prime paint coat for metal structures including edges, nuts, bolts, etc. shall be a factory mixed red lead Ready-Mixed Paint, AASHTO M-72.

Red lead pigment in the dry form or as a paste in oil shall conform to ASTM D 83. The ninety seven (97) % grade shall be specified for dry pigment.

b) First Field Coat (2nd prime Coat)

The first field coat shall be a red lead paint as specified for the shop coat, tinted light brown as required with lamp black in an amount not to exceed 30 gms. per litre of linseed oil.

c) Second Field Coat (Finish Coat)

The paint to be used for the second field coat shall be field mixed and conform, unless specified otherwise on the Drawings, to one of the following AASHTO Specifications:

Foliage Green Bridges Paint,	M 67
Black Bridge Paint,	M 68
Aluminum Paint (Paste-Mixing Vehicle)	M 69
White and Tinted Ready-Mixed Paint (Lead and Zinc Base),	M 70
Red Lead (Dry and Paste-in Oil),	M 71
Red Lead Ready-mixed Paint (Tinted with Lamp black as directed by the Engineer),	M 72

d) Number of Coats and Colour

Steel shall be painted with one shop or prime coat and with not less than two field coats. The colour shall be as specified or determined by the Engineer. Coats shall be different in colour to permit detection of incomplete application.

e) Weather Conditions

Paint shall not be applied when the steel is damp, the air is misty, or when in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work.

f) Application

Painting shall be done in a neat manner and may be applied with hand brushes or by spraying (without the addition of a thinner). Aluminum paint shall preferably be applied by spraying. By either method the coating applied shall be smoothly and uniformly spread so that no excess paint will collect at any point.

g) Inaccessible Surfaces

All surfaces which will be inaccessible after fabrication or erection, with the exception of contact surfaces shall prior to assembly receive the full protective treatment specified for the component of the structure including any additional priming coat and finishing coats, which for accessible surfaces would be applied subsequent to erection.

h) Inspection of Cleaning and Painting

The cleaning and painting of all structural steel parts shall be subject to detailed inspection and approval of the Engineer. Contractor shall be responsible for all defects or faults and the correction thereof at his own expense during fabrication, erection or subsequently discovered before or during the Period of Maintenance.

20.3 CONSTRUCTION AND FABRICATION REQUIREMENTS

20.3.1 General

The Contractor shall submit as soon as possible to the Engineer for his prior approval, full details of their proposed fabrication and erection procedures together with details and calculations of any temporary works which the Contractor proposes to install for the purposes of erection of the structural steel work. Workmanship and finish shall be equal to the best general practice in modern bridge shops.

20.3.2 Straightening Material

Rolled material before being laid out or worked shall be straight. Subassemblies and completed members shall be straight before being incorporated into the work. If straightening is necessary, it shall be done by methods acceptable to the Engineer. Details for methods proposed for straightening shall be submitted in writing to the Engineer prior to their use. After straightening, evidence of fracture or other damage will be cause for rejection of the material.

20.3.3 Orientation of Plates

Steel plates for flanges, eye bars, hangar plates, and splice plates for flanges and eye bars shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile or compressive stress in the member.

20.3.4 Cutting with Torch

Torch cutting shall conform to the requirements for preparation of material to the American Welding Society's Structural Welding Code or equivalent.

20.3.5 Facing and Bearing Surfaces

Surface of bearing and base plates and other metal bearing surfaces that are to come into contact with each other or with ground concrete surfaces or with asbestos sheet packing shall be flat to within three tenths (0.3) cm. and to within one and six tenths (1.6) mm tolerance overall. Surface of bearing and base plates and other metal bearing surfaces that are to come in contact with preformed fabric pads,

elastomeric bearing pads or Portland cement mortar shall be flat to within three (3) mm tolerance in thirty (30) cm and to within five (5) mm tolerance overall.

Steel slabs where not in contact with other metal bearing surfaces may be hot-straightened in lieu of machining at the option of the Contractor, provided the above tolerances are met.

20.3.6 Fitting of Stiffeners

Girder stiffeners designated on the Drawings as bearing stiffeners shall be welded in accordance with details shown on the Drawings. Where the end of a stiffener is shown as "Tight-fit" on the plans, the end of the plate shall be so fitted that it bears on the girder flange with at least point bearing. Local clearances between the end of the stiffener and the girder flange shall not exceed one and six tenths (1.6) mm. Except where stiffeners are cut back, local clearances between the end of the stiffener and the girder flange which are too great to be sealed by the paint film shall be caulked prior to painting.

20.3.7 Bent Plates

Cold-bent load-carrying rolled steel plates shall conform to the following:

a) They shall be so taken from the stock plates that the direction of bending will be at right angles to the direction of rolling.

b) The radius of bend, measured from the concave face of the metal shall be as specified in the Manual of Steel Construction published by the AISC or equivalent.

c) Before bending, the corners of the plate shall be rounded to a radius one and five tenths (1.5) mm throughout that portion of the plate at which the bending is to occur. If a shorter radius is essential, the plates shall be bent hot.

20.3.8 End Connection Angles

Floor beams, stringers and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angle shall not be less than that shown on the detailed Drawings.

20.3.9 Finished Members

Finished members shall be true to line and free from twists, bends and open joints.

20.3.10 Screw Threads

Screw threads shall make close fits in the nuts and shall be American Standard Form, except that for pin ends of diameters greater than 3.81 cm (1.1/2 inches) they shall be made with six (6) threads to 2.54 cms (1 inch).

20.3.11 Match - Marking

Connecting parts pre-assembled for the purpose of setting up for welding or for drilling or reaming holes for field connections shall be match-marked, and a diagram showing such marks shall be furnished to the Engineer.

20.3.12 Finish

Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping shall be done carefully and accurately. All sharp corners and

edges, and edges that are marred, cut or roughened in handling or erection shall be slightly rounded by grinding or other suitable means.

20.3.13 Bolted Connections

Bolted connections unless otherwise shown on the Drawings shall be made with high-strength steel bolts conforming to ASTM Designation A 325. All bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening.

Bolts may be tightened to the required tension by use of a calibrated manual torque wrench, the turn-of-nut method, or by tightening and using direct tension indicators. The torque value or the direct tension indicator gap needed to develop the bolt tension will be determined by the Engineer. Checking of bolt tension shall be done by the Contractor in the presence of the Engineer and in such a manner that the Engineer can read the torque wrench gauge or direct tension indicator during checking.

Nuts shall be located, wherever practicable, on the side of the member, which will not be visible from the traveled way. Nuts or bolts that will be partially embedded in concrete shall be located on the side of the member that will be encased in concrete.

20.3.14 Bolt Holes

Bolt holes shall be either punched full size, drilled full size, sub-punched and reamed, or sub-drilled and reamed.

Attention is diverted to the provisions in Item 20.3.17, "Assembly", and details shown on the Drawings for connections where drilling or reaming is required after the joint is assembled.

The finished holes shall be cylindrical, perpendicular to the plane of the connection and shall not be more than one and half (1.5) mm larger than the nominal diameter of the bolt. Holes shall be clean cut, without torn or ragged edges. All burns, fins, sharp edges and hole irregularities which would prevent solid seating of the parts shall be removed.

All holes punched full size, sub-punched, or sub-drilled shall be located with sufficient accuracy so that after assembling (before any reaming is done) a cylindrical pin three (3.0) mm smaller in diameter than the nominal size of the punched, sub-punched, or sub-drilled hole may be passed through the hole without drifting in at least seventy five (75) percent of the holes for each connection. All holes shall pass a pin four and a half (4.5) mm smaller in diameter than the nominal size of the hole.

Mis-punched or mis-drilled holes shall not be corrected by welding unless approved by the Engineer.

Punching, drilling and reaming shall conform to the following:

a) Punching

Punching or sub-punching of structural steel conforming to ASTM Designation A 20 where the material is thicker than two and a quarter (2.25) cm. will not be permitted. Punching or sub punching of high-strength structural steel where the material is thicker than two (2.0) cm. will not be permitted.

Holes sub-punched for reaming shall be sub-punched decimal six five (0.65) cm less in diameter than that of the finished hole.

b) Drilling

Drilling full size shall be done with the parts assembled on to a steel template with hardened bushings or may be performed with gang drill equipment if approved by the Engineer. The Engineer may require a proof assembly to check the fit of major field connections.

Where bolt holes are sub-drilled for reaming, they shall be sub-drilled decimal six five (0.65) cm less in diameter than that of the finished hole.

Drilling through templates shall be performed only after the templates have been accurately placed and firmly clamped or bolted.

If members are drilled while assembled, the parts shall be held securely together while drilling is being done.

Stock drilling of plate parts with precision gang drills will be permitted if all parts are firmly clamed during drilling and if the drill bits remain perpendicular to the work during drilling operations.

c) Reaming

Reaming shall be done after the pieces forming a built-up member are assembled and are firmly bolted together so that the surfaces are in close contact or after templates are securely located over the member. The pieces shall be taken apart before bolting, if necessary, and shavings removed. If it is necessary to take the members apart for shipping or handling, the pieces reamed together shall be so marked in order that they may be reassembled in the same position. Reamed parts shall not be interchanged.

Reaming templates shall have hardened steel bushings and holes accurately dimensioned. Templates shall have reference lines, which will permit accurate location of the template on the member or members to be reamed. Templates used for reaming shall be properly located on the material and shall be firmly clamped or bolted in position. Templates used for the reaming of matching members, or the opposite faces of one member, shall be exact duplicates.

Holes through assembled material that are to be reamed shall not consist of both sub-punched or sub-drilled holes and holes punched or drilled full size.

20.3.15 Pin Connections

Pins shall be accurately turned to the dimensions shown on the plans and shall be straight, smooth, and free from flaws. The final surface shall be produced by a finished cut.

Pins and rollers shall be forged and heat-treated in accordance with the designation shown on the plans.

If pins are larger than twenty three (23) cms. in diameter, a hole not less than four decimal seven five (4.75) cms. in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Holes for pins shall be bored true to the specified diameter, smooth and straight, at right angels to the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

Machined surfaces for pins and holes shall be coated with a rust inhibitor that can be easily removed.

The distance outside-to-outside of holes in tension members and inside-to-inside of holes in compression members shall not vary from that shown on the plans by more than decimal eight (0.8) mm.

The diameter of the holes for pins shall not exceed that of the pins by more than half (0.5) mm for pins thirteen (13) cm. or less in diameter, or decimal eight (0.8) mm. for larger pins.

Holes for pins in built-up members shall be bored after assembly of the member, or may be bored prior to assembly, provided procedures approved in advance by the Engineer are followed which result in such holes being positioned to the same degree of accuracy as would be obtained if the holes were bored after assembly.

Pin-connected hangar plates shall be bored in pairs or in stacks firmly bolted or clamped together so that each pair of hangar plates is matched. Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members will take full bearing on them. In field assembling, the pin nuts on pin connections shall be tightened and the threads burred at the face of the nuts with a pointed tool.

20.3.16 Anchor Bolts

No anchor bolts shall be cast in the concrete.

Anchor bolts shall be set in round holes drilled or cast in the masonry. The size and length of bolts shall be as indicated on the Plans.

Bolts shall be accurately positioned by means of templates set to correct location and alignment so as to ensure proper span lengths, and tops of bolts shall be carefully set to proper elevation. Unless otherwise noted, bolts shall be installed plumb or normal to the finished bearing surface of the masonry.

When anchor bolt holes are drilled, a template shall be used to locate the bolts accurately and permit reinforcing steel bars to be shifted clear of holes before pouring concrete to prevent cutting these bars during drilling. The drilling shall be done prior to the erection of structural steel.

Bolts set in holes drilled or cast in the masonry shall have the portion below the bridge seat swedged, and the drilled or cast holes shall have a diameter at least one 1 inch (25 mm) in excess of the diameter of the bolt.

Anchor bolts for steel stringers for all bridges (weathering steel and/or painted steel) shall be A-36 galvanized steel and shall not be painted. The nuts and washers used on anchor bolts shall also be galvanized and shall not be painted.

Holes cast in the masonry for swedged bolts shall be formed with removable round sleeves sealed at their lower ends, and they shall be completely removed after the hole is cast. During cold weather, effective methods shall be used to prevent the freezing of water in anchor bolt holes.

After anchor bolts are finally and correctly positioned, the holes around them shall be completely filled. No grouting of anchor bolts will be permitted until all structural steel is set in its final position. After the masonry plates or shoes are set, the space between the bolts and the round holes through fixed plates or shoes shall also be filled with the same material. Slotted holes in expansion devices shall remain unfilled to allow free movement.

Mortar used for grouting anchor bolts shall be composed in accordance with one of the following:

a) One part Portland Cement and one part mortar sand by dry loose volume.

b) Non-shrink grout shall be used when specified. The grout shall have a minimum compressive strength of 350 Kg/Sq.cm (5000 psi) in seven days when tested in accordance with AASHTO T 106 except that the cube moulds shall remain intact with a top firmly attached throughout the curing period. The non-shrink grout shall have a minimum expansion of 0.0 percent after seven days when tested in accordance with AASHTO T 160.

When air temperature is below four (4) degree C, the Contractor shall provide adequate cold weather protection to maintain a minimum air temperature of four (4) degree C around surface of mortar for a period of three days.

If anchor bolts are mortared in place during cold weather, the bolts and surrounding masonry shall be kept at a minimum temperature of four (4) degree C for a period of three days.

When mortar filling is used for bolts inserted in holes drilled or cast in the masonry, the holes shall first be checked for depth by inserting and withdrawing the bolts. They shall then be partially filled with mortar into which the bolts shall be forced by uniform pressure or light blows from a hammer (flogging and running will not be permitted) so that excess mortar is pushed out at the top of the hole. The excess mortar shall be removed and finished off flush with the top surfaces of the masonry, masonry plate or shoe as the case may be.

Bolts shall be set to project approximately half (0.5) inch (13 mm) above the nut and shall be threaded to approximately half (0.5) inch (13 mm) below the nut in its final position.

Nuts shall be drawn up tight except over the slotted holes of expansion devices in which case they shall be positioned half (0.5) inch (13 mm) clear of the moveable parts. All anchor bolt threads shall be burred with a sharp pointed tool at the top of the nut. When nuts are set half (0.5) inch (13 mm) clear of moveable parts, the bolt thread shall also be burred immediately under the nut to prevent it becoming tight against the moveable parts.

Rockers or expansion plates with slotted holes shall be set with the proper tilt or offset as determined by the temperature prevailing at the time and so that they will be in their midway position at twenty (20) degree C or as indicated on the Drawings.

20.3.17 Assembly and Erection Procedures

a) General

The Contractor shall submit as soon as possible to the Engineer for his prior approval full details of their proposed erection procedure together with details and calculations of any temporary works which the Contractor proposes to install for the purposes of the erection of the structural steel work.

b) Storage at Site and Handling

The structural steelwork after arrival on Site shall be laid out in the area allocated by the Contractor. It shall be unloaded by crane, or other appliance, and carefully stacked on timbers and subsequently handled for erection in such a manner that no distortion or damage is done to the various members. No steelwork shall be stored directly on the ground.

c) Erection Generally

The works on site shall comply with the requirements stated in these specifications and the Contractor shall be responsible for providing all materials, skilled and

unskilled labour, plant, equipment, supervision and all other things necessary for the erection of the steelwork on the Site as specified in the Contract Documents and shown on the Drawings.

The Contractor shall ensure that suitable plant and equipment of adequate capacity is used on the Site.

d) Supervision

The erection of the steelwork shall be under the direct charge of a competent Supervisor who has had sound experience in the erection of structural steelwork and who shall work full time on the Site from start to completion of the work.

e) Security During Erection

During erection the work shall be securely bolted or otherwise fastened and where necessary temporarily braced, so as to make adequate provision for all erection stresses and conditions, including those due to the erection equipment and its operation.

Each part of the structure shall be aligned as soon as possible after it is erected. Members shall not be permanently connected until the structure has been sufficiently aligned, leveled, plumbed and temporarily connected to ensure that they will not be displaced during the erection or alignment of the remainder of the structure. All temporary bracing shall be left in position until such time as erection is sufficiently far advanced for it to be no longer required.

f) Temporary Connections

Connections for temporary bracing and additional holes, members or cleats used to facilitate handling or erection shall be provided in a manner, which does not weaken the permanent structure or impair its serviceability.

g) Erection Packs, Etc

The Contractor shall provide and shall be deemed to have included in his rates and prices for providing a suitable range of steel erection packs, shims and wedges to be used as necessary to ensure the accurate adjustment of line and level of the steelwork erected on Site and for the temporary works referred to in the previous sub-item.

h) Setting Out

The Contractor shall be responsible for the final positioning, leveling, plumbing and alignment of all steelwork and the accurate placing of every part of the steelwork in accordance with the Drawings and his own fabrication drawings.

No steelwork shall be finally concreted until the positioning, levels, plumbing and alignment of the steelwork (or part of the steelwork if agreed by the Engineer) has been finally checked by the Contractor.

i) Work on Site

All work on Site shall comply with the following:

1. The steelwork after erection and fixing complete shall comply with the following maximum permissible dimensional tolerances:

   i. Departure from overall plan dimensions at any level - ten (10) mm.

ii. Departure from theoretical centres of adjacent beams or girders in any floor or roof .-. five (5) mm.

iii. Departure from the true alignment of any plate girder relative to the associated setting out geometry shown on the Drawing .-. five (5) mm.

iv. Departure from the true vertical centre line or any girder throughout its length of height .-. five (5) mm.

v. Departure from the specified level of the top of any beam - five (5) mm.

j) Site Connections

The Contractor shall make all site connections in accordance with the details shown on the Contractor's detailed fabrication drawings, which shall comply with the requirements of these Specifications.

Drifting shall not be used to correct a bad alignment.

Any additional holes required in the steelwork (which must first be approved by the Engineer) shall be drilled on the Site. Burning holes in the steelwork will not be permitted.

k) Contact Surfaces

All steel to steel contact surfaces shall be thoroughly cleaned and painted with two coats of primer as described in clause No 20.2.10 in this Specification. The surfaces shall be brought together while the second coating is still tacky.

l) Site Welding

Site welding will only be permitted where shown on the Drawings and with prior consent of the Engineer.

m) Inspection of Site Works

All parts of the steel-work will be subject to inspection by the Engineer. The Contractor shall afford all facilities and assistance for inspection during the progress of the works.

The Contractor shall whenever possible, give the Engineer at least twenty four hours notice of when materials or parts of the steelwork will be ready for inspection.

Materials or workmanship or parts rejected shall be remedied or replaced by the Contractor without extra charge and without affecting the time for completion of the contract.

Inspection as aforesaid by the Engineer shall not absolve the Contractor from being responsible for any error or fault that may be discovered subsequently and for the final accuracy of the Works.

n) Painting after Erection

1) All paints shall be applied in accordance with the manufacturer's instructions and as specified under clause 20.2.10.

2) Damaged areas of paint-work shall be thoroughly scraped, wire-brushed and cleaned to remove all rust, dirt, grease and loose primer, back to sound paint.

All surfaces shall be thoroughly cleaned prior to further painting.

Damaged areas shall then be treated as described in the cleaning and painting section.

The second priming coat shall be allowed to dry for at least twenty-four hours before application of the finishing coat.

o) Inspection

i. The structural steelwork shall be subject to inspection by the Engineer. That inspection will as far as possible be carried out at the Contractor's workshops, but the Engineer may at his discretion defer inspection of any parts of the structural steelwork until after those parts have been delivered to the Site. The Contractor and his suppliers shall afford the requisite facilities at all reasonable times and at all places for inspection and testing to be carried out by the Engineer.

ii. All parts of the Works done on the Site will be subject to inspection by the Engineer. The Contractor shall afford all facilities and assistance for inspection as aforesaid during the progress of the Site Works and until the completion of the contract.

iii. Materials or workmanship or parts rejected on inspection as aforesaid shall be remedied or replaced by the Contractor without extra charge and without affecting the time for completion of the whole or any part of the Works.

20.4 MEASUREMENT AND PAYMENT

20.4.1 Measurement

The quantity to be paid for shall be the calculated theoretical number of kilograms of different shapes of members, based on data from a standard recognized steel book. No physical weighing will be allowed, no extra shall be added or deducted for welding or drilling etc.

20.4.2 Payment

The pay item shall include fabrication, erection, primer and protective coating (painting). The measurement shall be the total weight of the finished member comprising plates, rolled sections, shear connectors, stiffeners, cleats, packs, splice plates and all incidentals, necessary to complete the item, without allowance for tolerance for rolling margin and other permissible deviations from standard weights, and excluding the weights of welds, fillets, bolts, nuts, washers and protective coatings. No deductions shall be made for notches, holes and the like each less than 0.01 square meter measured in area.

Fabrication shall include:

a) Preparation and supply of shop drawings.

b) Examining and checking steel plates for segregation, laminations, cracks and surface flaws and carrying out any remedial measures required by the Engineer in respect of such defects.

c) Cutting, marking off, drilling, notching, machining, form fitting, edge preparation and cambering.

d) Welding, riveting, bolting as the case may be, assembling and pre-heating.

e) Bolts, nuts and washers required to fabricate the steelwork and to complete the erection and installation of steelwork on Site, together with spares and service bolts, drifts, draw-up cleats and the like.

f) Welding shear connectors to steel members either at the place of fabrication or on Site and preheating.

g) Approval testing of welders.

h) Production tests of welding during fabrication including non destructive testing.

i) Marking members for identification and delivery in matching sequence.

Permanent erection shall include:

a. Temporary bracing or stays to prevent displacement including the provision and removal of temporary attachments.

b. Approval testing of welders.

c. Permanent bolted and welded connections required on Site including the provision of preheat and shelters for welding.

d. Production tests of Site welding including non-destructive testing.

Protective coating shall include:

a. Specimen panels of blast cleaning.

b. Paint samples and dispatching to testing authority.

c. Paint application procedure trials.

d. Testing.

e. Masking and other measures to protect adjacent untreated steelwork.

f. Joint fillers and sealing of bolted joints.

g. Preparing materials for application.

h. Preparation of surfaces and painting of steelwork at the place of fabrication and on Site.

i. Complying with any special requirements in respect of ambient conditions for the application of protective treatment and for intervals between successive operations and applications.

j. Strip coats.

Pay Item No.	Description	Unit of Measurement
20.4 a	Providing, fabricating and fixing (Structural shapes) for trusses, space frames and small structural items as per ASTM A-36, according to standard drawings and design complete in all respect.	TON

SECTION 21 EXTERNAL PAVING, PARKING AREAS ETC.

21.1 DESCRIPTION

The work covered under this Section consists of providing and making the following items as per specifications laid down hereunder, drawings and Bill of Quantities.

Concrete Paving Blocks in Parking Areas / Footpaths.

Washed Terrazzo in Paving / Walkways.

Split Tiles Work in Paving / Walkways as dividing Strips / Panels.

Split Tiles on External Steps.

21.2 DEFINITIONS

For the purposes of this Part of the following definitions apply.

21.2.1 Concrete Paving Block

Paving blocks are designed to form a structural element and the surfacing of pavements, having the block-to-block joints filled so as to develop frictional interlock.

21.2.2 Wearing Surface (s)

Surface (s) of a paving block designed to be laid uppermost and to be trafficked in use.

21.2.3 Plan Area

Area bounded by those faces that are approximately normal to the wearing surface.

21.2.4 Compressive Strength

Average crushing strength of a sample of 16 paving blocks when tested as described in 21.4.6.

21.2.5 Work Size

A size and shape of paver, normally expressed in terms of dimensions of length, width and thickness, specified for its manufacture to which its actual size and shape should conform within specified deviations.

21.3 MATERIAL REQUIREMENTS

1. Cement, Sand, Aggregate shall conform to specifications given in Section-5 “PORTALAND CEMENT CONCRETE” of this Specification.
2. Concrete Blocks shall conform to specifications given in Section-9 "CONCRETE BLOCK MASONRY ".
3. Split Tiles and Special Dry Bond Mortar shall conform to specifications given in Section-15 "SPLIT TILE WORK".
4. Concrete Paving Block shall be as per manufacturer's specifications "Tuff-Tiles" or approved equivalent, conforming to BS EN 1338 “Concrete paving blocks. Requirements and test methods” with compressive strength of 49 N/mm^2 (7,100 psi).
5. Chips, for washed terrazzo shall conform to specifications given in Section-10 "TERRAZZO FLOORING".

21.4 CONSTRUCTION REQUIREMENTS

1. The entire area under external Pavings shall be prepared by dressing earth, to a hard or graded surface. Where necessary, the prepared surface shall be made upto the required levels by filling and consolidating earth in accordance with the specifications for earth filling under floors.

2. **Washed Terrazzo**

   3/4" Terrazzo in pigmented grey cement 1:2 shall be laid over 1-3/4" Plain Cement Concrete Class-C over 4" thick Plain Cement Concrete Class-E over 4" thick sand over compacted earth for Paving/Footpaths.

   After the Terrazzo topping has hardened sufficiently to prevent dislodging of the marble chipping, but before the cement has acquired enough hardness, so as to disable removal, the cement shall be washed away moving a wire brush and a steady flow of water from a flexible hose. Terrazzo surface shall be washed carefully and sponged to expose grains.

3. **Split Tile Strips**

   Washed Terrazzo in paving/walkway is divided into panels by providing and making strips of width indicated on the drawings with double glazed split tiles as specified hereunder:

   The Tiles 9-1/2"x2-1/4"x3/8" shall be jointed in 3/8" thick Dry Bond Mortar and laid over 1-3/8" thick Plain Cement Concrete Class-C over 4" thick Plain Cement Concrete Class-E over compacted earth.

4. **Finish on External Steps**

   Double glazed split tiles of approved shade and colour shall be fixed to the external stair steps of RCC with special Dry bond mortar or epoxy adhesive over 3/4" thick Cement Sand base plaster (1:3).

5. **Concrete Pavers in Parking Areas / Footpaths**

   Concrete pavers of approved shapes shall be installed over Parking Areas, Roads and Footpaths. Pavers of following thicknesses shall be adopted for various uses:

   a. Parking Areas and Roads 80 mm

   b. Footpaths and Walkways 50 mm

   Thickness of Crushed Aggregate Base Course or Granular Sub-Base will be as shown on the drawings, which shall be as under

   Road Parking

   i. Base Course 4”

   ii. Sub Base 6”

Foot Path

i. Sub Base 6”

Provided in design, the area under the pavers shall be prepared to the required level by compacting the earth to at least 95% modified AASHTO max. dry density. The compacted earth shall be tested and approved before the layer of sand is placed. The prepared subgrade shall then be covered over by 2" of sand cushion compacted, over which the specified pavers shall be laid closely packed tamped in place and filled with sand.

6. **Physical Requirements**

i) Compressive Strength

The compressive strength of paving blocks roads and parking areas sampled in accordance with clause 21.4.5(ii) and tested in accordance with BS EN 1338, shall not be less than 49 N/mm^2 (7,100 psi) and the crushing strength of any individual block shall not be less than 40 N/mm^2 (5,800 psi)

However, if the average crushing strength of the first four blocks tested is not less than 54 N/mm^2 (7,800 psi) and if none of these four blocks has a crushing strength of less than 40 N/mm^2 (5,800 psi), the consignment shall be considered to comply with this standard.

However, the strength required will be 5000psi for foot path and walkways.

ii) Sampling

The following sampling procedure shall be used for the compressive strength test.

a. Before laying paving blocks divide each designated section comprising not more than 5000 blocks, in a consignment, into eight approximately equal groups, clearly mark all samples at the time of sampling in such a way that the designated section or part thereof and the consignment represented by the sample are clearly defined. Take two blocks from each group.

b. Dispatch the sample to the test laboratory, taking precautions to avoid damage to the paving blocks in transit. Each sample shall be accompanied by a certificate from the person responsible for taking the sample stating that sampling was carried out in accordance with this Part of BS EN 1338.

c. Protect the paving blocks from damage and contamination until they have been tested. Carry out any tests as soon as possible after the sample has been taken.

iii) Marking

The following particulars relating to paving blocks made in accordance with this standard shall be indicated clearly on the delivery note, invoice, manufacturer’s or supplier’s certificate or brochure supplied with the consignment of blocks:

a. The name, trademark or other means of identification of the manufacturer.

b. The number and date of this British Standard, i.e. BS EN 1338.

c. Type of binder constituents (s) used.

d. Type of admixture (s) used.

iv) Binder Content

The binder content of compacted concrete shall not be less than 380 Kg/m^3 for Type I Portland Cement.

v) Tolerances

Maximum dimensional deviations from stated work size for paving blocks shall be as under

Length	± 2 mm
Width	± 2 mm
Thickness	± 3 mm

21.5 CONCRETE KERBS, GUTTERS AND CHANNELS

DESCRIPTION

This work shall consist of kerb, gutter, channel, or combination of kerb and gutter or channel; constructed of the following materials and in accordance with the specifications at the location and of the form, dimensions and designs shown on the Drawings or as directed by the Engineer. The kerb, gutter, channel or in combination may be constructed by one of the following methods.

i) Cast in place concrete kerbing.

ii) Precast concrete kerbing.

iii) Extruded concrete kerbing.

21.5.1 MATERIAL REQUIREMENTS

The concrete for cast in place concrete kerbs, gutters and channels shall be either Class 'A' or Class 'C' or as indicated on the Drawings and shall conform to the requirements of that particular class prescribed under item 401.1.1. “Classes of concrete”. An air entraining agent, if required, shall be added during mixing an amount to produce five (5) to eight (8) percent air by volume in the mixed concrete.

Precast concrete kerbing units shall consist of class 'C' concrete conforming to the requirement of item 401 and to lengths, shape and other details shown on the Drawings. Kerbing which shows surface irregularities of more than five (5) mm when checked with three meter straight edge or surface pits more than fifteen (15) mm in diameter will be rejected.

Forms to hold the concrete shall be built and set in place as described under item 403-Formwork.

Forms for at least sixty meters of kerb or combination of kerb and gutter or channels shall be in place and checked for alignment and grade before concrete is placed. Curved sections shall have forms of either wood or metal and shall be accurately shaped to radius of curvature shown on the Drawings. Steel Reinforcement if required shall conform to item 404 "Steel Reinforcement".

Expansion joint filler shall be either the performed type conforming to requirement of AASHTO-M 153 or shall be precast fiber board packing.

Joint filler shall consist of one part cement and two parts of approved sand with sufficient quantity of water necessary to obtain the required consistency. The mortar shall be used within thirty (30) minutes after preparation.

The Bonding compound when used shall conform to AASHTO M-200.

21.5.2 CONSTRUCTION REQUIREMENTS

21.5.3 Cast-in-Place

a) Excavation and Bedding

Excavation shall be made to the required depth and the base upon which the kerb or combination of kerb and gutter is to be set shall be compacted to a minimum density of ninety (90) percent of the maximum dry density as determined by AASHTO T-191 Method. All soft and unsuitable material shall be removed and replaced with suitable material acceptable to the Engineer.

Where directed by the Engineer, a layer of cinders or clean sand and gravel, or other approved porous material having a minimum compacted thickness, of fifteen (15) cm shall be placed to form a bed for the kerb or combination of kerb and gutter.

b) Placing Concrete

Concrete may be placed in the gutter to the full depth required. The top of the kerb or combination of kerb and gutter shall be floated smooth and the edges rounded to the radii shown on the Drawings. Before finishing, the surface of the gutter shall be tested with a three (3) meter straight-edge and any irregularities of more than five (5) mm in three (3) meters shall be eliminated. In finishing concrete only mortar normally present in the concrete shall be permitted for finishing. The use of a separate mortar finishing coat or the practice of working dry cement into the surface of the concrete will not be permitted.

c) Joints

The kerb and gutter shall be constructed in uniform sections of not more than twenty five (25) meters in length except where shorter sections are required to coincide with the location of weakened planes or contraction joints of the concrete pavement or for closures but no section shall be less than two (2) meters long. The sections shall be separated by sheet templates set perpendicular to the face and top of the kerb and gutter. The templates shall be approximately five (5) mm in thickness, of the same width as that of the kerb or kerb and gutter and not less than five (5) cm greater than the depth of the kerb or kerb and gutter. Templates shall be set carefully and held firmly during the placing of the concrete and shall be allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place. When pre-cut fiber-board packing is used in the expansion joints it may be used in place of the sheet template referred to above, on the approval of the Engineer. In this event the fiber board shall be pre-cut to the shape of the kerb so that its outer edge will be flush with the abutting kerb.

Expansion joints shall be formed in the kerb and gutter at intervals of six (6) to ten (10) meters in order to coincide with the expansion joints of cement concrete pavement or as shown on the Drawing.

d) Dowels at Expansion Joints in Channels

At expansion joints in channels and in the channel portion of kerbs and channel built monolithically, painted dowel bars with slip sleeve shall be provided as a load transfer medium at locations shown on the Drawings.

The size and spacing of the dowel bars shall be as indicated on the Drawings. Each dowel shall be set accurately parallel to the top surface of the gutter and accurately at right angles to the expansion joint.

e) Contraction Joints

Transverse contraction joints shall be provided opposite to all contraction joints in abutting concrete pavement and other locations shown on the Drawing spaced to a maximum of four (4) meters.

The contraction joints shall be provided by forming grooves in the face and surface of structure at right angle to the kerb alignment and kerb surface. The grooves shall be rectangular in cross-section, five (5) cm deep by five (5) cm wide. The grooves shall be formed in the top of all kerbs and in the exposed roadway face of kerb and in the channel surface of monolithic type kerb and channels and in the surface of channels. The edges of the joints shall be tooled and the joints shall be left clean, neat and of specified width and depth.

f) Removal of Forms and Finishing

The forms shall be removed within twenty four (24) hours after concrete has placed except that the form used against the face of the kerb in a combination of kerb and gutter shall be removed as soon as the concrete has set sufficiently to hold its shape. Minor defects shall be repaired with mortar containing one part of portland cement and two parts of the fine aggregate. Plastering shall not be permitted on the face of a kerb or kerb and gutter and all rejected kerb or gutter shall be removed and replaced without additional compensation. All surfaces which will be exposed in the finished construction of the kerb and gutter shall be finished, while the concrete is still "green" by wetting a wood block of float and rubbing the surface until they are smooth.

g) Curing

During seventy two (72) hours following placing of concrete, the kerbs, channels and gutters shall be protected against premature drying by covering with suitable cotton or Hessian mats and by frequent sprinkling with water, with liquid forming compounds or with waterproof paper or by any other method as mentioned in section 401.3.8-Curing Concrete and approved by the Engineer.

h) Backfilling

After forms has been removed and concrete has been cured as specified, the excavation of kerbs, gutters or channels shall be backfilled
with suitable earth or granular material tamped into place in layers of not more than fifteen (15) cms each until firm and solid.

21.5.4 Pre-Cast

a) Excavation and Bedding

Excavation shall be made to the required depth as shown on the Drawings. All soft and unsuitable material shall be removed and replaced with a suitable material acceptable to the Engineer.

Bedding shall consist of Class B Concrete conforming to the requirements of Item 401 and shall be to the section and dimension shown on the Drawings.

b) Placing

The precast concrete kerbs shall be set in 1:3 of cement sand mortar to the line, level and grade as shown on the Drawings or as directed by the Engineer.

c) Joints

Joints between consecutive kerbs shall be three (3) to five (5) mm wide and filled with cement mortar to the full section of the kerb.

d) Backfilling

Backfilling shall meet the requirements of Item 601.3.1(h).

21.5.5 Extruded Concrete Kerbing and Channels

a) Excavation and Bedding

Excavation and bedding shall conform to the requirements as described under item 601.3.1(a).

b) Placing

Concrete shall be fed to the machine at a uniform rate. The concrete shall be of such consistency that after extrusion it will maintain the shape of the kerb section without support and shall contain the maximum amount of water that will permit this result. The machine shall be operated under sufficient uniform restraint to forward motion to produce a well compacted mass of concrete which requires no further finishing other than light brushing with a brush filled with water only.

The forming tube portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine. A grade line gauge or pointer shall be attached to the machine so that a continual comparison can be made between the kerb being placed and the established kerb grade as indicated by an offset guide line.

The top end face of the finished kerb shall be true and straight and the top surface of the kerb shall be of uniform width, free from bumps or surface pits larger than fifteen (15) mm in diameter. When a straight-edge three (3) meters long is laid on the top or face of the kerb, or surface of the gutter, the surface shall not be more than five (5) mm from the edge of the straight-edge except at grade changes or curves.

Where adhesive is used to bond the kerb to an existing pavement, the surface shall be first thoroughly cleaned of all dust, loose material and oil, the cost of which shall be included in other items of work.

c) Joints

Expansion joints shall be constructed by sawing through the kerb section to its full depth. The width of the cut shall be such as to admit the joint filler with a tight fit. Preformed joint filler shall conform to the provisions of Item 601.2 and shall be inserted and mortared in place.

If sawing is performed before the concrete has hardened, the adjacent portion of the kerb shall be supported firmly with close fitting shields and the operations of sawing and inserting the joint filler shall be completed before curing the concrete.

Alternatively pre-cut joint fillers shall be permitted to be placed at the location of the expansion joints prior to the placing of the extruded kerb with the approval of the Engineer. The joint fillers shall be set firmly in place in a vertical position to the line and grade of the kerb profile.

d) Curing and Backfilling

Curing and backfilling shall be as described in item 601.3.1(g) and Item 601.3.1 (h).

21.5.6 CURING

All work involving cement shall be cured thoroughly for at least 7 days.

21.6 MEASUREMENT AND PAYMENT

Measurement for all the items covered under this Section shall be made in SM. of the actual surfaces completed and approved.

The unit of measurement for concrete kerb, gutter, or combination of kerb and gutter, channel, or extruded kerbs and channels shall be measured by the linear meter along the front face of the section at the finished grade elevation. Deduction in length will be made for drainage structure installed in the kerbings such as catch basins and drop inlets etc. Measurement will not include any area in excess of those shown on the Drawings except for any area authorised by the Engineer in writing.

21.6.1 RATE AND PAYMENT

The rate quoted for the work items covered in this Section shall constitute full compensation for all materials, labour, equipment, plant and all incidentals to complete the works as specified in the BOQ.

Measured and accepted quantities shall be paid for at the contract unit price per linear meter for each of the particular pay item listed below and shown in the Bill of Quantities which prices and payment shall constitute full compensation for furnishing and placing all materials for concrete, for reinforcing steel if required on the Drawings for expansion Joints, material, form for drainage opening, excavation, backfilling and dumping and disposal of surplus material and for all labour, equipment, tool and incidentals necessary to complete the item.

Payment for expansion joint filler material used in transverse expansion and contraction joints in kerbs and channel shall be understood to be included in the price tendered per linear meter for the kerbs and channels and shall not be paid for separately.

Concrete and mortar required for bedding of precast concrete kerbs as shown on the Drawings shall not be paid for as separated item, but the cost shall be included in the contract unit price for precast concrete kerb.

Pay Item No.	Description	Unit of Measurement
21.6 a	For roads and parking with 80mm paver of 7000psi strength, over base and sub base as specified, complete in all respect	SM
21.6 b	For foot path etc. with 50mm paver of 5000 psi strength over sub base as specified, complete in all respect	SM
21.6 c	For foot path etc. with 50mm concrete tile, over sub base as specified, complete in all respect	SM
21.6 d	Providing and laying of crushed aggregate 3/4" to 3/8" size	SM
21.6 e	Providing and laying as shown on drawing Kerb stone 18"x12"x6" (450x300x150mm) laid in cement mortar as described in Specification including excavation and backfill (lean concrete should be paid under relevant item)	LM

SECTION 22 HORTICULTURE

22.1 GENERAL REQUIREMENTS

22.1.1 SCOPE

Work covered under this section consists of furnishing all labour, equipment and material necessary to perform all operations required for landscaping inclusive but not limited to finished grading, supplying and spreading of soil and manures, turfing, planting/seeding/grass for lawns including supply and installation of tree guards, decorative stones, maintenance period, landscape, warranty, appliances and services necessary for and incidental to completing all the turfing operations and the associated works in a workmanship like manner, according to the provisions of the Contract.

22.1.2 QUALITY ASSURANCE

The work must be undertaken by an experienced contractor specialising in turfing work and other specified activities. Work shall be performed and supervised at all times by experienced personnel.

All materials shall be shipped with certificates of inspection as required by the Engineer-in-Charge. Manufacturer's certified analysis for standard packaged products shall be provided.

22.1.3 SUBMITTALS

The Contractor shall submit catalogue, data and literature of manufacturers and suppliers for approval of Engineer.

The Contractor shall submit manufacturer's certified analysis of all standard products, including soil, fertilisers, peat, seed, inorganic and organic mulches.

The Contractor shall submit a performance schedule for plantation of grass and carrying out other works within fourteen (14) days of the start of the Contract. This schedule shall identify the source of procurement of grass for plantation.

The Contractor shall submit a weekly work schedule for approval before work is started. The schedule shall identify tasks to be completed on a weekly basis and the anticipated schedule for completing the tasks. The Contractor will then modify and submit the schedule on a weekly basis identifying tasks completed tasks to be completed, problems encountered and recommendations.

If specified, soil report is to be submitted by the Contractor for all soils to be used for preparation of ground. The Contractor shall arrange an approved independent analyst to prepare a physical and chemical analysis of the soil and irrigation water to be used. The analyst shall also provide recommendations on soil amendment, fertiliser application and the like. The report shall be submitted to the Engineer-in-Charge for approval before soil is placed. In the case of imported soil, the report shall be submitted at least 10 days prior to delivery. The report shall identify the source(s) from which imported soils are to be furnished.

At a minimum, the soil shall be analysed for:

a) Total salts (electro-conductivity of soil solution)
b) Soil pH value
c) Exchangeable sodium, calcium, magnesium and potassium
d) Available phosphates
e) Organic matter as a percentage
f) Available zinc, manganese, iron and boron
g) Total sulphates

The soil analysis shall also include fertilisers and other amendment requirements and quantities when incorporated with the soil will provide the required nutrient levels for vigorous plant growth. Additional soil samples shall be taken at the rate of one in every 20 loads or as directed by the Engineer-in-Charge and analysed. The results will be compared with the original sample to ensure consistency and compatibility of supply.

If specified, an operation and maintenance manual is to be provided by the Contractor. Instructions shall be furnished for year round care of plantation to be followed by the Owner. As a minimum, the manual will include the following:

1. Irrigation details: including water application rates and maintenance procedures
2. Fertilisation: including fertiliser descriptions, application rates and application schedule
3. Salinity control: including leaching methods and leaching program monitoring.
4. Pesticide/fungicide/herbicide applications: including safety application rates, procedures, and schedules.
5. Turf grass management: including mowing procedures, a verification, topdressing, vertical mowing for thatch removal, rolling, over-seeding and springing.
6. General maintenance: including pruning, stakes and ties, replacement and clean-up, protective fencing and grading.
7. Equipment inventory including maintenance procedures and manufacturer's maintenance manual.
8. Landscape maintenance personnel requirements and job descriptions.

22.1.4 JOB CONDITIONS

The Contractor shall proceed with and complete grass planting operations as rapidly as possible as portions of the Site become available.

No planting shall be carried out during periods of heavy rain, sandstorms, heavy winds, or during intense daytime heat.

When special conditions warrant a variance to the planting time and conditions, a proposed planting schedule shall be submitted to the Engineer-in-Charge for review and approval. In such cases, the planting will be installed at no additional cost and all conditions and obligations such as maintenance and warranty remain the same.

22.2 SOIL

Soil shall be sweet soil or washed marine soil free of admixtures of subsoil, foreign matter, toxic substances, weeds and any material or substance that may be harmful to plant growth. The Contractor shall furnish agricultural soil from approved sources.

Material shall be stored in piles of less than 1 metre high. Piles shall be protected from undue compaction and maintained free of contamination and construction debris.

The soil shall comply with the following chemical criteria:

a) pH value: not less than 6.5 nor more than 8.5
b) Electro-conductivity: less than 4 mm mhos/cm saturated extract at 25^{o}C
c) Free carbonates: less than 0.5 % air dried.
d) Chlorides: less than 200 ppm in saturated extract.
e) Sulphates: less than 200 ppm in saturated extract.
f) Exchangeable sodium: less than 15 % in neutral normal ammonium acetate.
g) Boron: less than 1.5 ppm, hot water soluble.

The soil shall comply with the grading criteria in Table 22.4(a).

Table 22.2(a)

Sieve Size (mm)	% Passing
5.000	100
2.380	65 to 100
1.180	45 to 100
0.600	35 to 80
0.300	5 to 48
0.150	0 to 15
0.075	0 to 3

22.2.1 CONDITIONERS& FERTILIZER

Peat shall be used where specified. Peat shall be a natural product of sphagnum moss peat/peat humus derived from a freshwater site. Peat shall be shredded and granulated to pass through a 12 mm mesh screen and conditioned in storage piles for at least 6 months after excavation. The peat shall be free from sticks, stones, roots, and other objectionable matter. It shall have a pH value of not less than4 and no more than 7.5. The minimum organic content shall be 85% on a dry weight basis. Peat shall be delivered in undamaged commercial bales in air dry condition.

Manure shall be the decomposed animal manure of fully fermented pre-dried cow or chicken manure with minimum nitrogen, phosphoric acid and potassium percentage of 2 each and a PH value of 6.0 to 7.5. Sludge waste product may be used as a substitute subject to approval of the Engineer-in-Charge. Manure and sludge shall be free of stones, sticks and non-bio-degradable material.

Fertilizer shall consist of an approved compound containing not less than, as follows:-

- 10% Nitrogen
- 15% Phosphoric Acid
- 10% Potash
- or similar approved compound

22.2.2 PLANTING SOIL INGREDIENTS

The planting soil in gradients shall consist of approved soil, peat, manure and other soil conditioners as specified. The ingredients shall be placed in sequence as specified to meet the requirements of grass to be planted.

22.3 GRASS PLANTATION (lawns)

22.3.1 SITE PREPARATION FOR PLANTING AREAS

i. General Requirements

The Contractor shall examine areas to receive grass plantation with requirements and conditions affecting performance of work in this Section. The Contractor shall not proceed with plant operations until unsatisfactory conditions are discussed with the Engineer-in-Charge and corrected.

The Contractor shall determine the location of above grade and underground utilities and perform work in a manner which will avoid damage to them. Damage to underground utilities shall be repaired at the Contractor's expense.

When conditions detrimental to the growth of grass are encountered, such as rubble, adversed rainage or obstructions, the Contractor shall notify the Engineer-in-Charge prior to planting. The area shall be cleared of stones, pebbles, stubbles, grass roots and other injurious matters and clods shall be broken.

The following pre-planting steps shall be required for building a lawn.

a) Careful grading makes good drainage, so that lawn won't puddle and develop spots that are water logged and soft, or hard and dry.
b) Incorporating organic matter and other soil amendments which are needed for proper growth and easy maintenance.
c) Blending of top soil with native soil is done to make a transitional layer between top soil and native soil as it avoids trapping roots in a shallow top soil basin in which they would be dependent on frequent feeding and very frequent watering.

The Engineer-in-Charge shall verify that sub-grades are as specified.

ii. Sub-Surface Grading

All perennial weeds shall be treated with an approved herbicide and the period of time recommended by the manufacturer shall be allowed to elapse prior to commencing grading operations.

Grading operations shall occur when the sub-soil is reasonably dry and workable.

Areas to be graded shall be graded to smooth flowing contours with all minor hollows and ridges removed. Rock projections and boulders shall be removed and disposed of at a location agreed with the Engineer-in-Charge.

Non-cohesive, light subsoil shall be loosened with a 3-line ripper to a depth of 300 mm at 600mm centres. Stiff clay and other cohesive subsoil shall be loosened with a single line ripper to a depth of 450 mm. at 1 M. centres.

A minimum of 150 mm of approved soil in accordance with 22.2 shall be spread uniformly over the loosened area and incorporated into the sub-grade soil to obtain a uniform and well pulverised soil mix. The area shall be compacted to a minimum of 90 % of maximum dry density as determined in accordance with Test 13 of BS 1377.

iii. Finished Grading

Grades shall be brought to the finished ground levels agreed with the Engineer-in-Charge to a tolerance of ± 25 mm. Finished ground levels shall be 30mm below adjoining paving or kerbs after compaction and settlement. Grading shall be carried out in such a manner that even gradients are formed between the spot levels with a pleasant contour. No depressions shall remain, which could collect standing water.

Soil shall be placed in lifts not greater than 150 mm in thickness.

The filled area shall be compacted to a minimum of 90% of maximum density as determined in accordance with Test 13 of BS 1377. The manure shall be spread uniformly for the specified thickness.

iv. Scalping Old Lawns

The old lawn contains noxious weed grasses as Bermuda grass and old sod shall be stripped off with flat back spade before building a new lawn. The existing sod shall not be dug into soil as clumps of buried sod.

v. Making the lawn bed smooth

A lawn bed shall be as smooth and flat as possible. However it should have slight pitch, even in flattened garden. Figure on fall of 6 to 12 inches in 100 feet so that water can run off once the root has reached its saturation point.

22.3.2 SEEDING A PREPARED LAWN BED

Divide the amount of seed necessary for the area into four equal portions, so that there are four approaches over the seed bed. Divide the seed bed half by running a string down the middle. Broadcast one quarter portion down each half, spreading it evenly and uniformly within each marked area. Then run the string across the middle of the lawn in the opposite directions and scatter the remaining two quarter portions on the two halves.

Broadcast the seed on the prepared lawn bed while the air is quite. It shall be done with hand or mechanical seeder.

After the seed is broadcast, rake it in lightly to ensure a thorough contact of seed with seed-bed soil. Very lightly brush up the seeded surface with a wire rake using light circular motion so that the seed is dispersed evenly. In case there are concentrated patches, swirl them out lightly into the surrounding area to make an even covering. At this stage, do the cross raking and mulching in flat soled shoes, tennis shoes, or barefooted.

In case of hot dry weather or drying winds, within 30 days after sowing, apply a thin, moisture holding mulch, over the seed. After seeding and cross raking, put on a 1/8 to 1/16 inch layer of peat moss of screened sawdust that has been aged at last one year. Don't toss it upward so that it falls in piles.

Whatever the covering, roll it smooths with a light roller (empty) after it has been applied. If a peat moss covering is lumpy, chop up the lumps with the back side of a wire rake before rolling.

For initial watering, use adequate length of hose to get all the way around the lawn without dragging across it and a hand sprinkler that throws out a through but gentle spray. An hour a day for 20 to 30 days of watering shall be needed when days are warm and windy, waters 2 to 3 times a day to keep the surface continuously wet and keep the top covered with moisture until all the grasses are up.

If seeds and mulch happens to wash off on to an adjoining paved area, don't attempt to blast them back into place with the spray as it may washout more seeds along the sides of the seedbed. After the first week, the little seeding will have gained enough stature to take a bending. It is possible at that time, to pull the weeds that come up with the seeds, lay a plank out across the seedbed and walk along it to pull the weeds.

Mow the lawn first time, when the grass is about 2 inches high or when the blades of grass take on a noticeable curvature. Bent grasses that are to be cut at 1 inch height should never be allowed to grow much higher than 1 inch. It is important that the mower be sharp at all times.

22.3.3 SEEDING ON A SLOPE

Lawns can be planted successfully on the ground that slopes upto 15%. If the slope is steeper, a ground cover or a system of terraces would be more satisfactory.

Prepare the seedbed as described in specifications 22.2.2 with following special care;

When racking the seed bed, rake across the slope, when rolling the seed bed, roll it up and down. Burlap or specially manufactured anti-erosion net spread over a newly seeded slope will keep moisture in the ground and prevent seed from washing away. If burlap is of a tight weave, remove it as soon as the grass begun to come up. Anti-erosion net or loose weave burlap can be left in place to vet. Sprinkler system can be used if the slope can be covered with burlap and holes are cut for the sprinklers head. Otherwise water the seedbed by hand, standing at the bottom of the top. Don't use sprinklers for at least two weeks and then run them slowly to avoid puddling or washout.

If erosion is likely to be a problem, install a drain scraper across the top of the slope to carry water off to one side. Sodding with desired permanent grasses is a good solution where an immediate erosion hazard exists.

22.3.4 SODDING A PREPARED LAWN BED

i. Shipping and Delivery

Prior to shipping the grass to be planted shall be inspected, dug, and made ready for shipping in accordance with standard practices and procedures. The Engineer-in-Charge shall be notified of the delivery schedule in advance so the grass may be inspected upon arrival at the Site.

All unacceptable grass shall be removed from the Site immediately. The Engineer-in-Charge may request inspection at the source prior to delivery of grass to the Site. The Engineer-in-Charge reserves the right to reject any delivery that does not meet the quality requirements.

ii. Storage

Grass shall be installed as soon as possible after delivery to the Site. Grass shall be protected from exposure to wind and direct sunlight prior to installation. Grass not installed on the day of arrival shall be stored in shaded areas, protected from the wind and maintained and watered to good horticultural standards until planted. Care shall be taken to ensure that the grass does not dry out.

Seed and fertilisers shall be kept in dry storage away from contaminants in areas as designated or approved by the Engineer-in-Charge.

Soil, compost, fertilisers and other amendments shall be delivered to the Site and stored separately in approved locations and in a manner to avoid contamination and wetting until soil mixing operations commence.

iii. Procedure

Unroll the sod on prepared soil, lay the strips parallel with the strips staggered as in the brick layer running bond patterns. Press each successively laid strip snugly up against the one next to it. The sod strips are all laid in this fashion, roll the sod with roller half filled with water to smooth out rough spots and bond the sod with soil. Now water a little more carefully than usual for a few days till the grass is set.

22.3.5 SPRINGING OR PLANTING GRASS ROOTS

i. Grass Materials

Grass sprigs shall be provided as healthy living stems stolons or rhizomes with attached roots including two to three nodes. The quality of nodes shall be (Dhaka/Australian) grass or any approved by the Engineer. They shall be 5 to 15 mm long without adhering soil. The limitation of time between harvesting and planting of sprigs shall be 24 hours. Sprigs shall be obtained from heavy and dense turf, free from weeds. Sprigs that have been exposed to heat and excessive drying will be rejected. Sprigs shall be planted at 150 mm apart in both directions.

Grass seed shall be the latest season's crop and shall be delivered in original sealed packages bearing the producer's guaranteed analysis for percentage of mixtures, purity, weed seed content, and inert material. Seed that has become wet, mouldy, or otherwise damaged will not be acceptable.

On-site seeding shall be done in the presence of the Engineer. The seed mixture shall be sown at the rate of 35 g/m2. Grass seed mixtures shall be listed by schedule with information as follows:

a) botanical name
b) common name
c) proportion by weight
d) minimum percentage of pure seed
e) minimum percentage of germination
f) maximum percentage of weed seed

Turf shall be strongly rooted, not less than 2 years old, free of weeds and undesirable native grass. Only turf that is capable of vigorous growth and development when laid shall be used.

Turf shall be of a uniform size in width and length. Broken pads or pads with uneven ends will not be acceptable.

ii. Grass Sowing

i. The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as specified to a depth of 15 cm. Dead grass and weeded shall not be planted. The Contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for mowing whichever is later.

   Generally planting in other direction at15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn.

ii. During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

22.4 IRRIGATION WATER

22.4.1 SALT CONTENTS

Irrigation water shall be provided by the Contractor from a source approved by the Engineer-in-Charge as being suitable for irrigation. Water shall be free from substances harmful to plant life. Water sources shall not exceed the following parameters:

a) pH : 6 to 7
b) total dissolved solids : less than 1000 ppm

22.4.2 CAPACITY

Each soil type has its own water holding capacity. The larger the sol particles, the less will be its water holding capacity.

Here is the capacity of 100 square feet of soil, 1 foot deep

i. In Sand -60 Gal. = 1" deep irrigation
ii. In Loam - 60 Gal. = 1-1/2" deep irrigation
iii. In Clay - 160 Gal. = 2-1/2" deep irrigation

Obviously the lighter soil must be watered more frequently than the heavy soil in order to keep moisture in it. In good deep soil grass roots will go down to from 24 to 30 inches, depending upon the type of grass, its age (a lawn root system goes deepest during the first year or two), and how the soil is watered. The root depth is however limited, if the top soil is under laid with a layer of soil that is impervious to water.

22.4.3 RATES OF WATER LOSS

The average water loss in mild summer areas is about 1 inch of water each week. In the hot localities, especially when a dry wind is blowing, the weekly loss increases to 2 inches and more in a week.

22.4.4 HOW DEEP DOES THE WATER GO

In dry soil one inch of water will penetrate as follows:

i. In Sand 12"
ii. In Loam 6"
iii. In Clay 4" to 5"

Water does not move down through soil until each soil particle has its film of water. After each particle has its quota, the additional water is free to move on the external particle. How deep one inch of water will penetrate depends on the moisture in the soil when water is applied.

For example an open field with a clay soil that was completely dried out by the time of a rain, had to receive 10 inches of rain before it becomes wet to a depth of 3 feet. But an added inch of water would penetrate 3 feet and more if the first were saturated.

22.4.5 INTERVALS FOR WATERING OF LAWN

Alternate wetting and partial drying out of soil, encourage healthier plant growth and deeper rooting in hot summer areas.

Normally the soils would need more than 1" deep irrigation every week depending upon the penetration, aeration and the wilting coefficient of soil. Deep watering once a week shall be preferable, which is however practicable only in canal irrigated area. In other areas light irrigation is resorted every 2nd or 3rd day or daily sprinkling.

22.5 LAWN MAINTENANCE DURING PLANT ESTABLISHMENT PERIOD

The Contractor shall be responsible for maintenance of lawn as specified. Maintenance shall consist of watering, fertilising, weeding, mowing, trimming and other operations as required to establish a smooth acceptable lawn free of eroded or bare areas. If required, the Contractor shall apply maintenance fertiliser after the second mowing. Any additional fertiliser shall be added when grass is dry. After application of the fertiliser, the area shall be watered well

The Contractor shall maintain lawns for not less than the period stated below and longer as required to establish an acceptable lawn.

Seeded lawn areas shall be maintained through three (3) maintenance cuttings but not less than sixty (60) days after substantial completion.

Sprigged and turfed lawn areas shall be maintained through two (2) maintenance cuttings but not less than thirty (30) days after substantial completion.

22.6 FINAL ACCEPTANCE

Prior to the completion of the plant establishment period, a preliminary inspection shall be undertaken by the Engineer-in-Charge. The time for this inspection shall be established in writing.

The plant establishment and warranty period will end with this inspection provided the grass is growing in healthy condition. The Contractor shall repair any damages and defective turf shall be replaced. Replaced plants will be ofthe same size and species as originally specified.

A final inspection, if required, shall be undertaken by the Engineer-in-Charge to determine that the deficiencies noted in the preliminary inspection have been corrected. The time for this inspection shall be established in writing.

22.7 DECORATIVE BOULDERS

The stone boulders for placement in lawns shall be of size and shape as specified. The stones shall be of quartzite from river gravel limestone, sandstone from quarry as approved by the Engineer-in-Charge. Stones shall be hard sound durable and free from weathering and defects and patches of loose or soft materials that may adversely affect strength and appearance.

The stones shall be placed in lawn as specified. The procurement shall be on the basis of sample stones presented by Contractor and approved by the Engineer-in-Charge.

22.8 TREE GUARDS

22.8.1 GENERAL

Tree guard shall be as specified and approved by the Engineer-in-Charge. All the item constituting Tree guards shall be paid under relevant chapters of Specifications.

22.8.2 RCCGUARDS

RCC guards shall be of specified sizes and shape and produced complying with the requirements of Section 5 – Plain and Reinforced Concrete. The guards shall be given three inside and outside white washing coats complying with the provisions of Clause 15.3 – White Washing of Section Finishing. The guards shall be cast to the length shown on drawings and shall have a smooth surface.

22.8.3 SOLID BLOCK MASONRY GUARDS

Solid Block Masonry Blocky Guards for trees shall be of Block Masonry for the size and shape as specified with perforations as shown. The Block masonry shall comply with the provisions of Section – 9 Block Masonry. In general the perforations shall be 33% of the surface area of guards. The foundation shall be of 1:2:4 Plain Concrete as shown in Drawings complying with the requirements of Section 5 – Plain & Reinforced Concrete.

22.8.4 BRICK MASONRY GUARDS

The Brick Masonry Guards for trees shall be of size and shape as shown on Drawings complying with provisions of Section 11 – Brickwork. The white washing shall comply with applicable provisions of Section 15 – Finishes.

22.8.5 STEEL FRAME TREE GUARDS

Steel frame Tree Guard shall be of size and shape as specified made of ASTMA-36 steel sections. The members shall be framed by welding according to AWS Code as specified using AWS 7016/7018 electrodes. The tree guards shall be given two coats of enamel paint over a primer as specified in accordance with applicable provisions of Section 15 – Finishes.

22.8.6 G.I.BARBED WIRE

GI barbed wire where specified shall be fixed as shown on Drawings and as directed by the Engineer. The work shall comply with applicable provisions of Sub-Section 19.2- Steel Doors, Windows & Misc. Works.

22.9 MEASUREMENT AND PAYMENT

22.9.1 COMPOSITE RATE

The measurement and payment for the items of the work of horticulture shall be made corresponding to the applicable CSR item as provided in Contract Agreement and shall constitute full compensation, for procurements, transportations, performance in all respect and completion of work as specified including the site clearance, as approved by the Engineer-in-Charge.

Pay Item No.	Description	Unit of Measurement
22.9 a	Rough dressing of the area for lawn including picking stones, pebbles, stubble, grass roots and other injurious matters and breaking of clods including disposal of rubbish within 300 ft (90m)	SM
22.9 b	Supplying and stacking well decayed cowdung manure from approved source including all leads and lifts, including Spreading cowdung manure and mixing the same upto required depth in the prepared bed including breaking clods, dressing for grassing including disposal of rubbish upto 300ft (90m), 1" thick layer before mixing	CM
22.9 c	Supplying, stacking and spreading approved garden soil (sweet earth) free from salts, pebbles and grass roots including leads lead up to 5Km radius, including Spreading in uniform thickness including mixing and breaking clods and dressing for grassing including disposal of rubbish within 300ft (90m)	CM

22.9 d	Supplying and fixing of approved quality grass in shape of grass mats including Providing and fixing of Grassing by dibbing live local grass roots 3" (75mm) apart including watering, rolling, weeding till such time the grass is set and becomes green and is fit for mowing (2kg for1sft area) complete in all respect	
	i. Local grass	CM
	ii. Korean grass	CM
	iii. Dhaka grass	CM
	iv. American grass	CM
22.9 e	Providing and fixing grass by dibbing live grass roots 3" apart from all four sides up to 2" depth, watering, weeding till such time the grass become set and green also fit for moving	
	i. Local grass	CM
	ii. Korean grass	CM
	iii. Dhaka grass	CM
	iv. American grass	CM
22.9 f	Providing and fixing 2" (50 mm) thick R.C.C. tree guards 48" x 30" x 30" (1.2 m x 0.75 m x 0.75 m) clear as per approved design and drawings including the cost of reinforcement and 3 coats of white washing.	NO
22.9 g	Providing and fixing 1:3:6 cement concrete solid block masonry 6" (150mm) thick honey combed, in tree guards average 5 ft (1.5 m) dia. & 5 ft (1.5 m) high including foundation set in 1:6 cement sand mortar including curing and 3 coats of white washing (outside) as per approved design and drawings.	NO
22.9 h	Providing and fixing first class burnt brick 4.5" (114 mm) thick masonry honey combed in tree guards average 5 ft (1.5 m) dia and 5 ft (1.5m) high including foundation set in 1:6 cement mortar including curing and 3 coats of white washing (outside) as per approved design and drawings.	NO
22.9 i	Providing 2X2 feet square and 6 feet height structural steel guard fixed/embedded on concrete paid, with structural steel angle 1"x1" properly welded as per approved design and drawings.	KG

PART-2
PUBLIC HEALTH ENGINEERING WORKS

PLANNING AND DEVELOPMENT DEPARTMENT GOVT OF AJK

GENERAL SPECIFICATIONS (Public Health Engineering)

Table of Contents

GENERAL REQUIREMENTS OF PLUMBING WORKS

G-1 SCOPE OF WORK

The work covered by this section consists of providing all material and equipment and performing all the work necessary for the complete execution and completion, including testing and commissioning of all the system of plumbing works as shown on the drawing and/or as included in plumbing works are as follow:-

i. Water supply (hot and cold) system

ii. Sanitary drainage and sewerage system

iii. Storm water drainage system

iv. Fire protection system

v. Gas supply system

vi. Fountain equipment, piping and accessories

Each of the hereinbefore listed system shall be completed in every respects including connection of these systems with external systems (city water supply, sewerage and gas) are included in the scope and shall be as shown on the drawings and as hereinafter specified.

G-2 GENERAL

The Tender Specifications and Drawings make reference to certain Standard Specifications and also to certain Model Numbers. The object of these references is to ensure that the equipment and materials offered by the Tenderers and supplied by the Contractor are in accordance with the required standard of quality, workmanship and capacities, etc. The object is not to limit the selection of equipment to a particular manufacturer unless specifically mentioned in the tender documents that a particular equipment and/or material is to be supplied.

It is clarified that the equipment and the material shall comply with various U.S. standards, BSS, DIN and VDE and of manufacturers other than mentioned in the tender documents shall be acceptable only after prior approval of the Engineer provided that they strictly conforms the required capacities as specified and meet the intent of the specifications regarding quality and workmanship.

In case there is any deviation between any item or material offered by the Tenderer from the Tender specifications and Drawings, the Tenderer shall furnish the specifications and samples to the Engineer and shall proceed only after obtaining written approval. It should be cleared that such deviations shall not stand as new item/items/work and the contractor shall not be liable to make any claim against this, and bound to complete the job on the tender rates.

These specifications and accompanying Drawings are to be considered as supplementing each other and as such are intended to serve jointly as the basis upon which the Contractor shall establish a Contract Price, and upon which he shall base the performance of the required work.

It is intent of these Specifications and Drawings to call for finished work, tested, complete, and ready for operation.

The work throughout shall be executed in the best and most thorough manner, under the direction of, and to the satisfaction of the Engineer, who will interpret the

meaning of the drawings and specifications and shall have the power to reject any work and material which in his judgment, is not in full accordance therewith.

Except for such changes as may be specifically approved by the Engineer, in accordance with alternates or options stated hereinafter, all work must be in full accordance with the intent of the plans and specifications, complete in every way and ready for satisfactory and efficient operation when delivered to the Employer.

If any item/specialty best available in the make is not in accordance with the specifications and/or as shown in the drawings, it is the responsibility of the contractor to import or manufacture it locally as per the requirement and standards.

The Contractor shall thoroughly acquaint himself with the work involved, and must verify at the building all measurements necessary for the proper installation of his work.

It is specially intended, and must be agreed to by each Contractor submitting a Tender under this specification that anything (whether material or labor) which is usually furnished as a part of such equipment as is hereinafter called for (and which is necessary for its proper completion and best operation), shall be furnished as a part of this Contract without additional cost, whether or not shown in the specifications. This provision is in consideration of the fact that in many cases, the use of apparatus of different makes may be considered, which differs in detail from that described (although intended to fulfill the same function).

Certain equipment such as pumps, starters, motors, valves etc., shall preferably be of the same make. Where the same type of equipment is used in the building this equipment must be of one manufacturer.

All special tools for proper operation and maintenance of the equipment provided under this Contract shall be delivered at no additional cost.

The Contractor shall allow in his Tender for cost of all cutting, making holes and subsequent making it good of the desired finish as per approval of the Engineer. No separate payment shall be made for this item.

The Contractor shall allow in his Tender for cost of providing protective painting or coating as specified in the relevant section and no claim shall be entertained for this item.

All pipes shall be properly installed as shown on the drawing and/or as directed by the Engineer, and shall be as straight as possible forming right angles and parallel lines with the walls and other pipelines. The position, gradients, true alignment and inverts shall be as shown on the drawings and/or as directed in writing by the Engineer.

The arrangements, positions, and connections of pipe fitting and appurtenances shall be as shown on the drawings but Engineer reserves the right to change the location etc. Special precautions shall be taken for the installation of the concealed pipes as shown on the drawings and/or as required. Should it be necessary to correct piping so installed, the Contractor shall be held liable for any injury caused to other works in the correction of piping.

G-3 CODES, PERMITS AND INSPECTION

All work shall meet or exceed the latest requirements of all authorities exercising jurisdiction over construction work at the Works Site.

All required permits and inspections certificates shall be obtained, paid for, and made available at the time of completion of the works.

All plumbing work shall be carried out in accordance with the National Plumbing Code and the Installation of the Fire Protection system shall be in accordance with BS codes and standard.

G-4 INTERPRETATION OF THE DRAWINGS AND SPECIFICATIONS

Except where modified by a specific notation to the country, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instructions to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

It shall be understood that the specification and drawings are complimentary and are to be taken together for a complete interpretation of the work. Exceptions are that notes on the drawings, which refer to an individual element of work that takes precedence over the specifications where they conflict with the same.

No exclusion from limitations, in the language used in the Drawings or Specifications shall be interpreted as meaning that the appurtenances or accessories necessary to complete any required system or item of equipment are omitted.

The necessary Drawings utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installation. The work shall be installed in accordance with the diagrammatic intent expressed on the electrical and mechanical drawings, and in conformity with the dimensions indicated on final Architectural drawings and Structural working drawings and on equipment shop drawings.

No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.

Certain details appear on the drawings which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work.

Information as to the general construction not evident in this specifications and drawings shall be derived from structural and architectural drawings and specifications.

G-5 SHOP DRAWINGS BY CONTRACTOR

Prior to commencement of works on site and at least 3 weeks in advance of all the drawings being required for actual execution the Contractor shall submit shop drawings in triplicate for approval to the Engineer. The Engineer shall review the drawings and (i) approve the drawings or, (ii) approve the drawings with comments or, (iii) disapprove the drawings with comments for rectifications/revisions of the drawings and resubmit 3 copies to the Engineer for approval. On a drawing being approved, the Contractor shall submit 6 CPIs for formal approval and distribution to the relevant offices.

All drawings shall have plan and sections with sufficient details to clearly reflect the installation of the plant. All material specification shall be provided on the drawings. All information required for preparing suitable foundation, for providing suitable access to the plant, for making openings in building structure, for working coordination with electrical, air-conditioning and other designs etc., shall be clearly provided.

Installation shall not be allowed to commence unless approved shop drawings are in possession of the contractor, for which purpose shop drawings shall be submitted by the Contractor to the Engineer three weeks in advance of actual requirements to allow for ample time in checking and approval and no claim for extension to the contract time will be considered by reason of the Contractor's failure to submit the drawings on time.

Each shop drawing submitted by the Contractor shall include a certificate by the Contractor that all related conditions on site relevant to that particular installation have been checked and that no conflict exists.

Any expanses resulting from an error mistake or omission in or delay in delivery of the drawings and information mentioned above shall be borne by the Contractor.

Drawings approved shall not be departed from except on the instructions of the Engineer.

The approval by the Engineer for any submitted data, working drawings, performance curves, test certificates for any items, arrangements and/or layout shall not relieve the Contractor from any responsibility regarding the performance of the Contract. Such approvals shall not also relieve the Contractor from responsibility of any error in the submitted data and workings, brought to light at any time subsequent to any approvals.

G-6 APPROVAL FOR MATERIAL AND EQUIPMENT

a. General

All the material and equipment shall be of the specification mentioned herein and the Contractor shall submit the sample, necessary catalogues, sketches, the name of manufacturer and guarantee if necessary, before installation and shall be installed after the Engineer approves it. All material and equipment shall be new and unused.

Approval of material and equipment by the Engineer shall not absolve the Contractor of the responsibility of furnishing the same of proper size, quantity, quality and performance characteristics to efficiently perform the requirements and intent of the Contract.

b. Approval of Imported/ Local Equipment

For approval of all equipment, the Contractor shall be required to submit, within two weeks of the signing of the Contract, detailed submittals stating the equipment proposed to be supplied and providing supporting Literature/Brochures etc., to enable the Engineer to check conformance to the specifications. Performance curves and charts shall be submitted with the operating points a clearly marked. All equipment be submittals shall be accompanied with the certificate stating that the equipment proposed to be supplied fit into the space allocated for it with sufficient clearance around it to allow for installation of related ducting, piping etc., and provides for maintenance clearance as required by the manufacturer of the equipment, and that all special requirements of the equipment have been accounted for. Any additional information, test reports etc., required by the Engineer shall be furnished by the Contractor. All work related to the equipment shall only be commenced after receipt of written approval from the Engineer.

c. Approval of Imported/Local Material

All imported material to be used in the works shall be submitted to the Engineer and approval obtained. Manufacturers literature/ brochure etc., that provide complete information on the material specifications, shall be

submitted. If manufacturer's literature is not available, a sample of the material shall be submitted along with type written notes indicating relevant source data and specifications on the material. Any other samples, information, test reports etc., required by the Engineer shall be submitted. Any additional information test reports etc., required by the Engineer shall be supplied by the Contractor.

G-7 CLEANING AND PROTECTION

The Contractor shall be responsible for his work until its completion and final acceptance and shall replace any of the same, which may be damaged, lost or stolen; without any additional cost to the Employer.

All openings left in floor for passage of lines of soil, drain, waste, vent, and supply pipes shall be covered and protected. All set traps shall be sealed with oil. Due precautions shall be taken against freezing during Cold Weather. All open ends of pipes shall be closed by a plug fitting to prevent obstruction and damage. The use of new permanent water closets and other new plumbing fixtures during the progress of the work is prohibited.

As soon as installed, all metal fixtures and trimmings shall be thoroughly covered by the Contractor with noncorrosive grease which shall be maintained until all construction work is completed.

Upon the completion of the work, all fixtures and trimmings shall be thoroughly cleaned and polished and left in first class condition.

Prior to delivering the works to the Employer the Contractor shall thoroughly clean all equipment fixtures, fittings etc.

Before final connections are made and before operation of equipment and piping, all piping interior and exterior shall be thoroughly blown out, rod out, or washed out at least twice in a manner as directed and/or approved by the Engineer, to remove all accumulation of dirt, chips or other deleterious material. The Contractor shall make all temporary connections and furnish all appliances required for the purpose of cleaning at no extra expense to the Employer.

Before erection, all pipes, tubing, valves and fittings shall be thoroughly cleaned of oil, grease or other combustible materials by washing a hot solution of sodium carbonate or tri-sodium phosphate mixed in the proportions of one pound to three gallons of water.

Scrubbing and continuous agitation of the parts shall be employed where necessary to remove all deposits and ensure cleaning. After washing, all materials shall be rinsed thoroughly with clean hot water.

After cleaning, great care must be exercised for the storage and handling of all materials and in the conditions of tools used in cutting and reaming to prevent oil or grease being introduced into the tubing. Where such contamination is known to have occurred the materials affected must be re-washed and rinsed.

G-8 PAINTING, COATING AND STENCILING

a. General

Painting shall include furnishing labor, materials equipment, ladders, scaffolding, protective covers, other items required to prepare and finish surfaces of work specified herein or in any of the other sections. Paint color scheme shall be specified at the time of painting or earlier and shall be based on "American Standard Scheme for Identification of Piping System" ASA A-13.1 of 1975.

b. Surface Preparation

i. Surface to be painted shall be dry and free form burrs, weld spatter, dirt, dust, rust, loose mill scale, grease, oil and other foreign matter before any paint is applied.

ii. All rust and loose mill scale etc., shall be removed by thoroughly chipping, scraping and wire brushing. Oil, grease, dust etc., shall be removed by washing down with a suitable solvent, as recommended by the paint manufacturer, and wiping with clean rags.

iii. All tools shall be used in such a manner so as not to leave rough or sharp surfaces. No cuts shall be made on steel surfaces.

iv. Before applying the finish coat the printed surface shall be scuffed lightly with sand paper recommended by the paint manufacturer.

c. Applications

i. All material shall be applied in strict accordance with the paint manufacturer's directions unless otherwise specified.

ii. Paint shall be applied by brush, spray or any other paint manufacturers approved method in such a manner that a uniform thickness (as per manufacturer's recommendation) is maintained in each coat and no defects are produced in the previous coats.

iii. Each coat shall preferably be of different color so as to produce a contrast assuring complete covering by the next coat. Sufficient time shall be allowed between coats to permit drying. A minimum of 24 hours between applications on any one surface shall be allowed unless otherwise specified by the manufacturer.

iv. No painting work shall be done on exterior surfaces during rainy, damp, foggy or dust weather and no painting material shall be applied if the temperature is above 50°C. Painting work shall be avoided in cases where the surface is damp or blowing winds. The Engineer shall determine whether the conditions are suitable for painting or not.

v. The primer coat of paint shall be applied as soon as possible after the surface preparation but, in any case, on the same day.

vi. Before application of painting material, the Engineer shall inspect and approve the quality of surface preparation and the preparation of painting material.

d. Paint System

i. Materials and Equipment

All materials and equipment factory fabricated, imported or otherwise shall be provided with a fresh coat of paint, of same color as the original factory paint, if in the opinion of the Engineer the same has deteriorated to an extent to require fresh painting. Paint shall be applied as per the accepted norms and as directed by the Engineer.

ii. Un insulated Surfaces

Including piping, valves and fittings shall be painted with two coats of primer followed by the two coats of enamel paint.

iii. Insulated Surfaces

Shall be painted with one coat of primer and one coat of enamel paint

iv. Underground Galvanized Iron or Black Steel Piping

Or piping concealed in wall chase and concrete shall be wrapped with approved polyethylene anticorrosive tape. (Also see Section 42.12)

v. Extent of Painting on Pipes

All exposed interior utility piping and all piping readily serviceable in walk-in utility spaces and in serviceable spaces, shall be painted as noted above and specified herein.

e. Print

i. Primer for Iron Surfaces

Shall be "KORMIC" steel protective primer as manufactured by Johnson & Nicholson or equivalent

ii. Primer for Galvanized Surfaces

Shall be "KORMIC" galvanized Iron Primer as manufactured by Johnson & Nicholson or equivalent.

iii. Finishing Paint

Shall be generally enamel paint, unless the application requires special paint, in which case suitable special paint manufactured by Johnson & Nicholson shall be used or equivalent.

f. Stenciling

i. **Piping**

The Contractor shall attach a sheet metal label near each valve on the pipe, indicating the name of the fluid. Also an arrow should be painted next to the legend indicating the direction of flow in pipe. The legend shall be placed in a location so that it can be easily read from the floor. The legend shall conform in size of letters and color to ASA A-13.1 of 1975, "Scheme for the Identification of piping System".

ii. **Equipment**

All equipment shall be provided with rating shields to be fixed at a suitable external location of the equipment. Rating shields shall be of laminated plastic of suitable size with the ratings painted on. The shields shall generally display the following data:

1) Fluid Flow Rates
2) Pressures, Pressure Drops.
3) Capacities.
4) Motor Data

Laminated Plastic shall have white core with black outer layers, which when engraved will produce white letters and/or numerals on a black background.

iii. **Identification Tags**

Shall be installed on all Valves, controls, and other parts of the system Tags shall be of laminated engraved plastic 50mm round or square with letters or numbers 12mm high and fastened securely with brass “S” hooks or chains indicating system, pressure and diameter of valve.

The Contractor shall further provide charts, diagrams, of size and type as approved designated numbers, service or function and location of each tagged item.

G-9 CUTTING AND PATCHING

Cutting will be done under Specification of other trades. This Contractor is called upon to set openings and sleeves for pipes accurately before the concrete floors are poured or may set boxes on the forms so as to leave openings in the floors in which the required sleeves can be subsequently located in which case he is called upon to fill in the concrete voids around the sleeves, water tight.

All patching will be done under Specifications of other trades. Should the Contractor neglect to perform his preliminary work and should cuttings be required in order to install the piping equipment, then the expense of the cutting and restoring of surface to their original condition shall be borne by the Contractor.

G-10 OPERATING AND MAINTENANCE INSTRUCTIONS

Three sets of operating and maintenance instructions covering completely, the operation and maintenance of all plumbing equipment, pumps and the like shall be furnished to the Employer. Three sets of lubricating charts and manuals for each item of equipment shall be furnished to the Employer.

G-11 STANDARDS ABBREVIATIONS

ANSI	American National Standards Institute
API	American Petroleum Institute
ASA	American Standards Association
ASTM	American Society for Testing & Material
BSS	British Standards Specifications
DIN	Deutsches Institute fürNormung (German Standard)
DVS	German Plastic Welding Standards
IEC	International Electro technical Commission
ISO	International Standards Organization
NFPA	National Fire Protection Association
OHSAS	Occupational Health & Safety Assessment Specifications
PS	Pakistan Standard Specifications

G-12 **PRIORITY OF ITEM**

If there is any disparity between nomenclature of bill of items and text specification than following will be the priority.

a) Specification of the text will get the priority over bill of items (Text).

b) If there is any difference in dimensions than the figures in bill of items shall priority.

SECTION 40 PUMPING MACHINERY

40.1 SCOPE OF WORK

The work to be done under this section of the specifications includes furnishing all plant, labor, equipment, appliances and materials and in performing all operations required in connection with the installation of pumping machinery including all accessories, testing commissioning as specified herein or shown on the drawings or as directed by the Engineer.

40.2 MATERIALS AND PRODUCTS

Materials and machinery shall conform to the latest referenced specifications and other provisions specified herein and shall be new and unused. In case where manufacturers are specified, materials and equipment will be of the same manufacturers. In all other cases the Contractors shall submit the names and addresses of the Manufacturers and trade names of the materials and equipment that he intend to buy. Other information such as diagram, drawing and descriptive data will be supplied if so desired by the Engineer. Approval of materials and all the machinery under this provision shall not be construed as authorizing any deviations from the specifications. The approval of the machinery of manufacturer other than that specified will be purely to the discretion of the Engineer. The Engineer will be fully ascertained the facts and satisfy himself as to the performance and selection of the machinery offered by the Contractor.

40.3 SPECIAL REQUIREMENTS OF PUMPS

The Contractor shall furnish with each pump properly identified characteristic curves prepared and certifies by the manufacturer showing capacity, head, efficiency and brake horsepower throughout the entire range of the pump.

The pump shall have stable throttling curves and be suitable for unrestricted parallel operation.

All pumps shall be electric driven.

The pumps and their drives shall not over load or trip when operating against zero pressure.

The design construction and materials shall be such that damage as a result of cavitations is completely eliminated.

Pumps shall have journal bearings and be suitable for continuous as well as intermittent operation without external sealing or cooling water.

The pumps shall be such that they shall come into operation at once after a prolonged shutdown period without having to take special measures.

Pumps shall be capable of delivering specified quantity of work at the specified pressure.

Pumps shall be tested at site before their final acceptance.

Pumps shall be installed at positions shown on the Drawing and/or as directed by the Engineer.

During installation pumps shall be properly leveled, grouted in and realigned before operation in accordance with manufacturer recommendation. Suction and discharge

connection shall be installed through flexible connectors and electrical wiring shall be done.

Drain lines from pumping base plate at dip pocket shall be installed equals to the size of the opening.

Pumps and their drives shall be in perfect alignment when installed in position.

Pumps shall be suitable for automatic operation.

Foundation for pumps installation shall be 1:2:4 concrete serial to provide an internal block having a mass equal to 3 times the weight off the pump and motor. The foundation shall be isolated from the structure and plant room floor by using 50mm thick high density cork, Edges of the foundation shall be chamfered and the same shall be provided with two coats of oil paint.

40.4 MAINTENANCE MANUALS AND TOOLS

a. A book or books containing the complete information in connection with the assembly, operation, lubrication, adjustment and repair of the pumping equipment, electric motors, together with detailed parts list with drawings or photographs shall be furnished in duplicate.

b. For the pumping stations, special tools necessary for maintenance and repair of the pumps and electric motors including tools kits, grease guns etc., with accessories shall be furnished.

c. The equipment supplied for the pumping station shall be provided with spare parts necessary for the operation and maintenance for 1 year.

d. The manufacturer recommended by the Contractor to the Engineer for approval shall submit list of spare parts to be stocked by the Employer. The Contractor will also furnish such spare parts after approval of the Engineer.

e. All the maintenance manuals, tools, spare parts etc., shall be supplied by the Contractor at no cost to the Employer and such cost shall be deemed to be included by the Contractor in his Tender against item of pumping etc.

40.5 COMMISSIONING AND TESTING

The pumps shall be commissioned and tested by the Contractor. The pump operational curve shall be identified by testing no flow reading and shall be checked on the pump curve. Operational part at full flow shall be identified submitted to the Engineer. Test shall be conducted and test reports submitted to the Engineer and approval obtained.

40.6 POTABLE WATER PUMP AND ELECTRIC MOTOR

Pump shall be centrifugal type as approved manufactured, which shall be used for pumping potable water from U/G tank. Two pumps one service and one stand by, shall required to be installed. The operation of the pumps will be controlled automatically by means of level switches.

Shaft shall have sufficient strength and accuracy for successful operation under high speed. Pump capacity and head shall be as specified in schedule of pumps. Pumps shall be installed as shown on drawings. Pumps shall be supplied and installed complete with Electric motor.

The motor for driving pump shall be squirrel cage induction type, suitable for operation on 3 phase, 400 volts, 50 c/s a/c. supply as manufactured by SIEMENS or approved equivalent. The motors to be totally enclosed, fan cooled vertical

mounting type, protection class IP44 and designed to work satisfactory with a voltage fluctuation of ± 5%.

The motor shall be fully tropicalized. The motors shall have speed and torque characteristic suitable for the driven pump and shall be dimensions so as to be suitably coupled and aligned with the pumps. The motors shall have totally enclosed terminal box suitable for the starting method employed.

Pumps and motors shall be mounted on a common heavy base.

For starter Control Panel and Level Switches refer electrical specification.

40.7 HOT WATER RECIRCULATION PUMP AND ELECTRIC MOTOR

Pumps shall be in line centrifugal, which shall be used for recirculation of hot water. It shall be suitable for pipeline mounting. The hot water, circulator pump shall be of imported brand or equivalent approved by Engineer. Pump shall be directly coupled motor pump set and suitable for hot water applications. Impeller shall be of bronze and shaft of stainless steel. Casting shall be of close-grained cast iron. Motor shall be drip proof type.

40.8 DRAINAGE SUMP PUMP AND ELECTRIC MOTOR

Pumps shall be vertical single stage submersible centrifugal pumps with horizontal or vertical manufactured by approved manufacturer, discharge port designed for free standing installation or installation by means of an auto coupling guide rail system. The pump shall have level switch and control box for automatic ON/OFF operation between two liquid levels for three phase pumps. The pump fitted with level switch shall also be suitable for manual ON/OFF operation.

The stainless steel pump sleeve shall be made in one piece and equipped with an insulated carrying handle. The suction strainer is clipped on to the pump housing and can easily be removed for maintenance. The strainer shall not only prevent the passage of large solids but also ensures a slow flow into the pump. The stainless steel pump housing shall be fitted with an internal riser pipe ensuring high efficiency. The riser pipe shall have a number of holes which enable efficient cooling of the motor during operation. The cable entry shall be of socket and plug connection type, which makes quick and easy dismantling possible.

The pumps are directly connected to an asynchronous submersible motor for 1X230 V & 3 x 230 V or 3 x 400 V, 50 Hz.

Enclosure class shall be IP 68 & Insulation class shall be F (155 degree C)

The motor shall have single phase AP-12, AP 35 and AP 50 incorporate thermal overload protection and require no additional motor protection.

All explosion proof AP pumps, AP 100, APG and APL pumps shall have a thermal switch built into the motor windings. The thermal switch shall be connected to the control circuit of the motor starter.

The pumps shall be suitable for free standing installation as well as installation on an auto coupling guide rail system.

Permanent installation of pump consists of stationary auto coupling at the bottom of the pit. A twin guide rail going to the top of the pit ensures that the pump is positioned correctly when lowered from the top of the pit down to the auto coupling and connected to the pipe system. Due to this system pump can easily be pulled up for service.

The shaft shall be made of chromium steel and rotates in maintenance free pre-lubricated ball bearings. The lower bearing shall comprise of a double row of ball bearings.
The impeller shall be semi open multivane cast iron impeller with a clearance of 10 mm. Cast iron shall be chosen to give high resistance to mechanically wearing particles. An adjustable cast iron wear plate is fitted at the inlet side of the impeller.
The shaft seal shall be a combination of a mechanical shaft seal of the bellows type and a lip seal. The shaft seal of AP 12.40 shall have a cartendere seal faces and AP 12.50 shall have tungsten cartendere seal faces.

a. STARTER CONTROL PANEL AND LEVEL SWITCHES
Refer electrical specification.

b. SPARE PARTS
The Contractor shall supply the necessary spare parts for each pump.

40.9 SLUDGE PUMP

A pump used to process and move waste fluids with high solids content. They are very similar to slurry pumps, mud pumps, and other types of waste water pumps. Sludge pumps require a high-powered mechanism to move fluids that are often very heavy and sometimes viscous and full of volatile or corrosive content.
Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work moving the fluid.
Two types of pumps, centrifugal and positive displacement, are suited for pumping sludge.

a. Centrifugal Pump
Continuous energy increases the flow velocity of the fluid, which is later converted to lift or pressure. Require a vortex (chopper) impeller to handle TS >2 percent.

Advantages – low starting torques means they are less susceptible to blockages, better for long distances.

Disadvantages – can't develop high-pressures, affected by fluid viscosity, impeller wear reduces performance over time.

b. Positive Displacement Pump
Diaphragm pumps, piston and plunger pumps, screw pumps, vane pumps, and lobe pumps) – periodically added energy directly increases pressure or lift.
Advantages – multiple designs to choose between, generate high pressures, can pump material with TS 10–15 per cent, long life expectancy.
Disadvantages – lower flow rates, can be expensive due to large installation requirement.

Engineer will decide which type of pump will suit his requirements.

40.10 MEASUREMENT AND PAYMENT

a. Measurement for payment of pumping machinery shall be the actual number of pumping sets provided and installed in position; the Contractor's rate against this item shall include cost of providing and installing the pumping machinery including the provision of manuals, tools, spare part etc., as shown on the drawings, as specified herein or as directed by the Engineer.

b. Payment for pumping machinery shall be made at the unit rate given in the Bill of Quantities which shall be deemed to be full compensation under the Contract.

Pay Item No.	Description	Unit of Measurement
40.10 a	Supply and fixing at site Centrifugal Pump (EU/JAPAN/USA) for Clean Water (ISO 9906 Grade 3B),2900 RPM, including testing and commissioning with all other accessories, complete in all respect.	
	i. Capacity 0.25 cusec, 100ft Head, 5.5HP Motor	NO
	ii. Capacity 0.50 cusec, 100ft Head, 10HP Motor	NO
	iii. Capacity 0.75 cusec, 100ft Head, 15HP Motor	NO
	iv. Capacity 1.00 cusec, 100ft Head, 20HP Motor	NO
	v. Capacity 1.25 cusec, 100ft Head, 25HP Motor	NO
	vi. Capacity 1.50 cusec, 100ft Head, 30HP Motor	NO
	vii. Capacity 0.25 cusec, 200ft Head, 15HP Motor	NO
	viii. Capacity 0.50 cusec, 200ft Head, 25HP Motor	NO
	ix. capacity 0.75 cusec, 200ft Head, 30HP Motor	NO
	x. Capacity 1.00 cusec, 200ft Head, 40HP Motor	NO
	xi. Capacity 1.25 cusec, 200ft Head, 50HP Motor	NO
	xii. Capacity 1.50 cusec, 200ft Head, 60HP Motor	NO
40.10b	Supply and fixing at site Centrifugal Pump (EU/JAPAN/USA) for Waste Water (ISO 9906 Grade 3B), Capacity, 960 RPM, including testing and commissioning with all other accessories, complete in all respect.	
	i. Capacity 0.25 cusec, 40ft Head, 5.5HP Motor	NO
	ii. Capacity 0.50 cusec, 40ft Head, 7.5HP Motor	NO
	iii. Capacity 0.75 cusec, 40ft Head, 10HP Motor	NO
	iv. Capacity 1.00 cusec, 40ft Head, 15HP Motor	NO
	v. Capacity 1.25 cusec, 40ft Head, 15HP Motor	NO
	vi. Capacity 1.50 cusec, 40ft Head, 20HP Motor	NO
	Supply and fixing at site Centrifugal Pump (EU/JAPAN/USA) for Waste Water (ISO 9906 Grade 3B), Capacity, 1450 RPM, including testing and commissioning with all other accessories, complete in all respect..	
	vii. Capacity 0.25 cusec, 75ft Head, 10HP Motor	NO

	viii. Capacity 0.50 cusec, 75ft Head, 15HP Motor	NO
	ix. Capacity 0.75 cusec, 75ft Head, 20HP Motor	NO
	x. Capacity 1.00 cusec, 75ft Head, 25HP Motor	NO
	xi. Capacity 1.25 cusec, 75ft Head, 30HP Motor	NO
	xii. Capacity 1.50 cusec, 75ft Head, 30HP Motor	NO
40.10c	Supply and fixing at site Deep Well Turbine Pump (EU/JAPAN/USA) (ISO 9906 Grade 3B), 1450 RPM, including testing and commissioning with all other accessories, complete in all respect.	
	i. Capacity 0.25 cusec, 100ft Head, 7.5HP Motor	NO
	ii. Capacity 0.50 cusec, 100ft Head, 15HP Motor	NO
	iii. Capacity 0.75 cusec, 100ft Head, 20HP Motor	NO
	iv. Capacity 1.00 cusec, 100ft Head, 20HP Motor	NO
	v. Capacity 1.25 cusec, 100ft Head, 25HP Motor	NO
	vi. Capacity 1.50 cusec, 100ft Head, 30HP Motor	NO
	vii. Capacity 0.25 cusec, 200ft Head, 15HP Motor	NO
	viii. Capacity 0.50 cusec, 200ft Head, 25HP Motor	NO
	ix. Capacity 0.75 cusec, 200ft Head, 30HP Motor	NO
	x. Capacity 1.00 cusec, 200ft Head, 40HP Motor	NO
	xi. Capacity 1.25 cusec, 200ft Head, 50HP Motor	NO
	xii. Capacity 1.50 cusec, 200ft Head, 60HP Motor	NO
40.10 d	Supply and fixing at site Submersible Pump (EU/JAPAN/USA) (ISO 9906 Grade 3B), 2900 RPM, including testing and commissioning with all other accessories, complete in all respect.	
	i. Capacity 0.25 cusec, 150ft Head, 10HP Motor	NO
	ii. Capacity 0.50 cusec, 150ft Head, 15HP Motor	NO
	iii. Capacity 0.75 cusec, 150ft Head, 20HP Motor	NO
	iv. Capacity 1.00 cusec, 150ft Head, 25HP Motor	NO
	v. Capacity 1.25 cusec, 150ft Head, 40HP Motor	NO
	vi. Capacity 1.50 cusec, 150ft Head, 50HP Motor	NO
	vii. Capacity 0.25 cusec,300ft Head, 20HP Motor	NO
	viii. Capacity 0.50 cusec,300ft Head, 25HP Motor	NO

ix.	Capacity 0.75 40HP Motor	cusec,300ft	Head,	NO
x.	Capacity 1.00 50HP Motor	cusec,300ft	Head,	NO
xi.	Capacity 1.25 60HP Motor	cusec,300ft	Head,	NO
xii.	Capacity 1.50 75HP Motor	cusec,300ft	Head,	NO

SECTION 41 FIRE PUMPING SYSTEM AND EQUIPMENT

41.1 SCOPE OF WORK

The work to be done under the section of this specification includes furnishing all plant, labor equipment, appliances and materials and in performing all operation required in connection with installation of pumping machinery including all accessories, testing and commissioning and firefighting equipment as specified herein show on the drawings or as directed by the Engineer.

For pumping equipment, refer to Sec: 40 of this document.

41.2 FIRE FIGHTING EQUIPMENT

a. Hydrant Valve Cabinet

It shall be as show on drawings. It shall have hinged fixed door with locking arrangement. It shall have a valve of 1.5" diameter and shall have a space for placing 2 No. water type Fire Extinguishers. Cabinet shall be painted internally and externally with two coats of synthetic "KROMIC" red lead paint and two coats off synthetic enamel red colored paint. A sample construction of the cabinet shall be submitted to the Engineer for approval, prior to final fabrication. The whole equipment shall be installed as shown and shall be tested in the installed position.

Cabinet shall be recessed type, constructed of stainless steel sheet. Cabinet size shall be 58 inches high, 30 inches wide and 10 inches deep.

Cabinet shall have two compartments, each with an independent door. The smaller compartment shall accommodate 2 No. Water type fire extinguishers. The longer compartment shall have the following components.

i. A 3/4" x 100 ft swinging type hose reel.

ii. Shut off three way nozzle.

Payment shall be made as per rate quoted for complete supply and installation of each unit.

b. Flanged Fire Hydrant

It shall have Grey Cast Iron Body with internal and external epoxy coating. It shall conform to BS 750. Size of hydrant shall be one of the following. Fire hydrant shall be installed on minimum 3" dia. pipe.

i. 6"x3"x2.5"

ii. 4"x3"x2.5"

iii. 3"x3"x2.5"

c. Portable Fire Extinguishers

Specific type Portable Fire Extinguishers shall be installed at locations shown on the drawings. Extinguishers shall be installed on purpose made hooks at a suitable height as approved by the Engineer. The extinguishers shall be of the following types:-

i. Multipurpose Halotron-1 Fire extinguishers

These shall be suitable for fighting class A, B, C, & E fires. Extinguisher shall be manufactured by American Pacific corp. USA. Weight of Extinguisher shall be 4 Kg.

ii. Water type fire extinguishers

Model for water type fire extinguisher shall be WSP-10. Also include the pressure gauge and hook. Extinguisher shall be of 10 liter capacity.

iii. Siamese Inlet

The contractor shall supply and install Fire Department Connection (Siamese Connection) size 65 x 65 x 100mm of brass body and plate. The connection should be complete with chain caps and quick coupling etc.

d. Fire Pump

Fire pumps shall be electric and diesel powered pump sets of modular design, designed to be coupled with each other, and shall comply with EN 12845 and UNI 10779 standards. Pump shall be coupled to an electric (efficiency level IE3) or Diesel motor by means of an elastic spacer coupling, capable of providing the power absorbed by the pump at any pump load condition, from no-load, to a load corresponding to NPSH16m (as requested by section 10.1 of the UNI EN 12845 standard).

i. Motors

The motors of all the main pumps shall be sized in accordance with standard EN 12845 - 10.1 to supply the power absorbed by the pump under any load conditions up to an NPSH value of 16 m.c.w. All the engine-drive pumps have a fuel pump sized to ensure 6 hours of operation, as required for the highest hazard classes pursuant to standard EN12845 - 10.9.6.

ii. Hydraulics

Fire pumps shall have end-suction back pull out design (as required by the EN 12845 - 10.1 standard), horizontal axis standardized centrifugal pump coupled with an electric or Diesel motor by means of an elastic spacer coupling protected by safety coupling cover.

iii. Control panels

All the fire-fighting sets shall have an electric control panel pursuant to EN 12845 /UNI 10779 for each main pump and an electric control panel for the jockey pump, already connected to the main components (motor, pressure switches, sensor, batteries, etc.).

41.3 MEASUREMENT AND PAYMENT

a. Pumping Machinery and Pressure Gauges

Measurement for payment of pumping machinery shall be the actual number of pumping sets provided and installed in position, the contractor's bid against this item shall include cost of providing and installing the pumping machinery, the provision of manual tools, spare parts, etc. as shown on the drawings, as specified herein or as directed by the Engineer.

b. Fire Fighting Equipment

Measurement for Hydrant valve cabinet, portable fire extinguishers and Siamese inlet shall be made as per actual number provided and installed and shall be for complete work specified herein or as shown on drawing.

Payment for Hydrant cabinet, portable fire extinguisher and Siamese connections shall be made at the applicable unit rate in the Bill of Quantities. The rate shall be full compensation for the complete work specified herein or as per contract drawings.

Pay Item No.	Description	Unit of Measurement
41.3 a	Providing and fixing single nozzle fire hydrants, standard pattern and screw outlet. BSS-750 quality and weight, complete in all respect, cost of jointing material is included.	
	i. 3" (75mm) inner dia.	NO
	ii. 4" (100mm) inner dia.	NO
	iii. 6" (150mm) inner dia.	NO
41.3b	Supply and fixing at site Fire Pump Set (EU/JAPAN/USA) (NFPA-20), including testing and commissioning with all other accessories, complete in all respect.	
	i. Set 500gpm @ 8 Bar	NO
	ii. Set 750gpm @ 10 Bar	NO

SECTION 42 WATER SUPPLY, GAS, FIRE PROTECTION & FOUNTAIN PIPING AND SPECIALITIES

42.1 SCOPE OF WORK

The work to be done under this section of the specification consists of:

a. Providing all material and labour for proper installation of pipes, pipe fittings including jointing, clamping, cleaning, painting etc. both above ground and underground as shown on the drawing or as specified herein.

b. Providing all material and labour, equipment, appliances etc. for proper installation of valves, strainers and piping specialities etc. as shown on the drawings or as specified herein.

42.2 SYSTEM PRESSURE AND TEMPERATURE

All pipes, fittings, valves and pipe specialities referred in this section or other, used for water supply system shall be capable to withstand the max. Test pressure of 90 psi or 1.5 times the working pressures whichever is greater for a period of One (1) Hour and the temperature of 65.6℃.

42.3 PIPES AND FITTINGS

42.3.1 PE Pressure Pipes

Polyethylene Pressure Pipes (PE 100) for potable water application shall conform to ISO 4427:1996, DIN 8074/8075 and PS-3580:1997. PE pipes are suitable for outside water supply and distribution network and for other applications i.e. chemicals, compressed air, hazardous wastes, slurries, marine, mining and agriculture etc.

Polyethylene used for Pipes shall contain Carbon Black (2% min.) as UV stabilizer when they are to be used in exposed conditions.

Pipes up to 75 mm Outer Diameter (OD) shall be joined by using compression fittings of the same operating pressure as the pipe. Pipes of 90mm or larger OD shall be joined using Butt Fusion or Electro Fusion methods as specified by the manufacturer. Manufacturer's recommendations shall be strictly followed to ensure proper joints in pipes.

Cold Bending Radius for PE pipes at 20^{o}C shall not be less than 22 x Pipe OD. For lesser radii, Bend fittings shall be used.

PE pipes (PE 100) shall conform to the following pressure ratings, dimensions and physical properties.

Table 42-1 :PE 100 Pressure Pipe Dimensions (ISO 4427)

OD (mm)	PN (bar)	SDR (OD/Th)	Th. (mm)	OD (mm)	PN (bar)	SDR (OD/Th)	Th. (mm)
20	16.0	11.0	1.9	110	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	5.3 6.6 8.1 10.0 12.3
25	12.5 16.0	14.0 11.0	1.9 2.3	125	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	6.0 7.4 9.2 11.4 14.0
32	12.5 16.0	13.0 11.0	2.4 2.9	140	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	6.7 8.3 10.3 12.7 15.7
40	12.5 16.0	13.0 11.0	3.0 3.7	160	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	7.7 9.5 11.8 14.6 17.9
50	12.5 16.0	13.0 11.0	3.7 4.6	180	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	8.6 10.7 13.3 16.4 20.1
63	10.0 12.5 16.0	16.0 13.0 11.0	3.8 4.7 5.8	200	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	9.6 11.9 14.7 18.2 22.4
75	8.0 10.0 12.5 16.0	17 13.6 11.0 9.0	4.5 5.6 6.8 8.4	225	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	10.8 13.4 16.6 20.5 25.2
90	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	4.3 5.4 6.7 8.2 10.1	250	6.0 8.0 10.0 12.5 16.0	21.0 17.0 13.6 11.0 9.0	11.9 14.8 18.4 22.7 27.9

Table 42-2: TYPICAL PHYSICAL PROPERTIES OF POLYETHYLENE (BLACK) PE 100

Properties		Typical Value	Unit	Test Method
Density	(Compound)	950-959	Kg/m^3	ISO 1183
Melt Flow Rate	(190℃/5.0 kg)	0.3	g/10 min	ISO 1133
Tensile Stress at Yield	50 mm/min	19-21	MPa	ISO 1133
Elongation at Yield		9	%	ISO 527-2
Elongation At Break		>350	%	ISO 527-2
Charpy Impact Strength, notched	0℃	14	Kj/m^2	ISO 179/1eA
Carbon Black Content		≥2	%	ASTM D 1603
Brittleness Temperature		<-70	℃	ASTM D 746
BSCR	10% Igepal, F_{60}	>10000	h	ASTM D 1693-A
Thermal Satiability	210℃	>15	Min	EN 728

42.3.2 PPR Water Supply Pipes

Water supply pipes (internal cold and hot lines) shall be Polypropylene Random 80 PN 20 and fittings of the same material as of pipe shall be PN 25. Pipes shall conform to following specifications:

DIN 1988	DVGW Code of Practice (Drinking water supply system; materials' components' appliances, design and installation).
DIN 8076	Standard for testing metal threaded joints,
DIN 8077	Polypropylene (PP) pipe dimensions.
DIN 8078	Polypropylene (PP) pipes; general quality requirements testing & chemical resistance of pipes and fittings
DIN 2999	Standard for fittings with threaded metallic inserts.
DIN 16962/ Pt 1	Pipe joints assemblies and fittings for type 1 & 2 Polypropylene (PP) pressure pipes; bends produced by segment inserts for butt welding dimensions.
DIN 16928	Installation, pipe and fitting connections.
DIN 4109	Noise control in buildings.
DIN 4140	Insulation of service installations.
DVS 2207	Welding of thermoplastic pipe and fittings.
DVS 2208	Welding machines & devices for thermoplastic pipes and fittings
OHSAS 18001	British standard for Health and safety management system.
BS 6920	Suitability of non – metallic product for use in contact with water intended for human consumption with regard to their effect on the quality of the water

Table 42-3: Standard Pipe (PPR) Sizes

Outer Diameter	Wall thickness	Internal diameter
mm	mm	mm
20	3.4	13.2
25	4.2	16.6
32	5.4	21.2
40	6.7	26.6
50	8.4	33.2
63	10.5	42.0
75	12.5	50.0
90	15.0	60.0
110	18.4	73.2

All PPR pipes shall be welded carried out by simultaneously heating the male and female parts to be jointed together. Once the welding temperature reached, coupling is carried out to obtain tight joint.

The surfaces of the pipe and fittings must be clean and without blemish. Ends must be clean cut at right angles. Before carrying out welding, check that the poly-melting welding device operates correctly and that the welding temperature has been reached.

Pipes and fittings are inserted to the edges of welding bush and held steady without rotating. Once the heating has been completed the parts are extracted from heating element and rapidly joined axially so as not to create an excessive seam. It is important to follow the correct coupling depth without going beyond the ledge on the fitting.

Heating, working and cooling time for joining the pipes shall be as specified by the manufacturer.

42.3.3 Galvanized Iron (G. I.) pipe, fittings and specials shall conform to the following specifications

Water supply (cold and hot) and vent pipes shall be of galvanised steel conforming to BSS 1387/1985, Medium Grade, given below. Pipefitting shall be of malleable cast iron, screwed or flanged.

Table 42-4: Pipe (G. I.) Sizes as per BS 1387

Nominal size of thread (DN)	Designation of thread	Outside diameter		Thickness	Mass of black tube	
		Max.	Min.		Plain end	Screwed and socketed
		mm	mm	mm	Kg/m	Kg/m
8	¼	13.9	13.3	2.3	0.641	0.645
10	3/8	17.4	16.8	2.3	0.839	0.845
15	½	21.7	21.1	2.6	1.21	1.22
20	¾	27.2	26.6	2.6	1.56	1.57
25	1	34.2	33.4	3.2	2.41	2.43
32	1 ¼	42.9	42.1	3.2	3.10	3.13
40	1 ½	48.8	48.0	3.2	3.57	3.61
50	2	60.8	59.8	3.6	5.03	5.10
65	2 ½	76.6	75.4	3.6	6.43	6.55
80	3	89.5	88.1	4.0	8.37	8.54
100	4	114.9	113.3	4.5	12.2	12.5
125	5	140.6	138.7	5.0	16.6	17.1
150	6	166.1	164.1	5.0	19.7	20.3
NOTE: Maximum and Minimum outside diameters meet the requirements of ISO 65.						

Fire protection pipe shall also be galvanised steel conforming to BSS 1387/1985 medium quality.

Pipe fittings shall be of malleable iron or cast iron screwed or flanged conforming to following specifications:

a. Malleable Iron (Galvanized Fittings (i.e. coupling, elbows, Tees etc.) for G. I. Pipes 2-1/2" and below shall be of at least same thickness and quality as G. I. Pipe.

b. Cast Iron threaded flanges for joining G. I. Pipe of dia 3" and above.

   - BS-10: 1962, Table D.

c. Cast Iron flanged fittings, for G. I. pipe 3" and above.

   - BS EN 545: 2002
   - Working Pressure = 400 ft. of water.

All screwed tubes, sockets and fittings shall have pipe threads in accordance with BS EN 10226-1:2004.

42.3.4 FC Water Supply Pressure Pipes

FC (Chrysotile Fibre) pipes are suitable for water supply mains and distribution lines. FC is chemically known as Hydrous Magnesium Silicate ($3MgO.2SiO_2.2H_2O$) with traces of Al_2O_3, CaO.

FC pipes and couplings shall conform to Pakistan Standard Specification No. PS 428:1984 and International Standard ISO 160:1980 “Asbestos Cement Pressure Pipes & Joints”. The rubber rings shall conform to PS 1915:1985

FC pipes are manufactured in 3 classes B, C & D which correspond to Max. Working Pressure of 6, 9 & 12 Bars. Comet coupling and rubber ring of the same class as that of the pipes is to be used for joining the pipes. Specifications for pipes are given in the table below:

Table 42-5: DIMENSIONS OF FC PRESSURE PIPE

Nominal Internal diameter mm	CLASS (B) Max. Working pressure 6 Bars = 87 lbf/in² = 200 ft.				CLASS (C) Max. Working pressure 9 Bars = 130.5 lbf/in² = 300 ft.				CLASS (D) Max. Working pressure 12 Bars = 174 lbf/in² = 400 ft.			
	Nominal Thickness of turned end mm	Tolerance on Thickness of Turned end mm	External Diameter at turned end mm	Min. Weight Kg	Nominal Thickness of turned end mm	Tolerance on Thickness of Turned end mm	External Diameter at turned end mm	Min. Weight Kg	Nominal Thickness of turned end mm	Tolerance on Thickness of Turned end mm	External Diameter at turned end mm	Min. Weight Kg
80	9	-1.5	98	21	9	-1.5	98	21	9	-1.5	98	23
100	9	-1.5	118	26	10	-1.5	120	27	11	-2	122	31
150	10.5	-2	171	45	12	-2	174	49	15	-2	180	61
200	13	-2	226	72	14	-2	228	76	20	-2	240	110
250	15	-2	280	100	17	-2	284	115	25	-2.5	300	165
300	17	-2	334	136	20	-2	340	155	30	-2.5	360	235
350	19	-2	388	173	24	-2.5	398	220	35	-3	420	320
400	19	-2	438	205	28	-2.5	456	290	40	-3	480	415
450	21	-2.5	492	250	31	-3	512	360	45	-3	540	530
500	23	-2.5	546	315	34	-3	568	445	50	-3	600	650
600	27	-2.5	654	430	40	-3	680	620	60	-3	720	920
700	32	-3	764	580	47	-3	794	850	-	-	-	-
800	36	-3	872	750	54	-3	908	1100	-	-	-	-
900	40	-3	980	920	60	-3	1020	1350	-	-	-	-
1000	45	-3	1090	1125	-	-	-	-	-	-	--	-

42.3.5 u-PVC Water Supply Pressure Pipes and Fittings

UN plasticized Polyvinylchloride (u-PVC) Pressure Pipes shall conform to BS 3505 and rubber rings shall conform to PS 3051:1991. U-PVC Fittings shall conform to DIN 8063. U-PVC pipes are manufactured in four classes B, C, D & E specifications for these are tabulated below.

MAXIMUM SUSTAINED WORKING & FIELD TEST PRESSURES:

Table 42-6: WORKING PRESSURE

Class	Bar	Kgf/cm^2	lbf/in^2
B	6	6.12	87
C	9	9.18	130
D	12	12.25	173
E	15	15.30	217

Table 42-6.1: TEST PRESSURE (1 Hour)

Bar	Kgf/Cm^2	lbf/in^2
9	9.18	130
14	13.77	195
18	18.38	259
23	23	325

Table 42-7: Short-term hydrostatic pressure resistance at 20C

Maximum 1 h failure pressure

Class of pipe	Maximum 1 h failure pressure
6 bar Class – B	21.6 bar
9 bar Class – C	32.4 bar
12 bar Class – D	43.2 bar
15 bar Class - E	54.0 bar

a. Longitudinal Reversion:

When tested in accordance with BS 2782: Method 1102A using a temperature of 150 ℃ and the appropriate immersion period specified in following Table, at no position around the pipe shall the length change by more than 5.0 %.

Table 42-8: Test Piece Immersion Periods

Pipe wall thickness	Minimum immersion period
mm	min
< 8.6	15
> 8.6 but < 14.1	30
> 14.1	60

b. Impact resistance at 20 ℃:

When tested in accordance with appendix B of BS3505, the pipe shall have a True Impact Rate (TIR) below 10 % at a confidence level of 90 %.

c. Fracture toughness:

This requirement shall only apply to pipes of nominal size 3in or greater, which, when tested in accordance with appendix C of BS3505, shall withstand for not less than 15 min without breaking or cracking at the notch the test force corresponding to a true fracture toughness, K_{IC} (see appendix D of BS 3505), of not less than 3.25 $MN \cdot m^{-3/2}$ for pipes of wall thickness e_n less than 6mm or not less than 3.75 $MN \cdot m^{-3/2}$ for pipes of wall thickness e_n greater than or equal to 6mm.

Table 42-9: APPROXIMATE WEIGHTS OF u-PVC PRESSURE PIPES

Normal Size (Inch)	CLASS-B Kg/m	CLASS-C Kg /m	CLASS-D Kg/m	CLASS-E Kg/m
3/8	-	-	-	0.11
1/2	-	-	-	0.15
3/4	-	-	-	0.22
1	-	-	-	0.32
1-1/4	-	-	0.41	0.50
1-1/2	-	-	0.54	0.65
2	-	0.68	0.82	1.03
2-1/2	-	1.01	1.20	1.58
3	1.17	1.41	1.82	2.22
4	1.78	2.32	0.03	3.65
5	2.44	3.49	4.55	5.51
6	3.46	5.01	6.57	7.95
8	5.30	7.72	10.05	12.17
10	8.26	11.72	15.59	18.89
12	11.55	11.97	21.91	26.68
14	13.87	16.85	26.49	32.16

Table 42-10 : U-PVC PRESSURE PIPE DIMENSIONS FOR CLASSES B, C, D AND E (as per BS 3505)

Nominal Size	Mean Outside diameter		Wall thickness											
Inch	Min.	Max.	Class B 6 bar			Class C 9 bar			Class D 12 bar			Class E 15 bar		
			Averaged value	Individual value		Averaged value	Individual value		Averaged value	Individual value		Averaged value	Individual value	
			Max.	Min.	Max.	Max.	Min.	Max.	Max.	Min.	Max.	Max.	Min.	Max.
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
3/8	17.0	17.3	-	-	-	-	-	-	-	-	-	1.9	1.5	1.9
1/2	21.2	21.5	-	-	-	-	-	-	-	-	-	2.1	1.7	2.1
3/4	26.6	26.9	-	-	-	-	-	-	-	-	-	2.5	1.9	2.5
1	33.4	33.7	-	-	-	-	-	-	-	-	-	2.7	2.2	2.7
1-1/4	42.1	42.4	-	-	-	-	-	-	2.7	2.2	2.7	3.2	2.7	3.2
1-1/2	48.1	48.4	-	-	-	-	-	-	3.0	2.5	3.0	3.7	3.1	3.7
2	60.2	60.5	-	-	-	3.0	2.5	3.0	3.7	3.1	3.7	4.5	3.9	4.5
2-1/2	75.0	75.3	-	-	-	3.5	3.0	3.5	4.5	3.9	4.5	5.5	4.8	5.5
3	88.7	89.1	3.4	2.9	3.4	4.1	3.5	4.1	5.3	4.6	5.3	6.5	5.7	6.6
4	114.1	114.5	4.0	3.4	4.0	5.2	4.5	5.2	6.8	6.0	6.9	8.3	7.3	8.4
5	140.0	140.4	4.4	3.8	4.4	6.3	5.5	6.4	8.3	7.3	8.4	10.1	9.0	10.4
6	168.0	168.5	5.2	4.5	5.2	7.5	6.6	7.6	9.9	8.8	10.2	12.1	10.8	12.5

7	193.5	194.0	6.0	5.2	6.0	8.7	7.7	8.9	11.4	10.1	11.7	13.9	12.4	14.3
8	218.8	219.4	6.1	5.3	6.1	8.8	7.8	9.0	11.6	10.3	11.9	14.1	12.6	14.5
9	244.1	244.8	6.7	5.9	6.8	9.8	8.7	10.0	12.9	11.5	13.3	15.8	14.1	16.3
10	272.6	273.4	7.5	6.6	7.6	10.9	9.7	11.2	14.3	12.8	14.8	17.5	15.7	18.1
12	323.4	324.3	8.8	7.8	9.0	12.9	11.5	13.3	17.0	15.2	17.5	20.8	18.7	21.6
14	355.0	356.0	9.6	8.5	9.8	14.1	12.6	14.5	18.6	16.7	19.2	22.8	20.5	23.6
16	405.9	406.9	10.9	9.7	11.2	16.2	14.5	16.7	21.1	19.0	21.9	26.0	23.4	27.0
18	456.7	457.7	12.3	11.0	12.7	18.2	16.3	18.8	23.8	21.4	24.6	-	-	-
20	507.5	508.5	13.7	12.2	14.1	20.2	18.1	20.9	-	-	-	-	-	-
22	558.3	559.3	15.0	13.4	15.5	22.1	19.9	22.9	-	-	-	-	-	-
24	609.1	610.1	16.3	14.6	16.8	24.1	21.7	25.0	-	-	-	-	-	-

Table 42-11: GUIDE TO THE CONSUMPTION OF LUBRICANT, CLEANER AND SOLVENT CEMENT PER 100 JOINTS

RANGE OF PIPES AND FITTINGS DIAMETER (mm)

APROX	32-40	50-63	75-90	110-125	140-160
Lubricant (Kg)	-	2.00	3.50-	4.00-	5.0-
Cleaner (Liter)	0.35-	0.65-	1.00-	3.00-	6.5-
	0.50	0.90	2.00	5.00	9.0
Solvent cement (Liter)	0.78 – 1.00	1.30-1.80	2.00-4.00	6.00-10.00	13.0-18.0

Table 42-11.1 SETTING TIME

Ambient temperature	**Pipe diameter**	**Time during which the joint should not be moved**	**Waiting time before installation**
^{0}C	de (mm)	Minute	Minute
> 25	< 63	1/2	10
	>75	1	15
10 – 25	< 63	3	20
	75	5	30
< 10	< 63	8	60
	> 75	15	90

42.3.6 Natural Gas Pipes

All high-pressure Gas pipes shall be MS black tubes of API 5L grade B standards given below. All high-pressure gas piping shall be of welded construction and should be tested at pressure specified by the Gas Company. A double layer of bitumen with fibre glass is to be provided for pipes of 100 mm diameter and above.

Table 42-12: API 5L Grade B Standard

Nominal Bore mm	**Wall Thickness mm**	**Weight Kg/M**	**Test Pressure Kgf/Sq. cm.**
20	2.90	1.70	49.00
25	3.40	2.52	49.00
50	3.90	5.42	77.00
100	6.00	9.63	91.00
150	7.10	28.22	91.00
200	8.20	49.10	110.00

Low-pressure Gas pipes used in internal installation (house piping) shall conform to BS 1387 of 1985 “Medium Grade” or equivalent

All low-pressure internal gas piping may be of screwed connection. Reduction in sizes should be with reduction tees, elbows or reducers. All changes in direction should be made with the use of fittings.

42.3.7 Medium Density Polyethylene (MDPE) High Pressure Gas Pipes

Pipe shall conform to the standards ISO 4437 (DIN 8074) or ASTM D-2513 (DIN 8075) as specified, given in Tables below:

Table 42-13: ISO 4437 Dimensions in Millimeters (mm)

Nominal outside diameter	Minimum wall thickness	
	SDR 17.6	SDR 11
20	2.3	3.0
25	2.3	3.0
32	2.3	3.0
40	2.3	3.7
50	2.9	4.6
63	3.6	5.8

Table 42-14: ASTM D 2513 – Dimensions

Nominal Pipe Size	Outside diameter Inch (mm)	Tolerance for Max. / Min. out of roundness SDR 17 / SDR 13.5 / SDR 11	Wall Thickness and Tolerance					
			SDR	min. inch (mm)	Tolerance Inch (mm)	SDR	Min. inch (mm)	Tolerance inch (mm)
¾"	1.050 (26.7)	±0.010 (±0.254)	11	0.095 (2.41)	+0.011 (+0.279)	-	-	-
1"	1.315 (33.4)	±0.010 (±0.254)	11	0.119 (3.02)	+0.014 (+0.356)	-	-	-
1 ¼"	1.660 (42.1)	±0.012 (±0.305)	11	0.151 (3.84)	+0.018 (+0.457)	17	0.98 (2.49)	+0.012 (+0.305)
1 ½"	1.900 (48.3)	±0.012 (±0.305)	11	0.173 (4.39)	+0.021 (+0.533)	17	0.112 (2.85)	+0.013 (+0.330)
2"	2.375 (60.3)	±0.012 (±0.305)	11	0.216 (5.49)	+0.026 (+0.660)	17	0.140 (3.56)	+0.017 (+0.432)
2 ½"	2.875 (73.0)	±0.015 (±0.381)	11	0.261 (6.63)	+0.031 (+0.787)	17	0.169 (4.29)	+0.020 (+0.508)

SDR (Standard Dimension Ratio) = Outer Dia. / Thickness

42.3.8 Low density Polyethylene LDPE/HDPE water tank

42.3.8.1 Scope

The work under this section of the specifications includes furnishing all plant, labour, equipment, appliances, materials and in performing all operations required in connection with providing of Low-density polyethylene (LDPE) water tanks, in accordance with the Contract or as directed by the Engineer and the manufacturer's recommendations.

HDPE water tank shall conform to NSF/ANSI-61 with 5 layer construction of food grade, BPA free and FDA compliant material. Venting equipment shall be sized to limit pressure or vacuum to a maximum of 1/2" water column (0.018 Psi)

42.3.8.2 Materials

a. General

Tanks shall be of food grade, BPA free and FDA compliant material and shall conform to the latest referenced specifications and/or other provisions specified herein. Tanks shall be new and unused. In cases where manufacturer are specified, tanks shall be of the same manufacturers. In all other cases, the Contractor shall submit the names of the manufacturer from whom he intends to buy. Other information such as diagrams, drawings and descriptive data shall be supplied as desired by the Engineer. Approval of water tank under this provision shall not be construed as authorizing any deviations from specifications.

b. Manufacturing

The material from which the water tank is produced shall consist substantially of polyethylene, to which may be added only those additives that are needed to facilitate the manufacture of the polymer, and production of sound, durable pipe of good surface finish, mechanical strength. None of these additives shall be used separately or together in quantities sufficient to constitute a toxic hazard, or to impair the fabrication of welding properties of the pipe, or to impair its chemical and physical properties.

c. ASTM standards

Water tanks shall conform to ASTM D1998 – 13

d. HANDLING AND STORAGE

i. General

The Contractor shall be responsible for proper handling, as per manufacturers recommendations. The water tanks shall be stored in-accordance with the manufacturer's recommendations at approved places as directed by the Engineer.

ii. Transport

Transportation of water tanks shall be done in such a way that they are secure and that no more than an absolute minimum of movement can take place on the vehicle during transit. The same care is needed if tanks are to be transferred from one vehicle to another, how short the final journey may be.

iii. Storage

Water tanks if damaged during handling, transporting or lowering shall be rejected and replaced at the contractor's expense. Storage shall be under shade so that polyethylene tanks are not exposed to sunlight and extreme heat.

iv. Jointing

Jointing hall be made by butt fusion/socket fusion using plain/socket ended polyethylene fittings except for joining of valves and appurtenances.

42.4 VALVES AND STRAINERS

a. Gate / Sluice Valves

Gate valves up to 50 mm dia. shall be threaded ends and 65 mm dia. and above shall be flanged ends. All Valves of 75mm dia. and below shall be of Copper alloy conforming to BS EN 12288:2003 and valve of 100mm diameter and above shall be ductile or cast iron conforming to the following standards:

Valves shall be non-rising stem and double wedge or disc type and ends may be screwed or flanged.

Sluice Valves (Ductile and Cast Iron)

Sluice Valves of Ductile or Cast Iron shall be epoxy coated internally and externally and shall conform to following standards.

i. Flanged Sluice Valves (Ductile Iron) with Stainless Steel Wedge, stamp and seat as per BS 5163 with rating PN16

ii. Flanged Sluice Valves (Ductile Iron) with Bronze Wedge, stamp and seat as per BS 5153 with rating PN16

iii. Flanged Sluice Valves (Grey Cast Iron) with Stainless Steel Wedge, stamp and seat as per BS 5163 with rating PN10 or PN16

iv. Flanged Sluice Valves (Grey Cast Iron) with Bronze Wedge, stamp and seat as per BS 3464 with rating PN10 or PN16

v. Flanged Sluice Valves (Grey Cast Iron) Large Diameter serial with Bronze Wedge, stamp and seat as per BS 3464 and BS 5163 with rating PN10 or PN16

b. Globe Valves

All valves of 75mm dia and below shall be of copper alloy conforming to BS EN 12288:2003 and valve of 100mm dia and above shall be Cast Iron conforming to BS EN 13789:2002. The ends may be screened or flanged.

c. Ball Valves

All valves of 75mm dia and below shall be of copper alloy conforming to BS EN 12288:2003and valve of 100mm dia and above shall be Cast Iron conforming to BS EN 13789:2002. The ends may be screened or flanged.

d. Swing Check Valves

All valves of 75mm dia and below shall be of copper alloy conforming to BS EN 12288:2003, and valve of 100mm diameter and above shall be Cast Iron conforming to BS EN 13789:2002.

e. Float Valves

Shall be of best quality heavy duty type provided with 150mm dia. copper ball and heavy duty bronze float arm. Valve shall provide tight shut off at full closed position.

f. Y-Strainers

Strainers shall be 'Y' types with bronze body and threaded ends up to m diameter screen shall be of 20-mesh model.

Strainers above 50mm shall have Cast Iron body with flanged ends. Screen Cover shall be provided with blow off tapping. Screen shall be of perforated stainless steel, 36 holes per Sq. cm. with 1.14mm diameter and 0.5mm thick. All strainers for water supply application shall be suitable for 1055 Kg/cm² 120℃. All strainers for fire protection service shall be suitable for 21 Kg/cm² and 120℃.

g. Foot Valve

Shall be installed, on the suction line of the pumps where required or indicated on the drawings. Foot valve shall be of brass, and shall be provided with integral strainer. Foot valve shall be provided with a spring loaded vertical check disc with gasket for tight shut-off.

h. Air Release Valves

Air release valves shall be of Grey Cast Iron Body conforming to BS 1074 with epoxy coating internally and externally.

i. Pressure Reducing Valves

Air release valves shall comply with the following specifications:

Temperature Range Water: up to 70℃

Disc: EPDM

Strainer: Inline Mesh

Materials Body and Cover: Low Lead Bronze

Pressure Ratings:

- Maximum Inlet Pressure: 400 psi (25 Bar)
- Maximum Differential Pressure: 150 psi (10 Bar)
- Minimum Differential Pressure: 14.5 psi

j. Wash Out valve

Sluice Valves of Ductile or Cast Iron shall be epoxy coated internally and externally and shall conform to BS 5163

k. Gas Cocks

Shall be of bronze and have approved make.

42.5 VALVE INSTALLATION

All valves having stems over 2.13m height shall be provided with chain operate. Valves in horizontal lines shall be installed with stems horizontal or above. Isolation gate valves shall be installed on each side of each piece of equipment's as pumps, and other similar items at the mid-point of all looped mains; and at any other points indicated or required for draining, isolation sectionalising purposes. Strainers shall be installed wherever necessary to protect equipment and control valves, where proper functioning would be effected by dirt on the seat or scoring of the seat. Strainers shall be arranged not to clog piping and allow easy disconnection for change. All strainers 50mm and above shall be provided with 20mm ball valves for blow-off. Strainers shall allow removal of accumulated dirt and screen replacement without disconnecting main piping.

42.6 WATER & FIRE PIPING SPECIALITIES

42.6.1 Flexible Connectors

Flexible connectors shall be constructed of rubber, tetrafluoroethylene resin, or corrosion resisting steel, bronze, model or galvanised steel. The material used and the configuration shall be suitable for pressure, vacuum, temperature and circulation medium. The flexible section may have threaded, welding, soldering, flanged or socket ends and shall be suitable for service intended. The flexible section may be reinforced with metal retaining rings, with built-in reinforcement and restriction bolts

or with wire brained cover suitable for the service intended. Flanged assemblies shall be equipped with limited bolts to restrict maximum travel to within limits standard with the manufacturer. Unless otherwise shown on the drawings, the length of the flexible connectors shall be as recommended by the manufacturer for the services intended. Internal sleeves or liners shall be provided when recommended by the manufacturer suitable for the circulating medium. Covers to protect the below will be provided where necessary or directed. Flexible connectors shall be designed for 10.5 Kg./Cm² SWP, and 150°C for water supply system and 21 Kg./Cm² for water supply system and 21 Kg./Cm² SWP & 150°C for fire protection system. Flexible pipe connection or couplings shall be installed on piping connected to equipment where indicated on the drawings. Installation shall be as per manufacturer's recommendations.

42.6.2 AUTOMATIC AIR VENTS FOR LIQUID SYSTEMS

Automatic Air Vents shall be suitable for liquid systems. Body and cover shall be of malleable iron. Float and valve seat shall be of stainless steel. Valve head shall be of vision (Synthetic Rubber). Connections shall be 15mm or 20mm as specified, screwed. Vents shall be suitable for service up to 10.5 Kg./Cm² & 120°C service. Vents shall be similar to model AE 550 Manufactured by SPIRAX-SARCO.

Air Vents shall be provided at all high points, where shown on the drawings to ensure adequate venting of the piping system. A 20mm ball valve shall be provided to isolate the vent.

42.6.3 EXPANSION JOINTS

Shall be installed where shown on drawings as required. The expansion joints shall consist of bellows constructed of super-strong Plies of Nylon, with both ends attached to flanges. External tie bars for limiting movement shall be provided. Flanges shall be of galvanised steel to ASA B16.5.

Pipes alignment guides shall be installed as recommended by the joint manufacturer but in any case not more than 1.5mm on each side of expansion joint, expect in lines 100mm or smaller they may be not over 600mm each side of joint.

42.6.4 ANCHORS

Shall be provided wherever necessary or indicated to localise expansion or to prevent undue stain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor branches, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results, suing turnbuckles wherever required. The Wright or expansion of the pipeline shall attach anchors, supports or stays in places where such supports will not injure the construction during installation or damage the structure. Detailed drawings of pipe anchors shall be submitted for approval before Installation.

42.6.5 WATER METER

Line size water meter of turbine type, equipped with instantaneous flow dial, and totalized read-out window. Water meter shall be imported but make and quality shall be approved by the Engineer. The water meter shall be installed in an underground concrete chamber suitably plastered and water proofed. The top slab of the chamber shall be provided with a water tight heavy-duty cast iron cover. Both the chamber and the C.I. Cover shall be suitable sized to provide easy removal of the water meter for maintenance.

42.6.6 VALVE CHAMBER

Shall be constructed in accordance with the clearance for valves and the operations, as instructed by the Engineer In charge. It shall include 450mm dia (18") C.I. manhole frame and cover medium duty single seal. Chamber shall be constructed of 1:2:4 R.C.C. convenient for operation and maintenance of the valves, installed in the valve chamber. 3/4" (20mm) thick cement plaster shall be provided at the internal and external surface of the valve chamber. Bituminous paint shall be provided in two coats outside the valve chamber. PVC pipe sleeves shall be provided for pipe connections.

42.7 THERMAL INSULATION (for Metal Pipes)

All hot water supply and return piping in false ceiling shafts and exposed shall be insulated as specified herein. Prior to insulation the pipes shall be thoroughly cleaned of all rust, scales and other contaminants by wire-brushing, sand blasting etc. and by using aromatic solvents to remove oil grease etc. Subsequent to the cleaning operation the pipe shall be coated two coats of approved, temperature resistant, anti-corrosion paint. Insulation shall be applied to the painted surface only after the hydraulic testing as specified under TESTING.

Table 42-15: Insulation Thickness

Nominal Pipe Dia. (mm)	Insulation Thickness (mm)
15	40
20	40
25	40
32	40
40	40
50	50
62	50
100	50

Installation shall consist of performed sections of long fine fibre glass, bonded with a temperature resistant binder, damage resistant, light in weight easy to handle, cut and fit with the product complying with the requirements of BS 3958: Part-4, 1968. The density of the fibreglass shall be between 5 to 7 lbs./ft.^{3} and a thermal conductivity of 0.24 Btu inch/hr. ft. ºF at 100ºF.

The insulation shall be rot-proof, odourless, non-hygroscope, and shall not sustain vermin. The fibreglass, insulation shall be covered with a layer of bituminised Kraft paper and finally jacketed with a layer of 15oz canvas. Two coasts of moisture proof paint shall be applied to the canvas. The insulation, covering and jacket shall be suitable fixed and an approved temperature resistant adhesive shall be used. The circumferential and longitudinal joints for the Kraft paper covering and canvas jacket shall be lapped at least 40mm. Further reinforcement shall be provided by the use of 20mm wide soft aluminium bands, generally spaced at 450mm, and on either side of elbows, tees, valves and other piping specialities. All but joints shall be sealed with self-adhesive type of approved quality.

All supply and return hot water pipe line embedded in floors and walls shall be provided with 10mm thick foam rubber insulation in preformed sections as manufactured by AEROFLEX.

All valves, fittings and other specialities shall be insulated with plain glass blanket of thickness equal to the adjoining pipe insulation thickness, and shall be covered by Kraft paper and canvas jacketing specified earlier. Two coats of moisture proof paint shall also be applied. The adjoining insulation near these fittings shall be metered and trimmed into suitable sections to tailor fit closely around the valves, flanges and fittings. All trimmed sections shall be secured by wrapping of approved type of self-adhesive tape to form a complete waterproof seal. All work shall be done in a neat workman like manner, and should reflect recommended practice.

42.8 FOUNTAIN EQUIPMENT, PIPING AND ACCESSORIES

The Contractor shall provide complete Fountain Unit with Pump. The pump shall be as mentioned in the approved manufacturer / supplier list. The Fountain unit shall be of Imperial Bronzelite complete with nozzle and piping. the unit shall be made of materials which under water, assure a safe and trouble free service over years. This will include installation of fountain nozzle in the fountain pool and pumps as shown on drawings and shall include wiring, which will be taken from nearby electric point provided by others.

42.9 INSTALLATION OF PIPING, VALVES AND FITTINGS

General

Pipes shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, properly clearing all Windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping insulation will not be permitted without written approval. Shop drawings by Contractor shall show locations of all supports, the load imposed on each fastening or anchor, typical details for special anchorage's, and details for special anchorage's for supports attached to metal roof decking, for suspended piping, valves, tank, pumps, converters and other mechanical equipment. Supports shall be attached to metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and detailed. Pipe shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints and hangers. Changes in direction shall be made with fittings, except that bending of pipe 4 inches (100mm) and smaller will be permitted provided a pipe bender is used and wide-sweep bends are formed. The centre line radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted. All piping shall be installed with sufficient pitch to ensure adequate drainage and venting. Piping connections to equipment shall be provided with Bends or flanges. Open ends of pipelines or equipment shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system.

All horizontal runs of piping, except where concealed in partitions, shall be kept as high up as possible and close to walls. Consult with other trades so that grouped lines will not interfere with each other. Where plans call for offsets, it shall be kept close to underside of beams and slabs, and run alongside of beams, girders of patron.

The arrangement, positions and connections of pipes, fixtures, drains, valves, etc., as shown on the drawings shall be taken as a close approximation and while they shall be followed as closely as possible the right is reserved by the Engineer to change the location etc., to accommodate any conditions which may arise during the progress of work prior to installation without additional compensation to this Contractor for such change. The responsibility for accurately laying out the work and co-ordinating his installation with other contractors rests with this Contractor.

Should it be found that any of his work is laid out so that interference will occur, he shall so report that to the Engineer.

All of the pipes shall be concealed in walls, slabs unless otherwise shown on drawings or director by the Engineer.

Special precaution shall be taken in the installation of piping concealed underground or in the building construction, to see that the piping is properly installed. Should it be necessary to correct piping so installed, this Contractor shall be held liable for any injury caused to other work in the correction of his piping.

All screwed pipes throughout the job shall be reamed smooth before being installed. Pipe shall not be split, bet, flattened nor otherwise injured either before or during the installation.

Fixture connections, shown to be installed concealed in building construction, shall in general, be carried concealed to points above floor (near fixtures) where they shall break-out and rise exposed to fixture, all as required or approved.

Reducing fittings, unless otherwise approved in special cases, shall be used in making reduction in size of pipe. Bushings will not be allowed unless specifically approved.

Exterior piping shall not be laid in water or when trench or weather conditions are unsuitable for the work, except by permission of the Engineer.

Fittings at bends or tees in buried water pipe lines shall be wedged against concrete thrust block poured between the vertical face of the trench and the fittings, to prevent the fittings form being blow off the lines when under pressure. The size of the blocks shall be based on the working pressure plus 3 bars, the pipe size and the bearing capacity of the soil, all as recommended in the Journal of the American Water Works Association.

Where chrome plated piping is installed, this Contractor shall cut and thread his pipe so that no un-plated pipe threads are visible when the work is complete.

Friction type wrenches and vices shall be used on all copper tubing and brass piping. Any pipes showing tools marks will be ordered to be removed and replaced with new materials, without additional cost.

Bends and flanges shall be provided at suitable intervals to enable easy assembly and disassembly of the pipes. All piping installation shall allow means of easy disassembly for cleaning and maintenance.

Screwed Joints

shall be used on pipes of diameter 2 inches (50mm) and below. Screwed joints shall be made with tampered threads properly cut. Joints shall be made tight with polytetrafluoroethylene (TEFLON) Tape, or other approved thread joint compound applied the male thread only. Not more than three threads shall show after the joint is made up.

For galvanised pipe threaded flanges shall be used for 100m dia pipe and above.

Flanges and Bends

Shall be faced true. Flanges shall be provided with 1/16 inch (1.6mm) asbestos gasket, and made square and tight. Except where copper tubing is used, Bend or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or such as coils, pumps, control valves & other similar items.

Welding of GI Pipe

Scope: This welding procedure specification details the procedure of pipe as required by CSA Standard Z662. Oil and Gas Pipeline Systems. This procedure uses CSR Evans Welding Equipment and includes a provision for Mechanized Gas Shielded FCAW Up for fill and cap passes.

Welding Process and Method

1. Shielded Metal Arc Welding (SMAW)
2. Flux Core Arc Welding (FCAW)

Base Material

1. Composition: This specification applies to pipe and/or component material manufactured in Accordance with, or listed as Acceptable Alternative Materials: in any of the following standards:
2. CSA Z662, Oil and Gas Pipeline Systems
3. CAN/CSA-Z245.1, Steel Line Pipe
4. CAN/CSA-Z245.11, Steel Fittings
5. CAN/CSA-Z245.12, Steel Flanges
6. CAN/CSA-Z245.15, Steel Valves
7. Pipe Grades: 483 MPa (SMYS) or less
8. Wall Thickness Qualified: 4.0 to 14.25 mm (0.157 to 0.561 in.) inclusive.
9. Pipe diameters Qualified: 457 mm (18 in.)
10. Carbon Equivalent: 0.33% maximum

Joint Geometry

1. Joint Type: Groove – Single Vee Butt
2. Bevel Angle: 30o, +6o / -1.5 o
3. Root Face: 1.6mm (0.063 in.), +/-0.8mm (0.031 in.)
4. Root Gap: 3.2mm (0.125 in.), +/-1.6mm (0.063 in.)
5. The surfaces to be welded shall be smooth, uniform, free of fine, laminations, tears, scale, slag, grease, paint or other foreign matter, which may adversely affect the welding.

PREHEATING, INTERPASS TEMPERATURE 7 CONTROLLED COOLING

1. Butt Welds: A minimum preheat temperature of 120oC (250oF) shall be applied to an area at least 51mm (2.0 in.) on each side of the weld joint for its entire circumference prior to welding.
2. During root and second pass welding, under no circumstances shall the minimum temperature fall below the minimum inter pass temperature from the start of the root pass until after the completion of the second pass. Reheating is permitted before the start of the fill/cap passes.

3. If the inter pass temperature falls below the minimum preheat temperature after completion of the second pass, the entire weld joint shall be heated to the minimum preheat temperature prior to stating the next weld pass.
4. The maximum inter pass temperature shall not exceed 204oC (400oF).
5. Preheating may be applied by oxy-fuel torch, propane torch, electrical induction coils or any other method approved by the owner.
6. Temperature of the joint shall be verified using temperature indicating crayons, thermocouples, pyrometers or other suitable method.
7. where applicable, precautions shall be taken through the use of insulating covers or other means to control the cooling rate of the weld after any pass.

POSTWELD HEAT TREATMENT

Welds prepared in accordance with this specification shall not be subjected to post weld heat treatment.

REMOVAL AND REPAIR OF DEFECTS

Repairable areas are restricted to the weld cap and shall be removed by grinding. Welding of such repairable areas shall be performed following the details outlined in this specification.

Subsurface weld repairs shall be made in accordance with WPS# EPI-11-WP9 Rev.1.

Table 42-16: Welding Parameter

Pass	Process	Electrode		Wire Speed Mm/min (in/min)	Amperage Range Amperes	Voltage Range Volts	Travel Speed Mm/min (in/min)	OSC/ BPM	Heat Input kJ/mm (J/in.)
		Size mm (in.)	AWS Class						
Root	SMAW	4.0mm (5/32)	E6010	NA	104-191	17.9-32.5	215-349 (8.5-13.7)	NA	0.50-1.14 (12700-28956)
Hot Pass	SMAW	4.8mm (3/16)	E8010-G	NA	161-245	19.6-40	320-508 (12.6-20)	NA	0.55-1.15 (13970-29210)
Fill-1	SMAW	4.0mm (5/32)	E8045-P2 H4R	NA	166-275	14.9-28.6	197-300 (7.7-11.8)	NA	0.76-1.57 (19304-39878)
Fill(s) Mech.	Mech. FCAW	1.2mm (0.047)	E81T1-GM	5029-7645 (198-301)	142-264	18.1-28.5	120-280 (4.7-11.0)	As Req.	0.96-2.13 (24384-54102)
Cap(s) Mech.	Mech. FCAW	1.2mm (0.047)	E81T1-GM	4623-7010 (182-276)	129-240	18.2-28.6	102-210 (4.0-8.3)	As Req.	1.11-2.56 (28194-65024)

PIPE SUPPORTS

General

Pipe hangers, brackets, saddles, inserts, clamps and pipe rolls including rods, bolts, turn buckles, bases and protection shields shall conform to standard recommended engineering practice. Design generally accepted as exemplifying good engineering practice, using stock or production parts shall be utilised wherever possible. Chain, wire, strap or other make shift devices will not be permitted as hangers or supports. Pipe hangers shall be capable of supporting the pipe in all conditions of operations. Hangers shall be supported from beams, clamps, concrete inserts Phillips concrete fasteners, and powder actuated drive pins. Concrete inserts when used shall be installed in the exact location prior to the pouring of the concrete.

Suspended Horizontal Piping

Shall be supported by adjustable hangers or supports, which shall provide a means of vertical adjustment after erection. Unless otherwise indicated on drawings maximum spacing between pipe supports for straight runs of pipe shall be in accordance with recommended spacing shown in the table given below:

Table 42-17:Maximum spacing between pipe supports

Nominal Pipe Size	in	0.5	0.75	1	1.5	2	2.5	3	4	5	6	8	10
	mm.	13	20	25	40	50	65	75	100	125	150	200	250
Max. Span	ft	5	6	7	9	10	11	12	14	16	17	19	22
	M	1.5	1.8	2.1	2.7	3	3.3	3.6	4.2	4.8	5.1	5.2	6.7
M.S. Rod size	Dia. mm	10	10	10	10	10	13	13	16	16	19	22	22

Table 42-18: CLAMP SPACES FOR PPR PIPES (PN20)

Diameter	Clamp spacing distances according to temperature, cm						
mm	20° C	30° C	40° C	50° C	60° C	70° C	80° C
20	120	115	109	105	104	100	95
25	140	130	125	121	118	112	108
32	160	158	154	150	145	140	135
40	185	175	168	164	160	155	150
50	200	178	185	175	170	165	155
63	210	205	195	187	180	175	165
75	230	225	215	195	182	180	170

Pipe hangers and supports shall be spaced not over 5 feet (1.5m) apart at heavy fittings and valves. A hanger shall be installed not over 1 foot (0.3m) from each change in direction of piping.

Vertical Piping

shall be guided or supported in the centre of each riser but not over 15 ft. (4.5m) on centres and shall be supported at the base of the riser on a base elbow or tee with a pipe stand only where required.

Piping in Trenches

Pipes shall rest on suitable wall or floor supports with rollers.

Pipe sleeves

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction or afterwards if necessary. Each sleeve shall extend through its respective wall, floor or roof and shall be out flush with each surface. Sleeves shall be of such size as to provide a minimum of ¼ inch (6mm) all around clearance between bare pipe and sleeve, or between jacket over insulation and sleeve. Sleeves in non-bearing wall walls shall be steel or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe or GI sheet metal 14 gauge 0.08 inch (3.04mm) with lock type longitudinal seam. Sleeves in bearing walls shall be steel or cast iron pipe. Sleeves in exterior walls and pits shall be of steel and shall have anchor flanges with the space between the pipe and the sleeve caulked watertight.

42.10 EXPANSION JOINT & EXPANSION LOOP

The Contractor shall provide and install where required the expansion joints of the type specified herein.

Expansion joint shall be of the Packless Bellows type, with stainless steel bellows and carbon steel end connections shall be 150 SWP flanged.

Expansion joint shall be suitable for Hot Water Service, with in internal design pressure of 3 atm. gauge and an internal test pressure of 5 atm. gauge. Maximum operating temperature shall be 82℃, minimum temperature 7℃ and installation temperature 32℃. No expansion joint shall be worked out for an axial compression of 25mm/30 meters without lateral deflection or angular rotation. Expansion joints shall be supplied

with internal sleeve or liner to reduce pressure drop through the assembly.

The expansion joint shall be single GENFLEX BELLOWS expansion JOINT as manufactured by VOKES Limited U.K. or approved equivalent.

The Contractor shall supply all mating flanges required for connection of this expansion joint to the piping. Engineer shall approve the shop drawing showing the position of expansion joints before start of work.

42.11 BENDING AND FORMING

Pipe may be bent by any hot or cold method permissible by radii and material characteristics of the pipe being bent. It may be bent to any radius, which will result in a bent surface, which is free of cracks and buckles. Generally bends should be made to a radius, measured to the centre line of the pipe, at least equal to five times the nominal diameter.

42.12 UNDERGROUND PIPING

Piping specified to be laid, directly underground or below floors, shall be laid in an excavated trench with a minimum of 450mm of soil cover. The trench bottom shall be smooth and of uniform grade with either undisturbed ground, or a layer of selected and compacted backfill so that no settlement shall be expected. Pipe must bear on this material through its entire length. Where rock is encountered in trench, it shall be removed to a point at least 75mm below the grade line of the trench and the trench shall be backfilled to grade with sand tamped in place. If soft material of poor bearing qualities is found at the bottom of the trench, stabilization shall be achieved by over excavating at least two pipe diameters and bringing up to grade with fine grade or crushed stone or a concrete foundation. Such concrete foundation shall be bedded with sand tampered in place so as to provide a uniform bearing for the pipe between joints.

Care shall be exercised in backfilling trenches. Loose earth free of rocks, broken concrete, broken chips and other rubble shall be placed in the trench in 150mm layers and tamped in place. Care shall be taken during compaction and back filling under and beside the pipe, that the pipe is properly supported. Proper alignment shall be maintained.

42.13 EXCAVATION & BACKFILLING FOR UNDERGROUND PIPE LAYING

As specified in related section.

42.14 PROTECTIVE PAINTING

Underground piping shall be painted two coats of black asphalt paint or two coats of bitumen wrapped with approved polythene anti-corrosion tape, if shown in the drawings / BOQ.

42.15 FLUSHING, TESTING AND STERILIZATION

Cold Water System

When the installations are complete they should be slowly and carefully charged with water, allowing all air to escape thus avoiding shock or water hammer. The systems should be inspected under working conditions of pressure and flow and when all draw-off taps are closed, should be absolutely watertight. Each draw-off tap should be opened and tested for rate of flow. Pressure testing of internal work should be tested as described below:-

The mains should be tested in sections as the work proceeds and joints should be left exposed for inspection during testing. After completion of each section, the main should be carefully and slowly changed with water so that all air is expelled from the main, allowed to stand full of water for 1-2 days if possible and then tested under pressure. The test pressure should be maximum working pressure plus 50% or 90 psi whichever is greater. The pressure should applied by means of a manually operated test pump or, in case of long mains or mains of large diameter, by a power driven test pump provided that the pump is not left unattended. Precaution must always be taken to see that the test pressure is not exceeded. Pressure gauges must be accurate and if necessary should be recalibrate before the test. After the pump has been stopped, the test pressure should be maintained as long as is necessary to inspect the whole of the pipe network under test and in any even not less than half hour. Open ends of main should be temporarily closed for testing under moderate pressure by fitting watertight expanding plugs. The end of the main and any test plug must be well secured to resist the end thrust of the water pressure in the main, i.e. maximum test pressure x cross sectional area of pipe. If the section of main terminates with a sluice valve, the wedge of the valve should never be used to retain the water because this might lead to permanent distortion of the working parts of the valve. Instead, the valve should be fitted with an open position whilst testing. End support should be provided as explained previously.

In such cases it may be necessary to isolate items of equipment from the pressure test if they are not capable of withstanding the test pressure. Where these items are removed, blanking flanges or plugs must be used or a make-up piece of pipe work installed temporarily.

All piping, fittings and appliances should be inspected and checked for satisfactory support and protection from physical damage, corrosion and frost. Because of the possibility of damage in transit, it is always advisable to retest cisterns, tanks and cylinders for water tightness on arrival at site and before fixing.

Hot Water System

Hot water system should be thoroughly flushed out and then tested in the same manner as described for cold water systems. Where thermal insulation is used, the hydraulic test should be made before the insulation work is completed and whilst all joints are exposed. Where a pressure test is employed boiler and calorific relief valves should be removed and these valves should be tested later. The

test pressure should be one and half times the normal working pressure and this should be maintained for thirty minutes after making good any leaks.

It may be necessary to carry out the hydraulic pressure test on sections of pipe network prior to completion of the whole installation where these are fixed in ducts, chases, trenches, etc., and are concealed from view. If rectification of faculty materials or workmanship on such sections is likely to involve disturbance to finished structural features, the test pressure should be twice the normal working pressure.

Sterilisation of water systems

The whole of the system should be sterilised to eliminate possible traces of bacteria.

The plumbing contractor should carry out the sterilising process in accordance with the following:

After cleaning the cistern of all debris, the cistern and pipe network should be filled with water and the whole thoroughly flushed out. The system should then be filled with water a second time, but as the cistern is filling a sterilising chemical containing chlorine should be added to ensure thorough mixing of the chemical and water. The dose should be such as to give 50 part of chlorine to one million parts of water (50 ppm). If ordinary bleaching powder is employed the proportion used should be 150g of powder to 1000 litres of water, the powder first being mixed with water to a creamy consistency before being added. Proprietary brands of sterilising chemicals should be added in the proportions as instructed by the manufacturers.

After filling the system, the incoming water supply should be shut off and each tap on the distributing pipes opened successively, starting with that nearest the cistern. As the water, which issues from each tap begin to smell of chlorine, the tap should be closed. The cistern should then be filled again with water to which has been added the correct dose of chemical.

The whole system should then be allowed to stand charged with treated water for a period of at-least 3 hours, after which a test should be made by smell for residual chlorine. If none is found, the sterilisation should be repeated.

Before any water is used for domestic purposes, the whole system must be emptied and thoroughly flushed out with clean water.

42.16 WATER CONNECTIONS

The Contractor shall be responsible for obtaining necessary permits, licenses etc., from the concerned authorities for the Water connections. He shall give notice to local authority of intention to connect to the main water line and forming connection should be carried out by permission from and under the supervision of the authorised representative of the relevant authorities.

42.17 MEASUREMENT AND PAYMENT

a. Pipes

Measurement for pipes shall be in running feet and the work to be done shall include providing and fixing of pipe, pipe fittings, jointing hangers, clamps and brackets, sleeves, cutting and making it good, applying protection painting, coating, cleaving, testing and disinfecting etc., and the measurement will be for the full work specified herein.

Payment will be made for the actual quantity installed at the unit rate per running meter of pipe given in the Bill of Quantities. The amount bid shall be the full payment for completion of the work in all respects as specified herein, including Testing and Commissioning.

The cost of fitting specials for pipes less than 6" dia shall not be paid separately but are deemed to be included in the measurement of pipe. However the specials for sizes of 6" dia or more will be counted and paid separately under the relevant item of bill of items.

b. Valves, Strainers and Piping Specialities

Measurement for Valves, Strainers Pressure Reducing Valves, Flexible Connector, Globe Valves, Automatic Air Vents, Expansion Joints, Anchors, Water Meter, etc., shall be made as per actual number provided and installed and shall be for the complete work specified herein or as shown on drawings, including Testing and Commissioning.

Payment for Valves, Strainers, Pressure Reducing Valves, Flexible Connector, Globe Valves, Automatic Air Vents, Expansion Joint, Water Meter etc., shall be made for the actual quantity installed at the unit rate given in the Bill of Quantities, which shall be deemed to be full compensation for all works under the Contract.

c. Chambers

Chambers of all sizes mentioned in the bill if items shall be constructed as per drawings to be prepared by the designer. The measurement of excavation, backfill, concrete of all types, steel, plaster, masonry work and cover with frame shall be measured and paid as per relevant item under civil work of these specifications.

Pay Item No.	Description	Unit of Measurement
42.17 a	Providing and fixing gun metal Gate valve of approved make (BS: 5163), including all connections.	
	i. ½" (12mm) dia. screwed end	NO
	ii. ¾" (20mm) dia. screwed end	NO
	iii. 1" (25mm) dia. screwed end	NO
	iv. 1.5" (40mm) dia. screwed end	NO
	v. 2" (50mm) dia. screwed end	NO
	vi. 2.5" (62mm) dia. screwed end	NO
	vii. 3" (75mm) dia. screwed end	NO
	viii. 4" (100mm) dia. screwed end	NO
	ix. 6" (150mm) dia. screwed end	NO
	x. 3" (75mm) dia. flanged end	NO
	xi. 4" (100mm) dia. flanged end	NO

	xii.	6" (150mm) dia. flanged end	NO
	xiii.	3" (75mm) dia. flanged end (DI)	NO
	xiv.	4" (100mm) dia. flanged end (DI)	NO
	xv.	6" (150mm) dia. flanged end (DI)	NO
42.17b		Providing, laying, cutting, any type of jointing, testing & disinfecting Light GI pipe with approved make (BSS 1387/2004) including the cost of jointing material and specials, complete in all respect.	
	i.	½" (12mm) inner dia.	LM
	ii.	¾" (20mm) inner dia.	LM
	iii.	1" (25mm) inner dia.	LM
	iv.	1.5" (40mm) inner dia.	LM
	v.	2" (50mm) inner dia.	LM
	vi.	2.5" (62mm) inner dia.	LM
	vii.	3" (75mm) inner dia.	LM
	viii.	4" (100mm) inner dia.	LM
	ix.	6" (150mm) inner dia. (without specials)	LM
	x.	8" (200mm) inner dia. (without specials)	LM
	xi.	10" (250mm) inner dia. (without specials)	LM
	xii.	12" (300mm) inner dia. (without specials)	LM
42.17c		Providing, laying, cutting, any type of jointing, testing & disinfecting Medium GI pipe with approved make (BSS 1387/2004) including the cost of jointing material and specials, complete in all respect.	
	i.	½" (12mm) inner dia.	LM
	ii.	¾" (20mm) inner dia.	LM
	iii.	1" (25mm) inner dia.	LM
	iv.	1.5" (40mm) inner dia.	LM
	v.	2" (50mm) inner dia.	LM
	vi.	2.5" (62mm) inner dia.	LM
	vii.	3" (75mm) inner dia.	LM
	viii.	4" (100mm) inner dia.	LM
	ix.	6" (150mm) inner dia. (without specials)	LM
	x.	8" (200mm) inner dia. (without specials)	LM
	xi.	10" (250mm) inner dia. (without specials)	LM
	xii.	12" (300mm) inner dia. (without specials)	LM
42.17d		Providing, laying, cutting, any type of jointing, testing & disinfecting Heavy GI pipe with approved make (BSS 1387/2004) including the cost of jointing material and specials, complete in all respect.	
	i.	½" (12mm) inner dia.	LM

	ii.	¾” (20mm) inner dia.	LM
	iii.	1" (25mm) inner dia.	LM
	iv.	1.5" (40mm) inner dia.	LM
	v.	2” (50mm) inner dia.	LM
	vi.	2.5” (62mm) inner dia.	LM
	vii.	3” (75mm) inner dia.	LM
	viii.	4” (100mm) inner dia.	LM
	ix.	6” (150mm) inner dia. (without specials)	LM
	x.	8” (200mm) inner dia. (without specials)	LM
	xi.	10” (250mm) inner dia. (without specials)	LM
	xii.	12” (300mm) inner dia. (without specials)	LM
42.17 e	Providing and fixing check valve of approved make (BS: 5163) for water supply lines.		
	i.	½” (12mm) dia. (brass)	NO
	ii.	¾” (20mm) dia. (brass)	NO
	iii.	1” (25mm) dia. (brass)	NO
	iv.	1.5” (40mm) dia. (CI)	NO
	v.	2” (50mm) dia. (CI)	NO
	vi.	2.5” (62mm) dia. (CI)	NO
	vii.	3” (75 mm) dia. (CI)	NO
	viii.	4” (100 mm) dia. (CI)	NO
	ix.	6” (150 mm) dia. (CI)	NO
42.17f	Providing and fixing 1.5" dia. PVC waste pipe for wash basin etc. including all fittings.		NO
42.17g	Providing and fixing valve with unsoldered copper ball (BS-EN-12288-2003).		
	i.	½” (12mm) dia. (brass ball valve)	NO
	ii.	¾” (20mm) dia. (brass ball valve)	NO
	iii.	1" (25mm) dia. (brass ball valve)	NO
	iv.	1.5” (40mm) dia. (brass ball valve)	NO
	v.	2” (50mm) dia.(brass ball valve)	NO
	vi.	2.5” (62mm) dia.(brass ball valve)	NO
	vii.	3” (75mm) dia.(brass ball valve)	NO
	viii.	4” (100mm) dia.(brass ball valve)	NO
	ix.	6” (150mm) dia. (SS ball valve)	NO
	x.	1.5” (40mm) dia. (CI non return valve)	NO
	xi.	2” (50mm) dia.(CI non return valve)	NO
	xii.	2.5” (62mm) dia.(CI non return valve)	NO

	xiii.	3” (75mm) dia.(CI non return valve)	NO
	xiv.	4” (100mm) dia.(CI non return valve)	NO
	xv.	6” (150mm) dia. (CI non return valve)	NO
42.17 h	Providing and fixing MS Flange (BS-5163) including all fittings/welding.		
	i.	3” (75mm) size	NO
	ii.	4” (100mm) size	NO
	iii.	6” (150mm) size	NO
	iv.	8” (200mm) size	NO
	v.	10” (250mm) size	NO
	vi.	12” (300mm) size	NO
42.17i	Providing, laying, cutting, jointing, testing and disinfecting PN-10 HDPE pipe, pressure classification of PE-100 black (DIN 8074/8075 or ISO 4427), including the cost of jointing material and specials, complete in all respects.		
	i.	1.0 “(25mm) outer dia.	LM
	ii.	1.25” (32mm) outer dia.	LM
	iii.	1.5” (40mm) outer dia.	LM
	iv.	2” (50mm) outer dia.	LM
	v.	2.5” (62mm) outer dia.	LM
	vi.	3” (75mm) outer dia.	LM
	vii.	4” (100mm) outer dia.	LM
	viii.	6” (150mm) outer dia. (without specials)	LM
	ix.	8” (200mm) outer dia. (without specials)	LM
	x.	10” (250mm) outer dia. (without specials)	LM
	xi.	12” (300mm) outer dia. (without specials)	LM
42.17j	Providing, laying, cutting, jointing, testing and disinfecting PN-12.5 HDPE pipe, pressure classification of PE-100 black (DIN 8074/8075 or ISO 4427), including the cost of jointing material and specials, complete in all respects.		
	i.	0.75”(20mm) outer dia.	LM
	ii.	1.25”(32mm) outer dia.	LM
	iii.	1.5” (40mm) outer dia.	LM
	iv.	2” (50mm) outer dia.	LM
	v.	2.5” (62mm) outer dia.	LM
	vi.	3” (75mm) outer dia.	LM
	vii.	4” (100mm) outer dia.	LM
	viii.	6” (150mm) outer dia. (without specials)	LM
	ix.	8” (200mm) outer dia. (without specials)	LM
	x.	10” (250mm) outer dia. (without specials)	LM

	xi.	12” (300mm) outer dia. (without specials)	LM
42.17k	Providing, laying, cutting, jointing, testing and disinfecting PN-16 HDPE pipe, pressure classification of PE-100 black (DIN 8074/8075 or ISO 4427), including the cost of jointing material and specials, complete in all respects.		
	i.	1” (25mm) outer dia.	LM
	ii.	1.5” (40mm) outer dia.	LM
	iii.	2” (50mm) outer dia.	LM
	iv.	2.5” (62mm) outer dia.	LM
	v.	3” (75mm) outer dia.	LM
	vi.	4” (100mm) outer dia.	LM
	vii.	6” (150mm) outer dia. (without specials)	LM
	viii.	8” (200mm) outer dia. (without specials)	LM
	ix.	10” (250mm) outer dia. (without specials)	LM
	x.	12” (300mm) outer dia. (without specials)	LM
42.17l	Providing, laying, cutting, jointing, testing and disinfecting PN-20 HDPE pipe, pressure classification of PE-100 black (DIN 8074/8075 or ISO 4427), including the cost of jointing material and specials, complete in all respects.		
	i.	1” (25mm) outer dia.	LM
	ii.	1.5” (40mm) outer dia.	LM
	iii.	2” (50mm) outer dia.	LM
	iv.	2.5” (62mm) outer dia.	LM
	v.	3” (75mm) outer dia.	LM
	vi.	4” (100mm) outer dia.	LM
	vii.	6” (150mm) outer dia. (without specials)	LM
	viii.	8” (200mm) outer dia. (without specials)	LM
	ix.	10” (250mm) outer dia.(without specials)	LM
	x.	12” (300mm) outer dia. (without specials)	LM
42.17m	Providing and fixing of approved quality LDPE food grade materials Overhead tank, including connections.		
	i.	300 gallons (double ply)	NO
	ii.	500 gallons (double ply)	NO
	iii.	1000 gallons (three ply)	NO
	iv.	1500 gallons (three ply)	NO
42.17n	Providing and fixing of approved quality HDPE five layers food grade materials Overhead tank, including connections.		
	i.	1000 litters	NO
	ii.	1500 litters	NO

	iii.	2000 litters	NO
42.17 o	Providing, laying, cutting, jointing, testing and disinfecting (PN-20) PPR-100 pipe with approved make (DIN-8077/8078) including the cost of jointing material and specials, complete in all respects.		
	i.	¾" (20mm) outer dia.	LM
	ii.	1" (25mm) outer dia.	LM
	iii.	1.5" (40mm) outer dia.	LM
	iv.	2" (50mm) outer dia.	LM
	v.	2.5" (63mm) outer dia	LM
	vi.	3" (75mm) outer dia.	LM
	vii.	4" (100mm) outer dia.	LM
42.17 p	Providing and fixing PN-10 CI sluice valve of approved quality and weight (BS 3464 or BS 5163) including the cost of jointing material, Complete in all respect.		
	i.	2" (50mm) inner dia.	NO
	ii.	3" (75mm) inner dia.	NO
	iii.	4" (100mm) inner dia.	NO
	iv.	6" (150mm) inner dia.	NO
	v.	8" (200mm) inner dia.	NO
	vi.	10" (250mm) inner dia.	NO
	vii.	12" (300mm) inner dia.	NO
42.17 q	Providing and fixing PN-16 CI sluice valve of approved quality and weight (BS 3464 or BS 5163) including the cost of jointing material, Complete in all respect.		
	i.	2" (50mm) inner dia.	NO
	ii.	3" (75mm) inner dia.	NO
	iii.	4" (100mm) inner dia.	NO
	iv.	6" (150mm) inner dia.	NO
	v.	8" (200mm) inner dia.	NO
	vi.	10" (250mm) inner dia.	NO
	vii.	12" (300mm) inner dia.	NO
42.17 r	Providing, laying, cutting, jointing, testing and disinfecting Class B U-PVC pressure pipe with approved make (BS 3505 or PS 3051) including the cost of jointing material and specials, complete in all respects.		
	i.	3" (75mm) outerdia.	LM
	ii.	4" (100mm)outerdia.	LM
	iii.	6" (150mm)outer dia. (without specials)	LM
42.17 s	Providing, laying, cutting, jointing, testing and disinfecting Class C U-PVC pressure pipe with approved make (BS 3505 or PS 3051) including the cost of jointing material and specials, complete in all respects.		
	i.	2" (50mm)outerdia.	LM

	ii.	2.5" (62mm)outerdia.	LM
	iii.	3" (75mm)outerdia.	LM
	iv.	4" (100mm)outerdia.	LM
	v.	6" (150mm)outerdia.(without specials)	LM
42.17 t	Providing, laying, cutting, jointing, testing and disinfecting Class D U-PVC pressure pipe with approved make (BS 3505 or PS 3051) including the cost of jointing material and specials, complete in all respects.		
	i.	1.5" (40mm)outerdia.	LM
	ii.	2" (50mm)outerdia.	LM
	iii.	2.5" (62mm)outerdia.	LM
	iv.	3" (75mm)outerdia.	LM
	v.	4" (100mm)outerdia.	LM
	vi.	6" (150mm)outer dia. (without specials)	LM
42.17 u	Providing, laying, cutting, jointing, testing and disinfecting Class E U-PVC pressure pipe with approved make (BS 3505 or PS 3051) including the cost of jointing material and specials, complete in all respects.		
	i.	½" (12mm)outerdia.	LM
	ii.	¾" (20mm)outerdia.	LM
	iii.	1" (25mm)outerdia.	LM
	iv.	1.5" (40mm)outerdia.	LM
	v.	2" (50mm)outerdia.	LM
	vi.	2.5" (62mm)outerdia.	LM
	vii.	3" (75mm)outerdia.	LM
	viii.	4" (100mm)outerdia.	LM
	ix.	6" (150mm)outerdia.(without specials)	LM
42.17 v	Providing and fixing MS specials/ fittings, including turning threading, facing and fitting for GI pipe line.		
	i.	6" (150mm) Elbow 90 degree	NO
	ii.	8" (200mm) Elbow 90 degree	NO
	iii.	10" (250mm) Elbow 90 degree	NO
	iv.	12" (300mm) Elbow 90 degree	NO
	v.	6" (150mm) Elbow 45 degree	NO
	vi.	8" (200mm) Elbow 45 degree	NO
	vii.	10" (250mm) Elbow 45 degree	NO
	viii.	12" (300mm) Elbow 45 degree	NO
	ix.	6" (150mm) Tee	NO
	x.	8" (200mm) Tee	NO
	xi.	10" (250mm) Tee	NO

	xii.	12” (300mm) Tee	NO
	xiii.	6” (150mm) Bend	NO
	xiv.	8” (200mm) Bend	NO
	xv.	10” (250mm) Bend	NO
	xvi.	12” (300mm) Bend	NO
	xvii.	6” (150mm) End cap	NO
	xviii.	8” (200mm) End cap	NO
	xix.	10” (250mm) End cap	NO
	xx.	12” (300mm) End cap	NO
42.17 w	Providing and fixing HDPE specials/ fittings, including turning threading, facing and fitting for HDPE pipe line.		
	i.	6” (150mm) Elbow 90 degree	NO
	ii.	8” (200mm) Elbow 90 degree	NO
	iii.	10” (250mm) Elbow 90 degree	NO
	iv.	12” (300mm) Elbow 90 degree	NO
	v.	6” (150mm) Elbow 45 degree	NO
	vi.	8” (200mm) Elbow 45 degree	NO
	vii.	10” (250mm) Elbow 45 degree	NO
	viii.	12” (300mm) Elbow 45 degree	NO
	ix.	6” (150mm) Tee	NO
	x.	8” (200mm) Tee	NO
	xi.	10” (250mm) Tee	NO
	xii.	12” (300mm) Tee	NO
	xiii.	6” (150mm) End cap	NO
	xiv.	8” (200mm) End cap	NO
	xv.	10” (250mm) End cap	NO
	xvi.	12” (300mm) End cap	NO
	xvii.	6” (150mm) Cross	NO
	xviii.	8” (200mm) Cross	NO
	xix.	10” (250mm) Cross	NO
	xx.	12” (300mm) Cross	NO
42.17 x	Providing and fixing U-PVC specials/ fittings, including turning threading, facing and fitting for U-PVC pipe line.		
	i.	6” (150mm) Elbow 90 degree	NO
	ii.	6” (150mm) Elbow 45 degree	NO
	iii.	6” (150mm) Tee	NO
	iv.	6” (150mm) Socket	NO
42.17 y	Providing and fixing pressure reducing valve of approved make (BS: 5163) including specials, flanges and gasket complete in all respect.		
	i.	1" (25mm) dia.	NO
	ii.	1.5” (40mm) dia.	NO
	iii.	2” (50mm) dia.	NO
	iv.	2.5” (62mm) dia.	NO
	v.	3” (75mm) dia.	NO
	vi.	4” (100mm) dia.	NO
	vii.	6” (150mm) dia.	NO

42.17 z	Providing and fixing Air release valve of approved make (BS 1074) including specials, flanges and gaskit complete in all respect.		
	i.	2” (50mm) dia. (single acting)	NO
	ii.	3” (75mm) dia. (single acting)	NO
	iii.	4” (100mm) dia. (single acting)	NO
	iv.	6” (150mm) dia. (double acting)	NO
	v.	8” (200mm) dia. (double acting)	NO
	vi.	10” (250mm) dia. (double acting)	NO

SECTION 43 SANITARY & STORM DRAINAGE & SEWERAGE PIPING &SPECIALTIES

43.1 SCOPE OF WORK

The work to be done under this section of the specifications consists of:

a. Providing all material and labour for proper installation of pipes, pipes fittings including jointing, clamping, cleaning, painting etc., both above ground and under-ground as shown on the drawings or as specified herein.

b. Providing all material and labour, equipment, appliances etc. for proper installation of drainage and sewerage specialities as shown on drawings or as specified herein.

43.2 PIPE AND FITTINGS

1. SOIL, WASTE AND VENT SYSTEM (u-PVC)

U-PVC soil, waste and vent pipe and fittings shall conform to ISO 3633:1991. Unplasticized polyvinyl chloride PVC-U pipes and fittings, with nominal outside diameters of 16mm to 400mm, intended for domestic installations inside buildings for:

a. Soil and Waste discharge pipe lines (including ventilation of these pipes) and

b. Internal Rainwater pipes

There are two types of pipes and fittings (Type-A and Type-B) for such discharge systems:

a. Type-A, which shall be used only for primary and secondary ventilation pipe work and internal rainwater applications;

b. Type-B, which shall be used for soil and waste discharge systems and may also is used for any type-A application.

2. MATERIALS

The material shall consist substantially of polyvinyl chloride PVC-U to which may be added only those additives that are needed to facilitate the manufacture of pipes and fittings having good mechanical strength and opacity.

Pipes and fittings shall be sufficiently stabilized against thermal ageing and ultraviolet light.

3. GEOMETRICAL CHARACTERISTICS

Nominal outside diameters and wall thicknesses are classified into two size ranges: a primary size range (see table 1 and table 2) and a secondary size range (see table 3 and 4). If dimensions other than those given for the primary size range are necessary, they shall be selected from the secondary size range.

i) Primary size range

a) Nominal outside diameter. Dimensions are in millimeters

Table-43-1 :Nominal outside diameter (mm)

40	50	75	90	110	125	160

b) Wall thickness. Dimensions are in millimeters

Table- 43-1.1 :Wall thickness

Nominal outside diameters (mm)	Minimum wall thickness	
	Type-A	Type-B
40	1.8	3.2
50	1.8	3.2
75	1.8	3.2
90	1.9	3.2
110	2.2	3.2
125	2.5	3.2
160	3.2	4

ii) Secondary size range

a) Nominal outside diameter. Dimensions are in millimeters

Table - 43-2.1 : Nominal outside diameter (mm)

16	20	25	32	63	200	250	315	400

b) Wall thickness. Dimensions are in millimeters

Table- 43-2.2 : Wall thickness

Nominal outside diameters	Minimum wall thickness	
(mm)	Type-A	Type-B
16	-	1.8
20	-	2.3
25	-	3.2
32	1.8	3.2
63	1.8	3.2
200	3.9	4.9
250	4.9	6.2
315	6.2	7.7
400	7.8	9.8

4. LAYING AND JOINTING PROCEDURE

a) For rubber ring system

Clean the outside of the pipe's spigot end and the inside of the sealing groove of the fitting. Apply the lubricant uniformly to the spigot end, sealing ring and pass the spigot end into the socket containing sealing ring until

fully home. Mark the position of the socket edge with the pencil or felt-tip pen on the pipe, then withdraws the pipe from the socket by approx. 10 mm (towards thermal expansion gap).

b) For Solvent system

Clean the outside of the pipe end and the inside of the fitting. Apply the lubricant uniformly to the outside of the pipe, inside of the fitting and pass the pipe into the fitting until fully home.

5. SPACING OF PIPE CLAMPS

With horizontal runs, the pipe clamps should be spaced at intervals of no more than ten times the outside diameter of the pipes, vertical lines are spaced at intervals of one meter to a maximum of two meters according to pipe diameter.

EXTERNAL SOIL AND WASTE LINES

External soil & waste lines unless otherwise shown on plans, shall be Reinforced Cement Concrete pipes, of manufacturer approved by Engineer as per BSS 5911 class 'C' for pipes up to 9" dia and ASTM C-76-88 class-II or class IV (as specified) wall "B" for pipes 12" dia and above.

6. SOIL, WASTE AND VENT SYSTEM (Cast Iron Spun Pipes)

Sanitary, storm drainage and sewerage pipe where specified shall be spun cast iron and shall conform to BSS No.416/1973 for "Cast Iron Spigot and Socket Soil, Waste and Ventilating Pipes and Fittings as manufactured by TEEPU, ALPINE or equivalent as approved by Engineer. The quality of material shall be according to BSS No.1452 for grade 10.

The Contractor shall supply coated pipes and fittings. The coating composition shall be of tar basis or a mixture of natural bitumen with suitable hardener and natural asphalt. The coatings shall be smooth, tenacious, sufficiently hard not to flow when exposed to a temperature of 63^{o}C and not so brittle at zero degree centigrade that it chips soft when scribed lightly with point of a pen knife.

Every pipe shall be tested at the manufacturer's works to a hydraulic test pressure of 1.406 Kgm/Cm^2 (approx.30 lbs/In^2). Every pipe and fitting shall ring clearly when tested for soundness by being struck all over with a light hammer.

7. REINFORCED CONCRETE PIPES

a. Classes of Pipe

The reinforced cement concrete pipes to be furnished and installed shall be of the strength Class II or as specified otherwise in the Drawings.

Following technical criteria shall be adhered to:

Class of Pipe	:	Class-II	Class-IV
Concrete Cylinder Strength	:	4000 psi	5000 psi

The design requirements for these classes of reinforced cement concrete pipes shall be as described in ASTM Designation C-76, Table 1 to 5 for the respective strength classes. Unless otherwise called for in other parts of these Technical Specifications or as ordered, all reinforced cement concrete pipes shall comply with the Wall-B design requirements as set forth in said Table 1 to 5 of ASTM Designation C-76-15 or latest revision.

For pipes smaller than 12 inches dia BSS 5911 shall be strictly followed:

b. Basis of Acceptance

Acceptance of reinforced cement concrete pipes will be on the basis of three edge bearing and material tests as per ASTM Designation C-76-15 or latest revision and inspection of manufactured pipes for defects and imperfections. The Contractor shall bear the cost of such tests and pay fees etc., including the carriage of such samples and all other expenses contingent to tests.

c. Pipe Dimensions

The internal diameters and wall thicknesses of reinforced concrete pipes under this contract shall be as set forth in ASTM Designation C-76-15 or latest revision in Tables 1 to 5 for "Wall-B" pipes as required and shown on the Drawings.

For Class II Pipes, the Wall Thickness for various dia. pipes is as under:

Table 43-3: Wall Thickness for various dia. pipes

1	12 inch dia. pipe	2.00 inch
2	15 inch dia. pipe	2.25 inch
3	18 inch dia. pipe	2.50 inch
4	21 inch dia. pipe	2.75 inch
5	24 inch dia. pipe	3.00 inch
6	27 inch dia. pipe	3.25 inch
7	30 inch dia. pipe	3.50 inch

The lengths of reinforced concrete pipes shall be as required to provide the designated laying length plus any overlap needed for the pipe joint. Pipe shall be of standard length of 8 ft. unless otherwise approved in writing by the Engineer-in-Charge. Only one laying length shall be permitted for each size of reinforced concrete pipe and pipes not of the approved uniform laying length shall not be used in the work.

For 9 inch dia. RCC pipes following data in addition to ASTM-76 shall be applicable:

Table 43-4:RCC pipes following data in addition to ASTM-76 shall be applicable:

1.	Wall thickness	1 inch
2.	Reinforcement square inches per linear foot of pipe wall	0.05
3.	Concrete strength	4000 Psi (Cylinder Test)
4.	Inside diameter at the mouth of socket	12½ inch
5.	Depth of socket	2¼inch
6.	Longitudinal Steel	As stated below

“Each layer of circumferential reinforcement shall be assembled into a rigid case supported by 4 Nos. longitudinal bar of quarter inch diameter”.

The strength test requirements in pounds per linear foot of pipe under the three--edge-bearing method shall be either the D-Load (test load expressed in pounds per linear foot per foot of diameter) to produce 0.01 in crack, or D-loads to produce the 0.01 in crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in ft.

D-Load to produce a 0.01 in crack	=	1000 pounds
D-Load to produce the ultimate load	=	1500 pounds

Lift holes in the walls of reinforced cement concrete pipes will not be permitted for the purpose of handling and laying. Other approved lifting methods shall be employed.

d. Certified Drawings and Data Sheets

The Contractor shall submit in triplicate, for approval by the Engineer-in-Charge certified drawings and data sheets as required to provide complete information on all concrete sewer pipes, dimensions, type and dimensions of pipe ends, joint details proposed concrete design mix for each different strength class of reinforced pipe and any other information needed to demonstrate full compliance with these specifications.

No concrete sewer pipe shall be delivered to the work site until the Engineer-in-Charge has formally approved the certified drawings and data sheets and until all test requirements called for in the respective ASTM Standard Specifications C-76 or latest revision have been met.

e. Joints for Concrete Pipe Sewers

The joints for concrete pipes shall be as specified and could be as follows:-

i. Rubber Gaskets Joints

Rubber gasket joints shall be used for either tongue and groove or bell and spigot pipes.

Rubber gasket joints shall be made using specially designed rubber gaskets, made to fit the applicable tongue and groove or bell and spigot pipes and adequately tested under operating conditions. Special care must be taken in the selection and handling of the concrete pipes for use with rubber gasket joints, to ensure that pipe ends shall be smooth and concentric with tolerances which closely conform to the requirements of the manufacturer of the rubber gaskets. The tongue or spigot end of each pipe shall be specially designed to perform groove or offsets to fit the manufacturer's rubber gaskets design.

The rubber gasket joints shall conform to all applicable requirements of the latest revision of ASTM Designation C443, entitled "Joints for Circular Concrete Sewer and Culvert pipe, using Flexible Watertight Rubber Type Gaskets" except that the test pressure need not exceed 10 feet of head at which the complete sewers shall meet the infiltration or ex-filtration limits set forth hereinafter.

The groove end of tongue and groove pipes shall have at least one line of wire reinforcement of 8 gauge size placed in the centre of the groove.

The rubber gasket shall be installed on the pipe in accordance with the instructions of the gasket manufacturer. In general the gaskets shall be pre-assembled at the pipe manufacturing plant. The pipes shall be handled with special care at all times to prevent damage to the pipe ends. A lubricant shall be used for jointing the pipes as recommended by the rubber gasket manufacturer. Care shall be taken to avoid contamination of the gasket and lubricated surfaces with earth or other undesirable material during installation.

For either tongue and groove or bell and spigot pipes, mechanical means shall be used to pull the pipe home for all sizes of 12 inches or larger diameter in accordance with the recommendations of the rubber gasket manufacturer. Pipes of 9 inches diameter may be coupled manually using a cross member and bar. Under

no circumstances will bars alone be used nor shall any motor driven equipment be used to force the pipe home.

ii. Cement Mortar Joints

Cement mortar may be used where called for. This type of joint will normally be permitted only for sewers laid above the water table. Bell and spigot joints with cement mortar shall be made as follows:

The first pipe shall be in place to the established line and grade. The interior surface of the bell (socket) shall be thoroughly cleaned with a wet brush, and a sufficient layer of stiff mortar shall be applied to the lower portion of the bell. The spigot of the second pipe shall be thoroughly cleaned with a wet brush, and uniformly fitted into the bell so that the interiors of the two pipes are closely fitted and accurately aligned. The remaining annular space in the bell shall then be solidly filled with mortar in sufficient amount to form a head around the outside of the spigot. The interior surface of the pipe at the joint shall be cleaned of all surplus mortar and brushed to a smooth finish. The Contractor may at his own option, use jute firmly caulked into place for holding the bell and spigot joint in proper position.

Tongue & groove joints with cement mortar shall be made as follows:

The first pipe (downstream) shall be in place to the established line and grade with groove upstream. The groove of the first pipe shall be thoroughly cleaned with a wet brush and a layer of soft mortar shall be applied to the groove in the entire lower half of the pipe. The tongue end of the second pipe shall be thoroughly cleaned with a wet brush and, while it is in the horizontal position, a layer of soft mortar shall be applied to the entire upper half of the pipe. The tongue end of the second pipe shall then be inserted into the groove of first pipe until mortar is squeezed out on the exterior surface. The Contractor will use hamper jute gasket soaked in cement slurry, for holding the two pipes in proper position. The joints shall then be completely and solidly filled with stiff mortar on the outside of the pipe. The Interior surface of the pipe at the Joint shall be cleaned of all surplus mortar and brushed to a smooth finish. The outside mortar joint shall be rubbed smooth with a moist rag and not trowelled.

The Portland cement mortar used for making joints shall consist of one part cement and one part clean sand thoroughly mixed dry with sufficient water slowly added to give proper consistency. The mortar shall be promptly used after it is made. The completed joints shall be immediately protected on the outside with an initial covering of moist earth canvas or burlap.

f. House Connections

House Connections shall be made through manholes as indicated in the drawing or as directed by the Engineer-in-Charge.

House connection shall be provided individually for each plot by means of a 6 inch dia. RCC sewer pipe and a dead end, laid at an average depth of 2.0 feet below NSL level and in such a manner that other services such as water supply, telephone and gas lines are not disturbed or interfered. The work of laying the sewer pipe shall conform to the specifications laid down in the relevant section of this specifications or as directed by the Engineer-in-Charge.

Tile inlet of each house connection shall be plugged with brick masonry 4½ inches thick in 1:6 cement sand mortar both in the manhole and the pipe in the plot.

g. Gully Grating

Gully grating shall be made through manholes as indicated in the drawings or as directed by the Engineer-in-Charge.

Gully grating shall be provided on the road junctions on as mentioned in the drawings by means of a 9 inch dia. RCC sewer pipe connecting the nearest manhole with the chamber of size 1 ft. – 6 inches x 1 ft. – 6 inches. The pipe is laid in such a manner that other services such as water supply and sewerage system are not disturbed or interfered. The work of laying RCC pipe shall conform to the specifications laid down in Sub-section 25.3.3.8. Mild steel grating shall be fixed at the top.

h. Installation

i. Handling of Pipes

Concrete sewer pipes shall be handled with special care at all times during the manufacture, while transporting to the site of work, and while installing. Each pipe shall be carefully inspected before being laid and no cracked, broken or defective pipe shall be used in the work. Chipping of the tongue and groove or bell and spigot pipe ends, which in the Engineer-in-Charge's opinion may cause defective joints, shall be sufficient cause for the rejection of any concrete pipe.

ii. Excavation and Backfill

The excavation and backfill for sewer installations shall be as specified in applicable provisions of Section 3 - Earthwork and will be paid for under separate contract items as classified.

iii. Placing of Bedding

a) Brick Ballast Bedding

The brick ballast shall be clean material of 1 to 1½ inch gauge broken from first class bricks or bats, or from dense over burnt bricks. No under-burnt bricks or bats nor those which have become spongy of porous in the process of burning shall be broken up for brick ballast.

The material shall be evenly spread over the full width of the formation in 4 inches loose layers and compacted with hand or mechanical rammers until the full thickness as shown on the drawings for the particular pipe size has been built up and finished no more than ¼inch below required level. The Contractor shall note that it is essential that the material at the sides of the pipes is adequately compacted. Before the subsequent placing of pipe surrounding material, pipe joints shall be protected. Protection may take the form of a twist of yarn lightly pressed into the annular joints space or other equal protection approved by the Engineer-in-Charge.

b) Crushed Stone Bedding

Crushed stone bedding shall be from an approved source. It shall be obtained from a dark colored igneous rock such as basalt etc. It shall be strong durable, hard and impervious, having crystalline structure. The broken stone shall have sharp edges and clear fractured faces, shall be free from thin elongated or laminated pieces.

The crushed stone shall have a maximum gauge of 1½ inch and shall be graded down to¾ inch when passing through a screen made of ¼ inch diameter bars spaced ¾ inch center to center, it shall yield not more than ten percent (10%) by volume of fine materials.

a. Laying of Sewers

Neither any sewer pipe nor the bedding shall be laid or placed till the alignment of the sewer and its levels nor have gradients been carefully checked and tested with the trench excavation and found corrected.

Each length of sewer pipe shall be checked for cracks and defects before placing in the line. Defects which in the opinion of the Engineer-in-Charge indicate imperfect placing shall make the pipe liable to rejection. Each pipe shall be placed carefully to line and grade and in close contact with adjoining pipe. These specifications require rejection of the work, if the sewer invert varies as much ½ inch from the proper elevation. As shown on Drawings, the bottom of the trench must be shaped to fit the pipe barrel, with holes left for the bells. If excavation has been carried below the correct grade, refilling must be done with satisfactory materials as approved by the Engineer-in-Charge at no extra cost. The concrete pipe joints shall be of the type specified above and shall be made in accordance with the aforesaid specifications.

When laying is not in progress, the already laid open pipe shall be closed with a tapered wooden plug to keep out foreign matter.

I. TESTING OF SEWER LINES

a) General

All sewer built shall be tested for infiltration or ex-filtration as specified below. The tests shall be made at times selected or approved by the Engineer-in-Charge. Sections of the completed sewer shall be isolated and measurements of the infiltration or ex-filtration shall be made by approved method. The contractor shall furnish all labor, material and equipment required for making the tests with no extra compensation over and above the agreed contract prices for the laying of sewer lines.

b) Infiltration Test

The sewers which are constructed with the ground water level above the invert level of the pipe shall be tested for infiltration after the sewers have been installed and backfilling has been substantially completed. The tests and measurement shall be performed by the Contractor in the presence of the Engineer-in-Charge as follows in accordance with ASTM C 969-02.

Conduct testing from manhole to manhole or between more than two manholes. The length of main tested shall not exceed 700 ft in length.

Following steps shall be taken to check infiltration:

i. Stop all dewatering operation and allow the groundwater to return to its normal level. Infiltration testing shall not be used unless the groundwater level is at least 2 ft above the crown of the pipe for the entire length of the test section.

ii. Plug all pipe outlets discharging into the upstream manhole.

iii. Measure the groundwater elevation and determine the average head over the test section.

iv. Measure infiltration leakage at the outlet of the test section. Because leakage allowances are small, measurements are best made by either filling of a small container of known volume, or by directing flow into a container for a specified time and measuring the content, or by using small weirs.

v. If the measured rate of leakage is less than or equal to the allowable leakage in accordance with (d) hereafter the section of sewer tested is acceptable.

vi. If the test section fails, the Contractor can repair the joints as per methods and using materials as approved by the Engineer-in-Charge and in accordance with this practice.

vii. The allowable leakage limit including manholes is 500 gallon/ inch of internal diameter (mile of sewer) (24 h) when the average head on the test section is 6 ft or less.

viii. The average head on the test section is the head above the crown of the pipe at the upstream manhole plus the head above the crown of the pipe at the downstream manhole divided by two.

ix. When the average groundwater head on the test section is greater than 6 ft. the allowable leakage shall be increased in proportion to the ratio of the square root of the average groundwater head to the square root of the base head of 6 ft.

x. Manholes shall be tested separately and independently or with the pipeline with the allowance of 0.1 gallon (ft of diameter) (ft of head) (h). If building or house leads are connected to the main line being tested, allowance shall be made for permissible leakage in such leads.

c) Ex-filtration Test

i. Conduct testing from manhole to manhole or between or between more than two manholes. The length of main lines tested shall not exceed 700 ft.

ii. Determine the groundwater elevation at both ends of the test section. If the ground water level is less than 2 ft above the crown of the pipe measured from the highest elevation of the sewer, the ex-filtration test shall be used.

iii. Plug all pipe outlets discharging into the upstream manhole and the test section outlet. Fill the sewer line with water.

iv. At the upstream manhole the test head shall be established as minimum of 2 ft above the crown of the pipe, or at least 2 ft above existing groundwater, whichever is higher.

v. Allow the pipe to remain saturated for a period long enough to allow water absorption in the pipe, a minimum of 4 h and up-to a maximum of 72 h. After the absorption period, refill the pipe to the required test head.

vi. Measure the leakage loss over a timed test period. The minimum test period shall be 15 min and the maximum shall not exceed 24 h.

vii. If the measured rate of leakage is less than or equal to the allowable leakage in accordance with (d) the section of sewer tested is acceptable.

viii. If the test section fails, the Contractor can repair the joints as per methods and using materials as approved by the Engineer-in-Charge and retested in accordance with this practice. The groundwater

elevation shall be re-determined prior to a second test and the test head adjusted, if necessary in accordance with (iv).

ix. For ex-filtration testing the allowable leakage limit including manholes is 500 gal. (In. of internal diameter) mile of sewer (24 h) when the average head on the test section is 3 ft or less.

x. When the average head on the test section is greater than 3 ft. the allowable leakage shall be multiplied by the ratio of the square root of the average test head and the square root of the base head of 3 ft.

xi. Manholes shall be tested separately and independently or with the pipeline with an allowance of 0.1 gal. (ft of diameter) (ft of head) (h).

d) Allowable Infiltration or Ex-filtration

The calculated amount of infiltration or ex-filtration over a 24 hour period shall not exceed 500 gallons per inch of pipe diameter per mile of sewer which rate shall be applied to the actual sewer size and length tested to determine the allowable infiltration or ex-filtration over the 24 hour period.

If the measured infiltration or ex-filtration exceeds the specified allowable limit, then the Contractor shall locate the points of leakage and make necessary repairs so as to reduce the leakage to less than the permissible maximum stated above.

e) Cleaning of Sewer Lines

The Contractor shall clean all the sewer lines at no extra cost with the method approved by the Engineer-in-Charge prior to handing it over to the Employer.

43.3 DRAINAGE & SEWERAGE SPECIALITIES

Manholes

Shall be constructed as shown on drawings they shall be of brick masonry and shall be complete, including excavation backfill and plastered both surfaces.

Benching shall be constructed in concrete, finished to a smooth even surface true to radius, line and level and shall be kept well watered often day after laying.

M.I. Rungs of 20mm dia of specified size with Bituminous Paint shall be provided in manholes and shall be fixed at 300mm spacing in all manhole having a greater internal depth than 1000mm. Manholes shall be constructed to a height up to finished ground level.

Manhole covers and frames shall be Grey Cast Iron conforming to BS 497: 1967, ALPINE make, Rubber sealed material conforming to BS 1452 Grade 150.

All manhole covers shall be of size 24" dia. heavy duty type ALPINE or approved equivalent make of sizes as specified on drawings and shall be supplied complete with base frame.

Sewer Connections

The Contractor shall be responsible for obtaining necessary permits, licenses, etc., from the concerned authorities for the sewerage connections. He shall give notice to local authorities of intention to connect to the public sewer. The work of breaking into the existing public sewer and forming a connection should be carried out by permission from and under the supervision of the authorised representative of the relevant authorities.

The cautious enlargement of a small hole should affect breaking into the sewer, and every precaution should be taken to prevent foreign material from entering the sewer. The express consent of the local authority must be obtained before any temporary obstruction is made to the flow of the public sewer.

Gully Trap Chamber

shall be constructed of 1:2:4 R.C.C., and shall be provided with au-PVC deep-seal 'P' trap with cast iron frame and cover of 12" dia, weighing 26 lbs. (12 Kgs.) where shown on drawing. Gully Trap chamber shall be made as instructed and approved by the Engineer In charge, prior to its construction.

Cleanouts

Cleanouts shall be U-PVC. A sample cleanout shall be submitted for approval to the Engineer.

Cleanout for Finished Floor Areas

Shall be of u-PVC designed to provide an air tight seal

Valve Chambers

Shall be constructed in accordance with the clearance for valves and the operations, as instructed by the Engineer In charge it shall include C.I. manhole frame and cover. Chambers shall be constructed of 1:2:4 R.C.C. convenient for operation and maintenance of the valves, installed in the valve chamber. 3/4" (20 mm) thick cement plaster shall be provided at the internal and external surfaces of the valve chamber. Bituminous paint shall be provided in two coats outside the valve chamber. G.I. pipe sleeves shall be provided for pipe connections.

Floor Drains

Floor Drains shall be of u-PVC with 5" (125 mm) dia opening. The drain shall be provided with a u-UPVC P-Trap having a minimum water seal of 50mm. The drain grating shall be of stainless steel, Master, Faisal or approved equivalent make.

Roof Drains

Roof Drains shall be as shown on drawing of best available locally manufactured. Body shall be of cast iron with threaded outlet that shall screw into a cast iron ferrule. Ferrule shall be caulked into CI Pipe "Bell". Dome shall be of bronze with a large open area to permit un-obstructed flow. The basic drain body shall be installed during the concrete pour, for full structural integration.

Master Trap

Master trap shall conform to specifications given above, except that it shall be provided with an RCC master trap of the same diameter on the main pipe line.

Vent Cowls

All vent-lines terminating above the building shall be provided with best quality u-PVC.

43.4 INSTALLATION

a) Each pipe shall be examined on arrival defective pipes shall not be used. Drains shall be laid in straight lines and gradients between the levels shown, with pipes and fittings. Great care shall be exercised in setting out and determining the levels of the pipes and the Contractor shall provide suitable instruments and set up and maintain all sight rails, and bench marks etc., necessary for the purpose. Cut pipe shall have smooth regular ends at right angles to arise of pipes. Pipe to be cut with an approved cutter.

   All drain shall be kept free from earth debris, superfluous cement and other obstructions during laying and until the completion of the contract when they shall be handed over in clean conditions. Pipes shall be laid with the sockets leading uphill and shall rest on solid and even concrete foundation for the full length of the barrel as shown on drawings.

   No pipes shall be laid on their collar or on block tiles or other temporary supports.

b) Drainage lines shall be accurately laid and shall be perfectly true to line and gradient from point to point in both vertical and horizontal planes. Every main shall be straight from manhole to manhole and any change in director shall take place inside the manhole by the use of the curved main channels, similar changes in internal diameter in drain shall be made in manhole by the use of tapers or bends.

c) Easily accessible clean outs, flush with the floor finish should be provided at each bend and bottom of stacks and at all points shown on drawings. The cleanouts should be made off "WYE" of full size the minimum size should be 75mm dia.

d) Special fittings required in the installation not generally Contractor matching with the shell thickness specified should be specially cast by manufacturers.

e) Branch connection shall be made with "WYE" and long "Tee-Wye" fittings. Short 1/4 bends, common offsets and double hubs will not be permitted. Short "Tee-Wye" fittings are to be used in vertical piping only. All fittings shall conform to Code Requirements.

f) Joints between Cast Iron to Cast Iron Soil Pipe (C.I.) shall be caulked joints and made with firmly caulked tarred yarn and then tightly caulked with molten lead. After the lead has cooled, the joints shall be thoroughly caulked, made tight and smooth faced. All lead for joints in cast iron piping shall be pure and soft and have best quality, and shall be sufficiently heated to run joints full at one pouring without hardening. Dross shall not be allowed to accumulate in the melting pot.

g) Approximate weight of lead for C.I. Pipe joints shall be as specified hereunder. Exact amount will depend upon the operator and gasket introduced.

Table 43- 5: Weight of lead for C.I. Pipe joints

PIPE DIA (mm)	CAULKING SPACE (mm)	DEPTH OF LEAD (mm)	WEIGHT OF LEAD (Kg)
50	10	45	0.7
75	10	45	1.8
100	10	45	2.2
150	10	45	3.4
200	10	45	5.0
250	10	45	6.1
300	10	45	7.2

h) Joints between cast iron and galvanised steel shall be made with a cementitious Cold Caulking Compound or may be caulked with lead.

i) Joint of PVC Pipes to cast iron socket should be made by means of purpose made cast iron sleeves jointed as indicated at (f).

j) All sewerage pipes laid underground shall be on concrete bed. All sewer pipes crossing road shall be completely encased in concrete as shown on drawings.

All soil and waste lines hung from the ceiling shall be supported at not more than 1m centres for horizontal pipe and 3m for vertical pipes. Provide supports at all special fittings. Supports shall generally conform to specification given in section 4.

43.5 PIPE SUPPORT

As specified in related section

43.6 SLEEVES

As specified in related section

43.7 PROTECTIVE PAINTING

As specified in related section

43.8 CUTTING AND PATCHING

As specified in related section

43.9 EXCAVATION AND BACKFILL FOR UNDERGROUND PIPE LAYING (RCC)

Pipes and accessories shall be carefully examined before being laid and defective damaged pipes shall not be used. The pipes shall be brushed clean inside and outside to remove any soil or foreign matter that may have accumulated, including inside of the sockets and outside of spigots, before being lowered into the trench, and shall be kept clean during laying operation by plugging or other approved method.

The bottom of the trench shall be shaped to give substantially uniform circumferential support to the lower fourth of each pipe. Pipe laying shall processed upgrade with the spigot ends of bell and spigot pipe pointing in the direction of flow. Each pipe shall be laid true to line and grade and in such manner as to form close concentric joint with the adjoining pipe. If the width of the trench at the pipe is exceeded than necessary, due to any reason other than under direction from Engineer, the Contractor shall install at no additional cost to the Owner, such concrete cradling pipe encasement or other bedding as may be required to satisfactorily support the added load of the backfill.

Trenches shall be kept free from water until the pipe jointing material has set, and pipe shall not be laid when the condition of the trench or the weather condition is unsuitable for such work. At times when work is not in progress, open ends of pipe and fittings shall be securely and satisfactorily closed so that no trench water, earth, or other substance will enter the pipe and fittings.

As the work progresses, the interior of the sewer shall be cleaned of all dirt and superfluous materials of every description. Where cleaning after laying is difficult because of small pipe size, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed. Where sewers cross above water line the sewer pipe for a distance of 3 meter (10 feet) each side of the crossing shall be of cast iron steel or other acceptable pressure pipe and with no joint closer than 3 feet (900 mm) to the crossing, or shall be fully encased in concrete of min. 15 cm. (6 ") thickness.

Any section of the pipe found to be defective before and after laying, shall be replaced with sound pipe without additional expense to the Owner.

The jointing or pipes with collars shall be done first with spun yarn rope (dipped in hot asphalt composition) fitted in between the ends of pipes and pressed together. The dia of rope shall not exceed 19mm (3/1") or as directed by Engineer.

The collar shall then be brought in the middle of the joint. Wooden wedges shall be placed at two or three places around the pipe so that the collar may have uniform gap all round the pipe for pressing pipes together. At a time five or six pipes shall be jointed together. Alter putting bitumen soaked hemp rope, suitable jacks and wedges or any other approved method shall be used. The inside of the collar and outside portion of the pipe shall be cleaned with brush and cement mortar of 1:1 proportion shall then be inserted from both ends of the collar. The mortar containing as little quantity of water as possible shall be carefully inserted by hand into the joints and tightly pressed with caulking tool. The mortar shall be finished off on the outside at an angle of 45 degree. The wooden wedges shall be carefully removed and mortar filled in the cavity before finishing. The joints shall be protected from weather and maintained wet for at least ten days and shall not be covered with backfill until the joints have been tested and approval given by the Engineers.

For jointing of pipes with spigot and socket joints, the first pipe shall be bedded with the socket end upstream. The interior surface of the socket shall be carefully cleaned with a wet brush and its lower portion filled with mortar to such a depth as to bring together the inner surfaces of the abutting pipes flush and even. All further joints shall be made in this manner. The remainder of the socket joint shall be filled in with mortar and well pressed with the help of caulking tool. The mortar shall be finished smooth on the outside at an angle of 85 degree. The joints shall be protected and cured as for collar joints.

43.10 TESTING AND INSPECTION

a) The entire drainage and vent system and building sewer shall be subjected to testing after installation under operation conditions.

All the openings in the piping system shall be tightly closed by inserting testing plug so that heavy rubber gasket fits snugly all around the opening. The highest point will be left snugly all around the opening. The highest point will be left open to supply water and may be raised if necessary by temporary jointing develop a minimum head of five (5) meters of water at each section of the system. Water is filled to the point of overflow and any drop in the level of water will be found by inspection. The water level will be checked for no drop for at least 15 to 30 minutes. Higher stacks will be tested in sections, starting from the top section and then connecting top section to next lower section.

b) A final test of completed drainage and vent system will be conducted by smoke to ensure that connection for water closest are absolutely gas and water tight and that fixture traps are sound.

All the traps will be filled with water and a thick smoke produced by burning oil, waste, tarpaper or similar material in the combustion chamber of a smoke test machine, will be introduced into the entire system. When smoke appears at highest point it will be closed and pressure equivalent to 25mm of water column will be built and maintained.

The drainage pipe and building sewer will also be inspected for slopes, which must conform to the slopes specified. The slopes will be checked with precision angle measuring equivalent like universal protector, plumb and level. Any portion found not laid according to the given slope will be rectified at the Contractor's expenses. The Contractor shall be required to inform the Engineers before any laid pipes are backfilled and approval obtained.

After the pipe is laid, the joints completed between manholes, and the trench practically backfilled leaving the joints exposed for examination, the newly laid piping shall be checked for alignment by flashing a light between manholes. If illuminated interior of the pipe line shows poor alignment, the displaced pipe, or any other defects, shall also be checked for the given slopes, and if found unsatisfactory, shall be repaired at the Contractor's expense.

c) This Contractor shall furnish & pay for all devices, materials, supplies, labour and power required in connection with all tests. All tests shall be made in the presence of and to the satisfaction of the Engineer, Plumbing Inspector of the City and Public Utility Inspectors having jurisdiction.

d) This Contractor shall also be responsible for the work of other trades that may be damaged or disturbed by the tests, or the repair or replacement of his work and he shall, without extra charge to the Employer, restore to its original condition, work of the trades so damaged and disturbed, engaging the original contractors to do the work of restoration.

e) Defects disclosed by the tests shall be repaired, or if required by the Engineer. Defective work shall be replaced with new work without extra charge to the Employer. Test shall be repeated as directed, until all work is proven satisfactory.

f) This Contractor shall notify the Engineer, Plumbing Inspector and other having jurisdiction at least ten days in advance of making the required tests, so that arrangements may be made for their presence to witness the tests.

43.11 MEASUREMENT AND PAYMENT

a) Pipes

i. Measurement for pipe shall be in running feet length and the work to be done shall include providing and fixing of pipe, pipe fittings, sleeves, anchors and supports, jointing, cutting and breaking concrete and then making it good applying protective painting, cleaning, testing and the measurement will be made for full work, specified herein, including Testing and Commissioning.

ii. Payment will be made for the actual quantity installed at the unit rate given in the Bill of Quantities which shall be deemed to be full compensation under the Contract.

b) Drainage and Sewerage Specialities

i. Measurement for manholes gully traps, floor drain, Roof drains, Vent Courts, etc., shall be made as per actual number provided and installed and shall be for conform work specified herein or as shown drawings, including Testing and Commissioning.

ii. Payment for Cleanouts, Floor Drains, Roof Drains, Master Trap, Valve Chambers, Vent Courts, etc., shall be for the actual quantity installed at the unit rate given in the Bill of Quantities which shall be deemed to be full compensation under the Contract.

iii. Gulley trap of all sizes mentioned in the bill of quantities shall be constructed as per drawings to be prepared by the designer. The measurement of excavation, backfill, concrete of all types, steel, plaster, brick masonry and cover and frame shall be measured and paid under civil work of these specifications.

Pay Item No.	Description	Unit of Measurement
43.11 a	Supplying and fitting Light (400 kg capacity) CI manhole cover with frame of approved quality (BS EN:124).	
	i. 12" (300mm) dia. (12.5 kg)	NO
	ii. 18" (450mm) dia. (25 kg)	NO
	iii. 24" (600mm) dia. (50 kg)	NO
	iv. 30" (750mm) dia. (100 kg)	NO
	v. 12"x12" (300x300mm) square (15 kg)	NO
	vi. 18"x18" (450x450mm) square (30 kg)	NO
	vii. 24"x24" (600x600mm) square (60 kg)	NO
43.11b	Supplying and fitting Medium (3 Ton capacity) CI manhole cover with frame of approved quality (BS EN:124).	
	i. 12" (300mm) dia. (25 kg)	NO
	ii. 18" (450mm) dia. (50 kg)	NO
	iii. 24" (600mm) dia. (100 kg)	NO
	iv. 30" (750mm) dia. (175 kg)	NO
	v. 12"x12" (300x300mm) square (27.5 kg)	NO
	vi. 18"x18" (450x450mm) square (60 kg)	NO
	vii. 24"x24" (600x600mm) square (125 kg)	NO
43.11c	Supplying and fitting Heavy (10 Ton capacity) CI manhole cover with frame of approved quality (BS EN:124)	

	i.	12" (300mm) dia. (50 kg)	NO
	ii.	18" (450mm) dia. (100 kg)	NO
	iii.	24" (600mm) dia. (200 kg)	NO
	iv.	30" (750mm) dia. (325 kg)	NO
	v.	12"x12" (300x300mm) square (60 kg)	NO
	vi.	18"x18" (450x450mm) square (120 kg)	NO
	vii.	24"x24" (600x600mm) square (225 kg)	NO
43.11d	Providing and laying R.C.C pipe with bell & spigot or tongued & grooved joint conforming to ASTM C-76 class-II wall-B or BS 3911 Part-I class-M including cost of reinforcement. moulded with cement concrete 1:1.5:3 with spigot socket or collar joint as specified, in trenches to correct alignment and grade, jointing with jointing materials including cutting pipes where necessary, finishing and testing complete in all respect (excluding excavation and backfill)		
	i.	9" (225 mm) inner dia.	LM
	ii.	12" (300 mm) inner dia.	LM
	iii.	15" (375 mm) inner dia.	LM
	iv.	18" (450 mm) inner dia.	LM
	v.	21" (525 mm) inner dia.	LM
	vi.	24" (600 mm) inner dia.	LM
	vii.	30" (750 mm) inner dia.	LM
	viii.	36" (900 mm) inner dia.	LM
43.11e	Providing and fixing PVC gully trap, size4" (100mm)		NO
43.11f	Providing and fixing 3" (75mm) inner dia CI ventilating shaft (BS 2035 class-B) with wall thickness 9.5mm including nut, bolt and cost of painting two coats of white zinc paint with pigment of approved shade, Excavation and Concrete work shall be paid separately		KG
43.11g	Providing, laying, cutting, jointing and testing SDR-41 U-PVC soil waste pipe with approved make (ASTM D2241) including the cost of jointing material and specials, complete in all respects.		
	i.	3" (75 mm) dia.	LM
	ii.	4" (100 mm) dia.	LM
	iii.	6" (150 mm) dia. (without specials)	LM
43.11h	Providing, laying, cutting, jointing and testing Medium U-PVC soil waste pipe with approved make (EN 1329) including the cost of jointing material and specials, complete in all respects.		
	i.	2" (50 mm) dia.	LM
	ii.	3" (75 mm) dia.	LM
	iii.	4" (100 mm) dia.	LM

iv.	6" (150 mm) dia. (without specials)	LM
v.	8" (200 mm) dia. (without specials)	LM

SECTION 44 PLUMBING FIXTURES AND ACCESSORIES

44.1 SCOPE OF WORK

The work to be done under this section of the specifications consists of providing all material and labour for proper installation of plumbing fixtures of wash basins, water closets, urinals etc. along with all their accessories, water inlet connection, waste outlet connection etc. complete in all respect as specified herein or as shown on the drawings and/or as directed by the Engineer.

44.2 MATERIALS AND INSTALLATION

General Requirements

Materials shall conform to the latest reference standard specifications and other provisions stipulated herein and shall be new and unused prior to procurement of the materials, the Contractor shall be required to prepare and submit to the Engineer for his approval, a complete schedule of materials to be used in the works together with a list of the names and addresses of the materials. The schedule shall include diagrams, drawings and such other technical data as may be required by the Engineer to satisfy him as to the suitability, durability, quality and usefulness of the material to be purchased.

Approval of the schedule shall not be construed as authorising any deviations from the specifications unless the attention of the Engineer has been invited to the specific changes in writing. If the material or equipment offered under this provision is, in the opinion of the Engineer, equal to or better than specified, it will be given consideration.

Plumbing fixtures shall have smooth impervious surfaces, be free from defects and concealed faulting surface. They shall be true to line, angles, curves and colour etc. Normally they shall be of local make and of the quality available, provided they conform to the requirements specified herein.

All taps, cocks, flush tank, hot & cold water mixture fittings shall be of best class as per the specifications of approved manufacturer and as approved by the Engineer, to work without damage or leakage on specified pressure and temperature of potable water system.

When any fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture cannot rise in the overflow when the stopper is closed or remain in the overflow when the fixture is empty.

Plumbing fixtures shall be installed in a manner to afford easy access for cleaning. The space between the fixture and the wall shall be closely fitted and pointed so that there is no chance for dirt or vermin to collect.

Floor Traps and P-traps shall conform to ASTM D2665 (PVC) or as per the specifications of approved manufacturer and as approved by the Engineer.

Bath Room accessories (Bath Mixer Shower, Shower Tray, glass shelf etc.) shall be as per approved manufacturer and as approved by the Engineer.

Where practical, all pipes from fixtures shall run to nearest wall.

Where fixture comes in contact with wall and floors, the joint shall be watertight.

Wall hung fixtures shall be rigidly supported by metal supporting members so that no strain is transmitted to the connections. Flush tanks and approved non-corrosive screws or bolts shall secure similar appurtenances.

Fixtures shall be set level and in proper alignment with reference to adjacent walls. No water closet shall be set closer than 400mm from its centre to any sidewall. No urinal shall be set neither closer than 300mm from its centre to any sidewall or partition nor closer than 600mm centre to centre.

The supply lines or fittings for every plumbing fixture shall be so installed as to prevent backflow.

All cutting, making holes etc., and making it good shall be included in the work.

44.3 WASH BASIN

Wash basin shall be of vitreous China of approved size and colour, best quality. It shall be installed as a complete unit including hot and cold water mixer fitting, 15mm CP Tee stop-cock, as manufactured by Master, Faisal or equivalent as approved, CP brass chain with 32mm rubber plug, CP brass bottle trap, Master or Faisal make for individual wash basin, CP brass strainer, heavy cast iron brackets with bolts, screws etc., PVC flexible water inlet connection pipe, CP brass steel waste outlet and/or waste pipe, joints, jointing and sealing material etc., with all other minor accessories required to complete the job in all respect ICL, or acceptable superior brand. `

44.4 COUNTER TOP WASH BASIN

Shall be of Vitreous China of approved size and colour, best quality. It shall be installed as a complete unit including hot and cold water mixer fitting, 15mm CP Tee stop-cock, as manufactured Master, Faisal or approved equivalent make, CP brass chain with 32mm rubber plug, CP brass bottle trap Master, Faisal or approved equivalent make, for individual wash basin, CP brass strainer, heavy cast iron brackets with bolts, screws etc., PVC flexible water inlet connection pipe, CP brass steel waste outlet and/or waste pipe, joints, jointing and sealing material etc., with all other minor accessories required to complete the job in all respect ICL, or acceptable superior brand.

44.5 WATER CLOSET

Squatting (Asian) type water closet of vitreous China, of approved colour, best quality as manufactured by approved make. It shall be installed as a complete unit including 15mm CP stop cock plastic water inlet connection pipe, flush tank installed at low level including interconnecting flush piping, foot-rests, porcelain P trap, joints, jointing and sealing material etc., with all other minor accessories.

Flush tank shall be made of vitreous China as manufactured by approved make for Asian Water Closet.

European type water closet of vitreous China with coupled flushing cistern as manufactured by approved make, shall meet all the requirements specified for Asian type water closet except the following. Flush tank shall be coupled, trap shall be porcelain integral with pan, shall be additionally provided with seat & toilet paper holder. The seat shall be smooth non-combustible non-absorbent materials like Bakelite and of the open front type fixed to the pan with hinges.

European water closet shall be provided with close-coupled vitreous China flush tank similar to approved make.

44.6 URINAL

Urinal shall be vitreous China best quality, light colour as manufactured by approved make complete with flushing valve Master, Faisal or approved equivalent make. All flush pipe, spreaders and clips shall be chrome plated. Urinal shall be of wall hung type either with integral water seal trap or with separate CP brass P trap. The complete unit shall be installed including 15mm CP stopcock. CP steel waste pipe, joints, jointing and sealing material etc. with all other minor accessories.

44.7 KITCHEN SINK

Sink shall be of best quality, stainless steel, Atlas, Master or approved equivalent make, double bowl double drain board; double bowl single drain board; single bowl double drain board, and single bowl single drain board type as indicated on the drawings/BOQ. Also include 40 mm (1½") diameter CP waste outlet with chain and plug, 15mm (1/2") diameter wall mounted mixer fittings with swivel spout and 40mm (1½") CP bottle trap Master, Faisal or approved equivalent make and 40mm (1½") CP brass waste pipe to floor or wall as indicated on the drawings. Cast iron support arms shall be provided.

44.8 ELECTRIC WATER COOLER

Water cooler local makes best quality as manufactured by approved make or equivalent as per approval of Engineer/Consultant. Water cooler shall be Instantaneous Pressure Type Water Coolers having water storage tank of specified capacity, made of finned copper total immersed evaporator coils for maximum thermal efficiency. Hermetically sealed slow speed compressor of required HP with overload protection for Refrigerant 12 controlled by capillary tube. The water cooler shall have 2 Nos. taps.

44.9 MUSLIM SHOWER

Muslim Shower shall be local make best quality (with or without double bib as specified in BOQ) from manufacturer approved by the Engineer. It shall consist of C.P. brass / PVC "T" Stop Cock at height of 18" from finished floor level, complete with 1/2" dia flexible stainless steel hose 3 ft long and hand spray, C.P. brass hose hook including the cost of all cutting, binding and making good, complete in all respects.

44.10 SOAP HOLDERS

Soap holder shall be of Vitreous China / PVC, best quality from manufacturer approved by the Engineer.

44.11 TOWEL RAILS

Shall be chromium finish brass / PVC rails of 20mm square, 600mm long with brackets, of best quality from manufacturer approved by the Engineer.

44.12 TOILET PAPER HOLDER

Shall be of Chromium finish brass / PVC type, best quality, from manufacturer approved by the Engineer.

44.13 TAPS AND COCKS

All the taps and cocks shall be from manufacturer approved by the Engineer, of best quality & shall be of brass, gun metal or other equally suitable corrosion resisting alloy conforming to BS 1010 and shall in addition be chrome plated. The nominal size specified shall be the nominal bore of the seating. The area of the waterway throughout the body shall not be less than the area of a circle of diameter equal to

the nominal size of tap/cock. Washers for cold water cocks shall be of specially selected leather, rubber asbestos composition or other equally suitable material.

Washers for hot water-cocks shall be of good quality fibre, rubber-asbestos composition or other equally suitable material. Every tap/cock shall be tested, complete with its component parts, to a hydraulic pressure of at least 20 Kg/Cm^2. During test is shall neither leak not sweat.

44.14 WATER HEATER

Electric and gas water heater shall be of specified capacity and of storage type with adjustable thermostatic range of 40^{0}C to 80^{0}C. It shall be of approved manufacturer. All controls are to be automatic.

It shall automatically shut off (electric) or come to pilot (gas) when temperature of hot water reaches80^{0}C and restart when temperature drops below 40^{0}C.

The vessel of water heater shall be constructed of steel with welded joints. The vessel shall be lined with copper on the inside and painted with baked stove enamel on the outside. The annular space between the copper and steel cylinders shall be filled with insulation material of thermal conductivity not more than 0.045 Watts/Sq.m^{0}C. The heater vessel shall be rated for a working pressure of 0.6MPa and test pressure of 1 MPa.

In electric water heater the electric heating elements shall be withdraw-able, mineral insulated, metalclad copper rods. In gas water heater the gas supply shall be controlled by a regulator allowing at least 4 volumes of gas supply including arrangements for a pilot.

The capacity of the heating equipment shall be sufficient to raise the temperature of water from +10^{0}C to + 70 ^{0}C in not more than one hour.

Water Heater shall be provided with the following accessories and control:

a) Thermostat
b) Pressure Relief Valve
c) Thermometer
d) Pressure Gauge
e) Drain Valve
f) In electric water heaters Automatic High Temperature Cut-off
g) In Gas Water Heaters, a Regulator & a Pilot

Water Heaters of capacity as shown on drawings/BOQ shall be supplied and installed where shown on the drawings or as directed by the Engineer.

Gas water heater shall be storage type or instant type as mentioned in the BOQ.

All heaters, after installation, shall be subjected to an operation test to determine the efficient working of the recovery side, thermostat, etc. to the satisfaction of the Engineer. The Engineer, prior to supply and installation shall approve all heaters.

44.15 MIRROR (LOOKINGGLASS)

One bevelled edge glass mirror of first class quality and make as specified securely fixed on bard board packing required to be fixed on the wall for wash basin shall be at least 6 mm thick and shall be of requisite dimensions.

44.16 BATH TUBS

These shall be of porcelain enamelled cast iron or fibre glass, ceramic or porcelain as specified. The bath tub shall be provided with 27 mm (1-1/2") trap, overflow and

anti-syphonic arrangements and connected to the waste and anti-syphonic stacks on the outside wall. Waste water may be allowed to discharge through over flow trap, if directed by the Engineer-in-Charge. The bath shall be fitted with two CP pillar cocks and CP chain with a plug. The approximate dimensions of the bath tubs shall be as per table.

Table 44-1: DIMENSIONS OF BATH TUBS

Description	Pattern					
	Magna		Rectangular		Parallel	
	cm	inch	cm	inch	cm	inch
Length overall	168	66	183	72	168	66
Width overall	71	28	1	28	71	29
Depth inside at waste	44	17-1/2	4	17-1/2	43	17
Height overall – exclusive feet & waste	46	18	6	18	44	17-1/2
Height overall - with feet for 38mm (1-1/2”) seal trap	58	23	8	23	57	22-1/2
High overall for 76mm (3”) seal trap top holes 35mm (1-3/8”) square centered	62	24-1/2	2	24-1/2	61	24
On-roll-Hole distance part	18	7-1/8	8	7-1/8	18	7-1/8
Waste hole 57mm (2-1/4) clear diameter distance from edge of roll at tap & to centre of waste hole	29	11-1/4	9	11-1/4	25	10
Overflow centre-distance below top edge	10	4	0	4	9	3-1/2
Capacity	118 L	26Gal	127 L	28Gal	122 L	27Gal

The fall along the bottom from head end to outlet should be adequate for complete emptying. The feet shall be suitable for bath tubs with traps having 27 mm (1-1/2") seal or for bath tubs with taps having 75 mm (3") seal.

Bath tub outlets may be rebated or tapered to receive the outlet piece. The later comprises a chamfered flange 7.3 mm (2-7/8) diameter with tail 35 mm (1-3/8") long provided at the end having an integral grating. A riding flange 7.3 cm (2-7/8") diameter for tightening to the bottom of the bath tub is also provided.

The overflow holes on magna/rectangular bath tubs shall be 10 cm (4") from top of bath tub to centre and on parallel bath tubs 9 cm (3-1/2") from top to centre.

Overflow holes on parallel bath tubs shall be 4.4 cm (1-3/4") in diameter intended for 3.1 cm (1-1/4") overflows.

A grating shall be fixed in the overflow hole. A brass bend 5.7 cm (2-1/4") long shall be attached to the grating. The tail of which shall have threads 3.18 cm (1-1/4") for connection to outflow pipe.

44.17 MEASUREMENT AND PAYMENT

i. Measurement for Wash Basins, Water Closets, Urinals, Electric Water Cooler, Towel Rail, Soap Dish, Soap Holder, Toilet Paper Holder, Muslim Shower, Water heater, Manhole, Traps, Gauges, Cleanout, C.I. Manhole Cover, Roof Drain and Cock, mixer fittings and etc., will be made as per actual number acceptably provided and installed. The Contractor bid against these items shall include supply and installation of complete unit as specified herein, inclusive of all work from inlet connection of water supply to outlet connection with the sanitary system, complete as per Contractor Documents and or as directed by the Engineer.

ii. Payment for Wash Basins, Water Closets, Urinals, Electric Water Cooler, Towel Rail, Soap Dish, Soap Holder, Toilet Paper Holder, Muslim Shower Water Meter, Manhole, Traps, Gauges, Cleanout, C.I. Manhole Cover, Roof Drain and Cock, mixer fittings and etc., shall be made at the applicable unit price per number bid for the respective item in the Bill of Quantities. The amount bid shall be full payment for the work specified herein.

Pay Item No.	Description	Unit of Measurement
44.17 a	Supply, installation, testing and commissioning, where required, for following items of works, including piping etc. complete in all respect.	
	i. Wash Basin (white), including mixer fitting and pedestal, size 25”x22”	NO
	ii. Wash Basin (coloured), including mixer fitting and pedestal, size 25”x22”	NO
	iii. Wash Basin (white), including mixer fitting and pedestal, size 22”x15”	NO
	iv. Wash Basin (coloured), including mixer fitting and pedestal, size 22”x15”	NO
	v. Wash Basin (white), including mixer fitting and pedestal, size 21”x19”	NO
	vi. Wash Basin (coloured), including mixer fitting and pedestal, size 21”x19”	NO
	vii. WC (white), Indian type including sistern, P-trap and piping.	NO
	viii. WC (coloured), Indian type including sistern, P-trap and piping.	NO
	ix. WC (white), European type including piping	NO
	x. WC (coloured), European type including piping	NO
	xi. Electric water cooler 60 liter	NO
	xii. Towel Rail (chromium) single rod 24”x3/4”	NO
	xiii. Soap Dish (chromium plated), as approved	NO
	xiv. Urinals white, including piping	NO

	xv.	Urinals coloured, including piping	NO
	xvi.	Toilet Paper Holder (chromium plated)	NO
	xvii.	Muslim Shower, as approved	NO
	xviii.	Water Heater, Electric 20 liter instant	NO
	xix.	Water Heater, Electric 30 liter instant	NO
	xx.	Water Heater, Electric 35 gallon	NO
	xxi.	Water Heater, Electric 55 gallon	NO
	xxii.	PVC floor trap 4" size	NO
	xxiii.	Common bath mixer wall showerC.P, as approved.	NO
	xxiv.	Shower tray (Glazed earthen ware) over 1" thick CS mortar	NO
	xxv.	Plastic bathroom accessories Set-7 pieces	NO
44.17 b		Providing and fixing looking mirror of Belgium/ Malaysian/ Indonesian glass with chromium plated screws.	NO
44.17 c		Providing and fixing 8mm glass shelf of 24"x5" size with guard rails and CP brackets.	NO
44.17 d		Providing and fitting CP or brass oxidized swan neck pillar cock (tap) of approved make (BS 1010).	
	i.	Single way	NO
	ii.	Double way	NO
44.17 e		Providing and fixing brass bib cock/ stop cock of approved make (BS 1010).	
	i.	½" (12 mm) dia.	NO
	ii.	¾" (20 mm) dia.	NO
	iii.	1" (25 mm) dia.	NO
44.17 f		Providing and fixing stainless steel sink for cold and hot water complete in all respects.	
	i.	18"x36" single bowl and single tray	NO
	ii.	20"x48" single bowl and double tray	NO
	iii.	20"x48" double bowl and single tray	NO
	iv.	20"x60" double bowl and double tray.	NO

SECTION 45 TUBE WELL

45.1 CONSTRUCTION OF TUBE-WELLS

45.1.1 SCOPE

The work covered shall consist of well drilling, installation of components, shrouding, development and testing including all plant, labour, equipment &other miscellaneous works necessary for the satisfactory completion of the tube-well as specified and approved by the Engineer-in-Charge.

Before proceeding with the work the Contractor shall submit a complete work plan for performing the work. This will include but be not limited to manpower, Plant and equipment and schedule of performance for completion of work.

The Contractor shall employ at site a fulltime competent superintendent for overall supervision of the work.

45.1.2 DRILLING

45.1.2.1 GENERAL

The Contractor shall drill bore hole for the tube-well at the designated location established by the Engineer-in-Charge, The Contractor shall prepare the site for the construction of the tube-well and shall provide water for construction requirements, the disposal of water, cuttings and waste from the operations away from the tube-well.

45.1.2.2 DRILL CONDITIONS

General overall conditions related to the ground water at the site of tube-well if available will be made known to the Contractor. The contractor is expected to make his own assessment of the character, quality and the conditions that may be encountered and shall take full responsibility for performance of work as specified.

45.1.2.3 DRILLING PROCEDURE

The bore hole shall be drilled by reverse circulation rotary method. The diameter of the drilling bit shall depend on the bore size as specified on drawings or as directed by the Engineer-in-Charge. The bore hole shall be drilled straight and plumb so that the pump and tube-well casing maybe installed concentric with the hole and within the tolerance specified for bulging of the casing. Waste materials from the drilling operation shall be disposed of in a manner approved by the Engineer-in-Charge.

The Contractor shall be responsible for protecting the tube-wells from contamination with foreign materials until the completion of the tube-well. The Contractor shall bear any expense that may result from any damage to tube-well, tools or equipment that may be caused by caving, washing or other disturbances within the tube-wells.

To prevent sloughing and caving of surface material and/or the hole, the Contractor shall furnish and install a boring casing pipe with a minimum diameter 2 inches greater than the bit diameter from not less than 6 inches above the ground surface to bottom of the hole. The casing pipe shall be new or used pipe of adequate strength for the purpose. After the drilling is completed, the casing pipe shall be removed by the Contractor and shall remain his property.

The use of drilling fluid additives or other suitable materials specially approved by the Engineer-in-Charge may be applied in stabilizing the bore hole. The casing shall be removed by the Contractor after the installation of pump housing pipe along with

the strainer in the bore hole. However, in case of the tube-wells where shrouding material is to be provided around the periphery of the strainer (or around the strainer and the pump housing pipe) and the inner walls of the bore hole the casing shall be removed in 1.5 to 3 meters stages as shrouding is placed.

If in the opinion of the Engineer-in-Charge, it is necessary to discontinue work on any bore hole because it is out of line more than the specified limit or on account of jammed tools, or caving ground, or because of negligence on the part of the Contractor, the Contractor shall drill another bore hole at an alternative location designated by the Engineer-in-Charge. The Contractor will not be entitled to payment for any work done or materials furnished for bore holes abandoned as a result of his operation or negligence.

45.1.2.4 DATA AND RECORDS

The Contractor shall keep an accurate drilling log of each bore hole including a description of all materials encountered and their location in the bore hole.

All records and data shall be kept by the Contractor on forms approved by the Engineer-in-Charge. The Contractor shall deliver to the Engineer-in-Charge the original of all records completed in all respects.

45.1.2.5 SAMPLING

Representative ditch samples or cuttings of the material penetrated shall be taken at every 5 ft. (1.5 m) depth of borehole or at each change in litho-logy encountered whichever is less. Special care shall be exercised to determine the thickness and location of each change in material encountered and to obtain satisfactory samples. Immediately upon taking the sample, each sample shall be placed in a plastic or cloth bag or specified partitioned wooden box, or other approved container, properly marked for identification, and plainly labeled with the depth of the top and bottom of the section of the bore hole represented. The containers shall be furnished by the Contractor. The method of obtaining, processing, and storing the samples will be subject to approval by the Engineer-in-Charge. The Contractor shall deliver all samples to the Engineer-in-Charge at the site of the tube-wells, except that when requested to do so by the Engineer-in-Charge, the Contractor shall deliver specified samples to the field headquarters.

45.1.3 INSTALLATION OF TUBE-WELL COMPONENTS

45.1.3.1 GENERAL

Installation shall consist of all work required in connection with the erection of pumping housing pipe, blind pipe, reducer, screen and bail plug/ sand trap required. For each tube-well as specified herein or on the Drawings or as directed by the Engineer-in-Charge and shall include, but not be limited to storing, fabricating and installing all the tube-well components including concentric reducers.

45.1.3.2 MATERIALS

i. Pump Housing Pipe

The housing pipe made of mild steel or PVC may have the same diameter as that of the other components or it may be bigger in which case tapered joint/reducer shall be used for connection of the housing pipe with the lower part of tube-well.

The mild steel pump housing pipes shall be new and shall be either seamless (Type S Grade 8 ASTM A-53), longitudinal welded (Type E Grade 8 ASTM A-53) or special seam fusion welded (Grade 8 ASTM A-139) mild steel of designated diameters and thickness indicated in the drawings.

PVC housing pipe shall conform to BSS-3505/1968.

All these pipes shall be free from dents, damages, scars and oval ties. The pump housing pipe shall be installed to extend above ground level as approved by the Engineer-in-Charge in addition to the housing as specified below ground level.

ii. Well Blind Pipes

Well blind pipes shall be of designated diameters as indicated in the drawings, which shall be fabricated in conformity with the specifications designated here above for pump housing pipes.

Fiber glass well blind pipes whenever used shall be new and shall consist of glass reinforced plastic pipe and couplings manufactured from thermosetting epoxy resins and glass fiber by either centrifugal casting process or by a filament winding process, both using continuous filaments and without the addition of fillers or pigments of any kind.

Glass fiber used in the manufacture of pipe and couplings shall be continuous filament, electrical glass. The glass shall have a finish suitable for use and compatible hardener. Each glass fiber or filament shall be thoroughly coated with epoxy resin.

All fiberglass casing pipe and couplings shall be round and straight of uniform quality and workman-ship, and free from all defects including indentations, delimitations, bends, cracks, blisters, porosity, dry spots, resin segregation and resin starved areas which due to their nature, degree or extent, detrimentally affect the strength and serviceability of the pipe and couplings. The impregnation of the glass fibres with resin shall be such that when the pipe is slotted no fraying or looseness of glass fibres shall be evident. All pipe ends shall be cut at right angles to the axis of the pipe and any sharp edges shall be removed. The inside of the pipe and couplings shall be smooth and uniform. Acetone rub tests may be employed to check resin nature and curing.

Pipe sections may be furnished with integrally fabricated couplings as specified herein- after, with plain or tapered ends for connection in the manufacturer's plant to separate coupling halves or with threaded ends for connection by means of threaded couplings. The Contractor shall be responsible for the co-ordination of all casing components to ensure proper connection to adjoining sections of the tube-well casing and the M.S Pump housing casing.

Couplings for fiberglass casing pipe may be threaded, mechanical or key type couplings of appropriate design and approved by the Engineer-in-Charge. The couplings shall be manufactured of the same materials used in the manufacturing of the fiberglass pipe.

All threaded pipe sections shall be field connected by the use of threaded fiberglass couplings. Thread geometry shall conform with the applicable sections of ASTM Standard: D -1694 or equivalent.

Key-type couplings shall consist of male and female halves designed for joining & locking together by means of key strip inserted in grooves in the coupling halves. The wall thickness at the groove on the male or spigot end of the pipe may be up to a minimum of 0.15 inches. Key strip and locking strips shall be fiberglass, plastic or other non-corrosive material capable of withstanding shearing and bearing stresses equivalent to the minimum axial tensile load for the couplings.

iii. Reducer

In case where the size of the pump housing pipe is larger than the size of the strainer, the mild steel pump housing pipe is connected with strainer or blind pipe by means of a reducer. The reducer shall be provided and made of the same material and of the same thickness as used for pump housing pipe specified above. The

upper end of the reducer shall be suitable for welding to the pump housing pipe and the lower end shall be designed for connection to the specified size and type of the well blind pipe.

iv. Bail Plug/Sand Trap

Bail plug/Sand trap shall be of the same material and thickness as followed for well casing. Sand trap shall be provided with a base plate, welded at one end of the pipe. A steel hook bent in the form of 'U' shall be bolted to the base plate to sustain suspended length casing including the strainer and blind pipe. Bail plug/Sand trap shall be one to three meters long in size or as indicated in the drawing.

v. Well Screen

Well screen shall be either brass, PVC or fiberglass suitable for gravel pack tube-well and strong enough for location at a depth as shown on the drawings, below ground level.

The strainer shall have smooth, sharp edged slots free of burrs, chipped edges, or broken areas on the interior or exterior surfaces of the pipe. The slots shall be machine cut having not more than 1.6 mm width. The width of the slot shall be dependent on the particle sizes of the sand. The open area of slotted casing shall be as approved by the Engineer-in-Charge. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe. The openings shall be free from jagged edges irregularities or anything that will accelerate or contribute to clogging or corrosion.

45.1.3.3 FABRICATION

The depth of pump housing pipe will be established by the Engineer-in-Charge depending on the future water levels and draw down anticipated. Length of the specified diameter of steel pipe shall be provided to extend the pump housing/casing from the elevation of the top of the pump housing pipe to the depth established by the Engineer-in-Charge.

Adjoining sections of mild steel pump housing pipe shall be assembled by field welding. The ends of the casing sections shall be lathe turned or other-wise prepared for joining. All field welding shall be performed by the electric arc method, using heavily coated welding rods suitable for all position welding. After being welded, the welds shall be cleaned of slag and shall show uniform smooth surface without over- lap, porosity and clinker. The pump housing pipe shall be connected to the tube-well casing (slotted and blind pipe) by means of a concentric tapered reducer.

The length and sizes of tube-well casing (slotted and blind pipe) to be installed shall be specified for the tube-well by the Engineer-in-Charge and shall be sufficient to extend from the bottom of the housing pipe to the top of the bail plug. Bail plug shall be provided at the bottom of the tube-well casing. The tube-well casing shall consist of sections for installation opposite water yielding formations and plain pipe sections or bail plug opposite non-water yielding formations as directed by the Engineer-in-Charge.

45.1.3.4 INSTALLATION

The Contractor shall install the entire pump housing and tube-well casing assembly straight, plumb, and concentric in the drilled hole to permit the installation of the pump in such a manner that it will operate satisfactorily and without damage. The methods employed by the Contractor in the installation of the casing and in obtaining or correcting the verticality & straightness of the pump housing/ casing shall be subject to the approval of the Engineer-in-Charge. Centralizers, spacers or other suitable devices shall be attached to the tube-well casing so that it will be

cantered in the drill hole throughout its entire length and held in such position while gravel shrouding is being placed. Centralizers shall be attached to the pipe in a manner that ensures that the pipe is accurately cantered in the drill hole. The detailed design of centralizers and the method of attachment to the pipe shall be subject to the approval of the Engineer-in-Charge. Unless otherwise directed centralizers shall be spaced not more than 60 ft. along the overall length of screen and casing assembly.

The Contractor shall install the pump housing casing so that the deviation of its axis from the vertical shall not exceed 4 inches (100 mm) at the bottom of the pump housing casing. Measurements for determination of verticality and straightness of the pump housing casing shall be made by the Contractor in the presence of the Engineer-in-Charge upon completion ofthe gravel shrouding.

Straightness shall be determined by lowering a section of pipe 40 ft. long or a dummy of the same length to the bottom of the pump housing casing. The minimum diameter of the pipe or dummy shall be 1 inch less than the inside diameter of the pump housing casing. If a dummy is used, it shall consist of a rigid spindle with three cylindrical rings, each ring having a height of at least 12 inches. The rings shall be true cylinders and shall be located at each end and in the centre of the dummy. The central shaft of the dummy shall be rigid so that it will maintain the alignment of the axis of the cylindrical rings. The pump housing casing shall be sufficiently straight so the pipe or dummy can be passed freely throughout the entire length of the pump housing casing. Plumbs, pipes and dummies used in these tests shall be approved by the Engineer-in-Charge.

Any tube-well failing to meet the specified requirements for straightness, verticality and concentricity shall be abandoned, and the Contractor shall construct a new well at his own expense at an alternative site designated by the Engineer-in-Charge.

After completion of installation of the pump housing casing and approval of the installation by the Engineer-in-Charge, the Contractor shall paint the letter and number designation of the tube-well on that portion of the pump housing casing which projects above the ground surface. All paint, brushes, stencils and other materials required shall be furnished by the Contractor. The characters shall not be less than 6 inches height shall be painted with lines 1 inch wide, and shall be positioned on the casing in accordance with the Engineer's instructions.

45.1.4 GRAVEL SHROUDING

45.1.4.1 GENERAL

Gravel shrouding shall consist of all work required in connection with supply and placing of gravel shrouding in annular space between the walls of the drilled hole and the outside of the pump casing. The work shall include, but not limited to development of source, excavation, stock piling, grading, washing, storing, transporting and placing of gravel shrouding as specified herein or as directed by the Engineer-in-Charge.

45.1.4.2 GRAVEL SOURCE

The Contractor may obtain gravel from any source or location subject to the approval of the Engineer-in-Charge provided that the gravel meets the requirements of the specifications. The Employer will not be responsible for the amount of work involved or the amount of materials wastage in order to obtain the required amount of gravel of proper gradation.

45.1.4.3 SPECIFICATIONS

The gravel shrouding shall be clean, washed, water worn, hard, well rounded of siliceous material, without flaky particles, free from gypsum and shale, and under no

circumstances shall contain > 5% calcareous material. The gravel supplied shall be subject to inspection and screening in the field to ensure proper gradation suitable to the formation. The gravel shall be reasonably graded and shall conform to the following requirements or as specified by the Engineer-in-Charge.

Table 45-1 : Gravel grading

U.S. Standard Screen Number	Percentage Passing
1 cm (3/8 inches)	100
No. 4	75-100
No.8	35-65
No.14	5-30
No.16	00-15
No. 35	00-00

PLACING OF GRAVEL

Gravel shall be placed at constant rate using tremie pipe, hoppers or other similar devices to provide a continuous and uniform gravel flow so as to minimize segregation of particle sizes. When tremie pipe or hoppers are used, gravel shall be introduced in the annular space between the pump housing and the edge of the hole at two points located 180 degree apart. The tremie pipe, when used, shall be of suitable size and lowered to the bottom of the well on two opposite sides of the bore hole and calculated quantity of gravel shall be poured in the pipe through a funnel and the pipe shall be raised by 6 ft. (1.83 meters) interval. In all cases water shall be circulated steadily during gravel placement by inserting the drilling rod into pump housing and operating the circulation pump on the drilling rig. The water level in the annular space outside the pump housing shall be maintained at or above natural surface level by return flow from the cutting bit. Temporary casing, if used, shall be carefully withdrawn in 6 ft. to 10 ft. (1.83 m to 3.0 m) interval during placement of gravel shrouding and the gravel shall be introduced so that each stage of the hole above bottom of the casing is completely filled before the casing is withdrawn to the next stage. The process of placement of gravel shrouding and withdrawing the temporary casing shall be continued to the ground level or up to level approved by the Engineer-in-Charge. As guidance the process of shall be continued until the bottom of temporary casing is at least 10 ft. above top of the topmost screen. Above this point temporary casing shall be removed or left at the option of the Contractor provided that no payment shall be made to the Contactor for temporary casing left in place except when it is of new material and is an acceptable substitute for an appropriate length of pump housing casing.

45.1.5 GROUTING OF PUMP HOUSING CASING

45.1.5.1 GENERAL

Grouting of pump housing casing shall cover providing all equipment, labour and doing all work required to seal the annular space between the pump housing casing and the bore hole face by the introduction of grout as specified herein and on the drawings according to procedures approved by the Engineer-in-Charge.

45.1.5.2 MATERIAL

The grouting operation shall be done with 1:2 cement sand mortar. Cement and sand shall conform to the requirements of Section 5 – Plain & Reinforced Concrete.

45.1.5.3 PLACEMENT OF GROUTING MATERIAL

The grout may be placed by either the tremie method or by being pumped into place provided that both the method and the type of grout is approved by the Engineer-in-Charge prior to the start of the operation.

If the tremie method is selected and approved, the grout material shall be placed by tremie pouring, (after water or other drilling fluid has been circulated in the annular space of tremie pipe sufficient to clear obstructions). The tremie method shall be used where there is a minimum annular space of 3 inches (75mm) only between the outer surface of the pump housing pipe and the inside surface of either the external casing or the bore hole. The minimum size of tremie pipe utilized shall be 2 inches (50mm) inside diameter. Where concrete grout is used the minimum size tremie pipe used shall be 3 inches (75mm) inside diameter. When making a tremie pour, the tremie pipe shall be lowered to the bottom of the zone being grouted and raised slowly as the grout material is introduced. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe continuously submerged in the grout until the zone to be grouted is completely filled. The minimum curing time before construction may be resumed is 72 hours.

If the method of grout placement selected and approved is by pumping, the grout shall be injected (after water or other drilling fluid has been circulated in the pumping pipe sufficient to clear obstruction) in the annular space between the inner casing and either the outer casing or the bore hole. The annular space must be minimum of 1 ½ inches (37mm) for sand and cement or neat cement grout, and not less than three times the size of the largest coarse aggregate used. The grout pipe shall extend from the surface to. The bottom of the zone to be grouted. The grout pipe shall have a minimum inside diameter of 1 inch (25mm) for sand cement or neat cement grout, It shall have a minimum diameter of 1 ½ inches (37mm) for concrete grout.

Grout shall be placed, from bottom to top, in one continuous operation. The grout pipe may be slowly raised as the grout is placed but the discharge end of the grout pipe must be submerged in the placed grout at all times until grouting is completed. The grout pipe shall be maintained full, to the surface at all times until the completion of the grouting of the entire specified zone. In the event of interruption in the grouting operation, the bottom of the pipe should be raised above the grout level and should not be re-submerged until all air and water have been displaced from the grout pipe and the pipe flushed with clear water. Curing time before construction may be resumed shall be minimum of 72 hours.

45.1.6 DEVELOPMENT AND TESTING

45.1.6.1 GENERAL

Development and testing shall consist of all work including power supply required in connection with the development of the tube-well to produce the design capacity of sand free water with a minimum drawdown, and the testing of the tube-well to determine the effectiveness of the development operations as specified herein. Development and testing shall include, but not be limited to surging, back washing and pumping the tube-well at higher than rated capacity, testing the tube-well for specific capacity, sand content and degree of development, and disinfection and sealing of the tube-well.

The Contractor shall be required to sound the well to determine whether excess sand has accumulated at the bottom of the well at the following stages of the work;

a. On completion of the casing and screen installation

b. Before the starting of the development and

c. After completion of development and testing

If it is found at any stage mentioned above that the well contains more than 3 ft. of sand or other material in the bail plug, the Contractor shall clear the well down to a level approximately 3 ft. above the bottom plate of the bail plug. Water obtained in development and testing shall be disposed of by the Contractor in an approved manner.

45.1.6.2 DEVELOPMENT

The development procedure and methods used for development of the tube-well shall be established by the Contractor subject to approval by the Engineer-in-Charge and the development operations shall be witnessed by the Engineer-in-Charge from their initiation to their completion. The Contractor shall maintain a complete record of the development operation and shall make regular periodic measurements of discharge rates, sand content and water level measurements.

The procedures used shall include backwashing and pumping at 1.5 times the rated capacity and may include surging or similar procedures determined by the Contractor. The Contractor shall notify the Engineer-in-Charge following the completion of the 6 hours pumping, period that the tube-well is ready for testing. In wells where bentonite or other formation stabilizing agents are used, the Contractor shall undertake a programme of cleaning the well with phosphates or other dispersing agents in a manner and with chemical dosages as approved by the Engineer-in-Charge prior to starting normal development work.

45.1.6.3 TESTING

The contractor shall test each tube-well under the direction of the Engineer-in-Charge as described herein. Upon completion of the development operations the tube-well shall be permitted to recover for a minimum period of one hour. During this recovery period, the tube-well shall be sounded. If the comparison of the depth by sounding and the length of the casing string indicates that there is more than 6.00 feet of material in the tube-well, it shall be cleaned to within 2.0 feet of the bottom of the casing by bailing.

At the end of the first five minutes of pumping, the sand content of the water shall be determined by using a 40 inches Imhoff cone or other device approved by the Engineer-in-Charge. The sand content of the water at this time shall be less than 100 mg/liter. A second sand content determination shall be made 10 minutes after the start of pumping. The sand content at this time shall be less than 30 mg/l. If the sand content tolerances are exceeded at this time, or at any subsequent time up to the time of final acceptance of the installation, sand content determinations, water level, and discharge measurements during the remainder or the one hour sand test period shall be made as directed by the Engineer-in-Charge.

When the sand test has been satisfactorily completed, the tube-well shall be further developed for 4 hours by surging and backwashing with the test pump at five to ten minute intervals. Following the development period, the tube-well shall again be pumped for a period of one hour during which time the sand test shall be repeated. The specific capacity of the tube-well shall be determined from the water level measurements and flow rates obtained, during the pumping periods. If the specific capacity obtained from the second pump test is found to be more than 10 percent

greater than that obtained in the first pump test, the development shall be continued as directed by the Engineer-in-Charge.

Upon satisfactory completion of the above one hour pumping period the tube-well shall be permitted to recover for a period of one hour. Upon the completion of this recovery period, a four hour multiple step pump test shall be performed by pumping the tube-well for one hour at each of approximately four equal increments.

45.1.6.4 SUMMARY

The following is a short summary of the development and testing procedure:

Development

Development time by air lift	
Development tool or/and	2 hours (minimum)
Development by pumping	

Testing

Recovery	1 hours (minimum)
Pumping Period(Sand Test)	1 hour
Development	3 hours
Pumping period(Retest) 1 hour	
Recovery	2 hour (minimum)
Step pumping	4 hours (one hour each of the rated capacities 35%, 70%, 105% & 140%)
Pumping period (Constant discharge test)	2 hours

45.1.6.5 EQUIPMENT

The Contractor shall furnish all necessary equipment for testing the tube-well, including a water lubricated or oil lubricated test pump, a valve for fine adjustment of the discharge, an electric measuring device to determine the drawdown during each stage of the test and Imhoff cones to measure sand content. If oil lubricated test pumps are used, the contractor shall exercise all reasonable precautions to keep the leakage of lubricating oil into the tube-well at a minimum and shall promptly remove all oil which collects on the water surface in the tube-well by the addition of detergents or other suitable chemicals proposed by Contractor and approved by the Engineer-in-Charge and pumping the emulsified oil from the tube-well. In the event the Contractor fails to keep the leakage of oil into the tube-well within acceptable limits or to promptly remove oil accumulations from the tube-well, the Engineer-in-Charge will order the use of oil lubricated test pumps discontinued and the Contractor shall use water lubricated pumps for testing of the tube-wells. The actual depth of setting for the test pump will be determined by the Engineer-in-Charge after the tube-well has been developed. Piping, gauges, orifices, meters, wire boxes or other measuring devices shall be furnished, installed and removed by the

Contractor and will remain his property. All measuring devices and testing equipment shall be subject to approval by the Engineer-in-Charge.

45.1.6.6 MEASUREMENT AND DATA

The Contractor shall take drawdown and discharge measurements and other pertinent data during each test at intervals as specified by the Engineer-in-Charge. All such data shall be recorded on forms approved by the Engineer-in-Charge, and the original of such forms shall be delivered to the Engineer-in-Charge at the completion of the development and testing operations.

45.1.6.7 DISINFECTION

After development and testing of the tube-well has been satisfactorily completed, and when approved by the Engineer-in-Charge, the Contractor shall disinfect the tube-well by dispersing chlorine solution throughout the entire depth of the well to obtain a minimum chlorine content of 50 mg/l. The procedure and equipment used to introduce and disperse the chlorine in the tube-well shall be subject to approval by the Engineer-in-Charge.

45.1.6.8 SEALING

Upon completion of the tube-well the Contractor shall seal the tube-well with a ¼ inch thick steel plate cap welded to the pump housing at few points using Arc welding, or by some other method approved by the Engineer-in-Charge. Compliance with this requirement will not relieve the Contractor of his responsibility for the safeguarding of any part of the tube-well completed until the Certificate of Acceptance is issued for the entire tube-well installation.

45.2 TUBE-WELL PUMPING FACILITIES

45.2.1 SCOPE

The work shall consist of furnishing, installing and commissioning deep well turbine pumps involving all mechanical and electrical works and construction of pump houses in accordance with these specifications and in reasonably close conformity with drawings and specifications and as established by the Engineer-in-Charge.

45.2.2 MATERIALS AND CONSTRUCTION REQUIREMENTS

Materials and construction requirements shall conform to those for Civil, Mechanical and Electrical Works.

Depending upon the strata, it is likely that the design of tube-well will require certain changes in the deep-well turbine pumps. Under such a deviation from the provisional design shown on the Drawings, capacity of motor (below or excess of the specified) shall form the basis for measurement and payment of such a deviation.

The installation, testing and commissioning of turbine pumps shall be strictly in accordance with the instructions of the manufacturer of such machinery.

45.2.3 CIVIL WORKS

Building for the pump house, fences and gates shall be constructed in accordance with the relevant specifications and Drawings or as directed by the Engineer-in-Charge.

45.2.4 MECHANICAL WORKS

a) GENERAL

The work shall consist of providing, installing & commissioning pumps. motors and accessories, furnishing all plant, labour, equipment, appliances and materials, and in performing all operations in connection with mechanical works in strict accordance with the specifications and the applicable drawings and subject to the terms and conditions of the contract. Equipment damaged by the Contractor during the course of installation shall be repaired or replaced by the Contractor at his own expense.

b) APPROVAL OF MATERIALS AND EQUIPMENT

As soon as practicable and within 30 days after receipt of notice to proceed and before any material or equipment is purchased, the Contractor shall submit, for approval by the Engineer-in-Charge a complete schedule, in triplicate, with the names and addresses of the manufacturers and their catalogue cuts, diagrams, drawings, and such other descriptive data as may be required by the Engineer-in-Charge. No consideration will be given to partial lists submitted from time to time. Approval of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications unless the attention of the Engineer-in-Charge has been directed to the specific deviations.

c) MATERIAL AND EQUIPMENT

Materials and equipment shall conform to the respective specifications and other requirements specified hereinafter and shall be new and unused.

45.2.5 WATER PUMPS

Pumps shall be of the open line shaft water lubricated vertical turbine type for installation and operation in tube-wells and shall be suitable for use with vertical, hollow-shaft, squirrel cage induction type motors. All pumps shall consist of pump bowl assembly, column pipe, line shaft and surface discharge head assembly, in-cluding water pre-lubrication system as required and all other parts and appurtenances to provide a complete operating pump in accordance with these specifications.

a) DESIGN

The material, design, fabrication and assembly of equipment shall be in strict accordance with American Water Works Association Standard A 101-61 Entitled" American Standard for Vertical Turbine Pump", or latest revision and the following requirements:

i. GENERAL

Water Pumps shall be vertical shaft centrifugal pumps with rotating impellers and discharge from the pumping elements coaxial with the shaft. The pumping element shall be suspended by the conductor system which encloses a system of vertical shafting used to transmit power to the impellers, the prime mover being external to the flow stream. The basic pump shall consist of the following three elements:

PUMP BOWL ASSEMBLY

The pump bowl assembly shall be either a single or multistage, centrifugal vertical pump with discharge coaxial with the shaft.

COLUMN AND SHAFT ASSEMBLY

The column and shaft assembly shall consist of the column pipe which suspends the pumps bowl assembly from the head assembly and serves as conductor for the fluid from the pump bowl assembly to the discharge head contained within the column pipe shall be the line shaft which shall transmit the power from the driver to the pump shaft. The line shaft shall be supported throughout its length by means of bearings which are lubricated with water.

HEAD ASSEMBLY

The head assembly shall consist of the base (from which the column and shaft-assembly and the bowl assembly shall be suspended) the discharge head which directs the fluid into the desired piping system and the driver.

ii. THE DRIVER COUPLING

The driver coupling is the mechanism, which transmits the power to the top shaft. It shall contain means for impeller adjustment and provide a bearing to carry the thrust load.

iii. DISCHARGE HEAD

A cast iron flange shall be integrally cast on the discharge head. The discharge flange shall have a companion flange suitable for connection to the discharge pipe.

iv. MOTOR MOUNTING FLANGE

The motor mounting flanges of pumps shall match the NEMAflanged base plates of motors and base plates of right angle gears.

b) MANUFACTURE

The pumps shall be those manufactured by M/s KSB or equivalent of the types as specified. The pumps shall be manufactured to meet the characteristics specified on the drawings or as directed by the Engineer-in-Charge.

i. PUMP ELEMENT

The impellers shall be the enclosed skirt seal type constructed of bronze meeting the requirements of ASTM Standard B 584 titled "Leaded Red Brass and Leaded Semi-Red Brass Sand Casting". Impellers shall be accurately fitted, smoothly finished, and dynamically balanced at the normal pump speeds. The bowls shall be constructed of close-grained cast iron. The inside of each bowl shall be hand finished to mirror-like smoothness. Three or four stage pumps as approved by the Engineer-in-Charge shall be supplied by the Contractor. Each suction bowl shall be fitted with a grease-packed bronze bearing and suction case plug. A suction case and collar shall be provided to protect the bearings. Each pump bowl shall have a fluted rubber bearings above each impeller and shall be designed for the future installation of bronze or cast iron wear rings.

Each discharge bowl shall be equipped with a bronze bearing. The pump and line shaft shall be of stainless steel conforming to ASTM Standard A 276-60 entitled Hot-Rolled and Cold-Finished Corrosion Resisting Steel Bars", type 416, and shall be of suitable size to transmit the loads and to maintain correct alignment without distortion or vibration. The pump shaft shall be turned, ground and polished and shall be threaded for connection to the line shaft.

ii. COLUMN PIPE AND LINE SHAFT

The column pipe shall be furnished in interchangeable sections having a normal length of 10 feet. Wall thickness shall be minimum 0.234 inches. The ends of each column pipe section shall be faced parallel and perpendicular to the axis of the pipe. The threads shall be machined so that adjoining sections of column pipe will butt together to ensure proper alignment on assembly. The line shaft shall be ground carbon steel shafting in accordance with ASTM Standard A 108-61T entitled "Cold Finished Carbon Steel Bars and Shafting" Grade 1020 or 1045 and shall be furnished in interchangeable sections having a nominal length of 10 feet. The ends of the shaft sections shall be faced parallel and perpendicular to the axis of the shaft. Adjoining sections of the line shaft shall be connected by means of threaded, sleeve-type couplings of the same material as shall be supported by fluted, oil resistant, rubber bearings designed to be lubricated by water. The bearings shall be mounted in bronze bearing retainers which shall be threaded into the column couplings and butted against the adjoining section of column pipe. The rubber bearing shall be replaceable within the bronze bearing retainers and shall be spaced at intervals of not more than 10 feet along the line shaft.

iii. SURFACE DISCHARGE HEAD

Each surface discharge head shall be of the above ground type and shall be a suitable base for supporting the specified electric motor and the pump column. The discharge head shall be of cast iron conforming to ASTM Standard A 48-62 titled "Standard Specification for Grey Iron Casting" Class 30 A or an approved equal quality of casting. Each surface discharge head shall be furnished with an integral ASA 125 pound flange conforming to ASA B16-1-1948 "Cast Iron Pipe Flanges and Flanged Fittings, Class 125". The discharge heads shall include half couplings connecting to discharge pressure and suction pressure to accommodate gear cooling water lines as required by the gear drive unit.

iv. PRE-LUBRICATION SYSTEM

The contractor shall furnish a manually operated water pre-lubrication system complete with all valves piping and storage tank for the turbine pump. The piping for pre-lubrication system shall be complete with necessary valves, lines and fittings to permit filling of the pre-lubrication tank from the pump discharge and to permit the water to be manually released prior to starting pump. The pre-lubrication tank shall be an enclosed tank of sufficient size to adequately lubricate the line shaft bearing before pump start-up and shall be equipped with an opening in the top through which it may be filled from the pump discharge or from an outside source.

c) QUALITY CONTROL TESTS

The manufacturer shall perform all the quality control tests as specified hereafter and all test results and anticipated field performance curves shall be submitted in triplicate, to the Engineer-in-Charge.

i. STANDARD RUNNING TEST

The pump bowl assembly shall be operated from zero capacity to the maximum capacity shown on the performance curve submitted with the manufacturer's bid. Readings shall be taken at a minimum of 5 capacity points, including one point within + 2% of design capacity specified. The pump shall be operated at a speed within + 5% of the design speed.

ii. CAPACITY MEASUREMENT TEST

The capacity of the pump shall be measured by means of a standard venturi tube, nozzle orifice plate or pilot tube traverse.

iii. HEAD MEASUREMENT TEST

For head measurement in excess of 36 ft. calibrated bourdon or other gauges with equivalent accuracy and reliability shall be used. All gauges shall be calibrated before and after each series of tests.

iv. TEST FOR VELOCITY

The average velocity in the pump column used to determine the velocity head shall be calculated from dimensions obtained by actual measurement of the pipe and shaft or enclosing tube diameter and the velocity head shall be obtained from actual measurement of the inside diameter of the discharge pipe at the point where the pressure tap is located

v. HORSEPOWER INPUT TEST

The power input to the pump shall be determined with vertical dynamometer or a calibrated electric motor. Calibrated laboratory type electric motors and transformers shall be used to measure the power input to all motors.

vi. MEASUREMENT OF SPEED

The rotating speed of the pump shall be obtained by a hand counter, electronic computer or a counting slip.

vii. HYDROSTATIC TEST

A standard hydrostatic test on the pump bowl assembly shall be made at 1 ½ times the shutoff head developed by the pump bowl assembly or at twice the rated head, whichever is greater.

d) HAND PUMP

Hand pump shall be capable of lifting water from a depth from 10 m to 45 m, with borehole ranging from 100 mm to 200 mm.

The rising main pipe shall be DN50 PN16 conforming to DIN 19532 'Pipelines of Unplasticized Polyvinylchloride (Rigid PVC, UPVC) for Drinking Water Supply'.

The steel plates, sheets, angle iron legs and square bars for fabrication of the hand pump shall conform to designation ISO 630 / DIN 17100, ST37-2 'Steels for general structural purposes: Quality standard'. Tensile strength: 340-470 N/mm^2 Yield strength: 235 N/mm^2

The steel pipes for fabrication of Afridev pump parts shall conform to designation DIN 1615, ST37-2 'Welded circular non-alloyed steel tubes not subject to special requirements: technical delivery conditions'. Tensile strength: 250-540 N/mm^2 Yield strength: 175 N/mm^2

Stainless Steel components shall be made of AISI Type 304 or 316 as specified.

The Brass cylinder liner shall be made of seamless tubing of CuZn37 conforming to DIN 17660.

The following assemblies shall be galvanized according to DIN 50976, 'Protection against corrosion: hot dip galvanized coatings on fabricated ferrous products: requirements and tests':

a) Pump head Assembly;
b) Cover Assembly;
c) Handle Assemblies, (front and rear);

d) Stand Assembly;
e) Pump rod Assemblies (unless Stainless Steel is used);
f) Rod hanger Assembly;
g) Steel Cone Assembly;
h) Fishing tool.

45.2.6 MOTORS

a) PUMP MOTORS

The pump motors shall be vertical hollow shaft fan coated totally enclosed weather protected squirrel cage, induction type and shall have 4 poles with approximate speed of 1460 rpm on 400 volts, 3 phase. 50 cycle. The motor horse power for each site shall be indicated in the Bill of Quantities. When operating continuously at full rated load, the temperature rise shall not exceed 40 degree centigrade above an ambient temperature of 50 degree centigrade. The motor shall have a service factor of 1.15 times the rated horsepower and horsepower loadings shall not exceed the name plate at any point on the pump performance curve. The motors shall conform to NEMA Standard MG 1, titled "Motors and Generators" for a class B design and shall have low starting current and normal starting torque. The locked rotor input shall not exceed 5.6 KVA per horsepower. The winding shall have Class B insulation and shall be suitable for operation under conditions of high humidity and at an ambient temperature of 55 degree centigrade. Each motor shall be equipped with three thermal devices embedded and symmetrically spaced in the stator winding. These devices shall operate on temperature rise to de-energize the control circuit of the motor thus disconnecting it from the power source. The thermal devices shall be so located in the winding and so constructed that they will prevent motor damage due to overheating resulting from overload, lack of ventilation, single phasing, stalling, high ambient temperature or Voltage imbalance. The pump motors shall be designed for mounting on the surface discharge, head and for direct connection to the line shaft. A thrust bearing of adequate capacity to carry the weight of all rotating parts, plus the hydraulic thrust shall be provided on each motor. The motors shall be provided with a completed oil or grease lubrication for each bearing. Each motor shall be provided with a non-reverse ratchet to prevent reverse rotation of the pump.

b) MOTOR CONTROL

The motor controls for each motor shall consist of motor starter and control switches with all necessary components for a complete installation. Each motor control shall be suitable for controlling and protecting 400 volts. 3 phase 50 c/s electric motor. Motor controls shall be furnished in complete accordance with the applicable provisions of NEMA Standard 1 CI, entitled “Industrial Controls". shall have a minimum insulation level for 600-volt class equipment, and shall be designed to provide short circuit protection in all phases and overload protection in all three phases. The thermal overload relay reset device shall be mounted to be opera table without the necessity of opening the casing. Each motor control shall be furnished complete as a unit with all component parts and accessories completely wired to conform to NEMA Class-II construction, Class-B wiring. The conductor shall be 600 volt. heat resistant, thermoplastic insulated wire suitable for 75' operating temperature. A weather proof enclosure NEMA Type-III with a lockable outer door, shall be provided.

45.2.7 PIPING

Piping for mechanical equipment shall be accomplished as indicated and shall conform to the relevant specification in the following Section 27.3 covering “PIPES, PIPE LAYING AND APPURTENANCE”.

45.2.8 INSTALLATION

Installation shall include all bolts, nuts, washers, shims, fittings, grout and other materials required for proper installation of the equipment which are not supplied as part of the equipment. Equipment damage during the course of installation shall be repaired or replaced by the Contractor at his own expense.

a) PUMPS AND MOTORS

The Contractor shall carefully clean, assemble, align and install the pumps in accordance with the manufacturer's recommendations. Care shall be taken that all connections are clean and free from burrs and foreign material so as to ensure tight fit and proper alignment. Connections between adjoining sections of column pipe and line shaft shall be correctly assembled and tightened to maintain accurate alignment. A suitable thread lubricant shall be used on all threaded connection to facilitate disassembly for maintenance. The pumps and motors shall be installed in tube-well in accordance with the manufacturer's instructions. The surface discharge heads shall be accurately set on the concrete pump platforms shown on the drawings and shall be aligned with pump housing casing. The surface discharge heads shall be rigidly connected to the reflux (check) valve and the dresser-type couplings. All the fittings shall be properly installed as shown on the drawings. In order to ensure the accurate and proper alignment of the pump, anchor bolts shall set only after the pump has been set and aligned. Anchor bolt holes may be formed in the concrete platform as the concrete is placed or may be drilled in the concrete after the concrete has set thoroughly. The anchor bolts shall be minimum 5/8 inch diameter and minimum 12 inches long with nut and lock washer, and shall be set in the anchor bolts holes with sufficient extension to permit the fun threads of the nuts to be engaged by the anchor bolt. The anchor bolts shall then be set in cement grout. Where holes are drilled after the concrete has set thoroughly, expansion bolts or lead expansion anchors may be installed at the option of the contractor in lieu of grouting anchor bolts. Non-shrink grout shall be placed under the entire surface of the discharge head to provide proper support for the pump. Non-shrink grout shall conform to the applicable requirements set forth in the Specifications for concrete.

45.2.9 ELECTRICAL WORKS

The work shall consist of furnishing all plant, labour, equipment, appliances, and materials and in performing all operations in connection with the electrical work in strict accordance with the applicable specifications, Section 30 – Electrical Works and the drawings, and subject to the terms and conditions of the Contract Agreement.

45.2.10 CHLORINATION EQUIPMENT

a) CHLORINATOR

Chlorinator shall be of vacuum solution feed, manually set cylinder mounted type. Chlorinator shall be capable of meeting requirements of water flows ranging from 1cusecs to 2 cusecs and delivering up to 1 lb/hr. of chlorine gas in solution to give a maximum dosing rate of 2 ppm. The chlorinator shall be supplied complete with all standard accessories and complete in all respects to ensure satisfactory operation.

b) CHLORINATOR ACCESSORIES

The chlorinator should include among its accessories an injector. a water booster pump with electric controls, a chlorine gas inlet connected via pressure regulating valve, a linear feed rate indicator, a feed rate adjuster, a pressure relief valve, a drain relief valve, and chlorine pressure gauge.

c) BOOSTER PUMP

The Contractor shall supply along with each chlorinator a water pump for booster water pressure to meet, requirement of the chlorinator. The pumps shall have adequate pumping capacity and to ensure proper mixing of chlorine and water in the injection assembly of chlorinator. The pumps shall be electrically driven by single phase motor capable of operation on 220 V, 50 hz. With +10% fluctuation in voltage. The pumps shall be supplied complete with suction and delivery isolating valves, check valves, pressure gauge and appropriate starters.

d) EMPTY GAS CYLINDERS

The Contractor shall supply with each chlorinator two 150 lb. empty chlorine cylinder designed and fabricated in accordance with AWWA or ASTM Specifications or equivalent. The welded seams shall be fully stress relieved after fabrication. A corrosion Allowance of 1/16 inch shall be provided for the design thickness of the cylinders. Material of construction shall be according to ASTM A-515 Grade 60 or ASTM A -285 Grade C or equivalent.

Cylinder shall be provided with matching outlets corresponding to chlorinator offered under this Contract. Each cylinder shall also have a protection cap provided along-with the cylinder.

45.2.11 GUARANTEE

Equipment furnished shall be guaranteed for a period of one year from date of acceptance hereof against defective materials, design, and workmanship or as stated in the Contract. Upon receipt of notice from the Engineer of failure of any part of the guaranteed equipment during the guarantee period, new replacement of part or parts of same trade mark as provided originally shall be furnished promptly by the Contractor at no additional cost to the Department.

a) OPERATION AND MAINTENANCE MANUAL

The Contractor shall furnish 6 copies of an illustrated operation and maintenance manual with each piece of equipment furnished under this section.

b) SPARES AND TOOLS

The Contractor shall furnish common spares such as O-rings, bushing, bearing, other similar items and special tools for each piece of equipment furnished under this section for its efficient service for over 3 years period.

45.3 WATER FILTRATION

45.3.1 FILTER MEDIA

The Contractor shall provide and place in the filters the filter media in accordance with the drawings and as directed by the Engineer. It is pertinent to note that at least five times quantity of sand shall be required to reproduce the specified quality of sand. The common source of sand in Pakistan is Haroriver. The Contractor shall have to provide 10% excess filter media to replace the material loss during filter washing

45.3.2 TYPICAL FILTRATION BED PROFILES

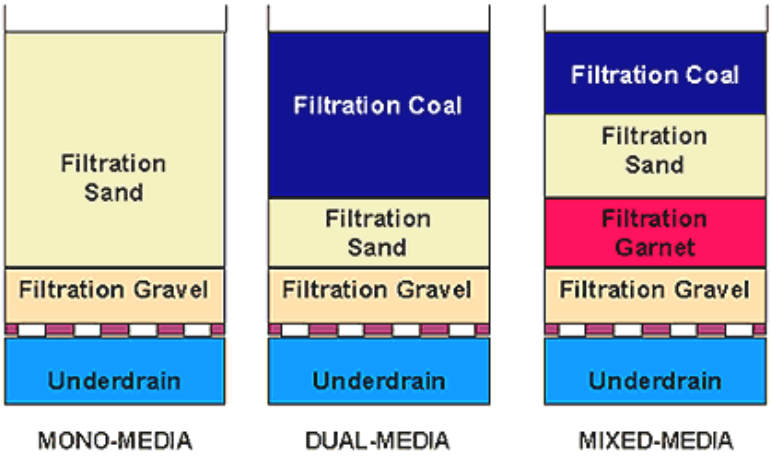


Table 45-2 :Typical Media Design Values for various Filters

Parameter	Mono - Media filters	Dual - Media filters	Mixed – Media filters
Anthracite Layer			
Effective size, (mm)	0.50 – 1.5	. 0.70 – 2.0	1.0 – 2.0
Uniformity Coefficient	1.20 – 1.7	.1.30 – 1.8	1.4 – 1.8
Depth, (cm)	50 – 150	.30 – 60	50 – 130
Sand Layer			
Effective size, (mm)	0.45 – 1.0	. 0.45 – 0.6	0.40 – 0.80
Uniformity Coefficient	1.20 – 1.7	.1.20 – 1.7	1.20 – 1.7
Depth, (cm)	50 – 150	.20 – 40	20 – 40
Garnet Layer	.	.	
Effective size, (mm)	.	.	0.20 – 0.80
Uniformity Coefficient	.	.	1.50 – 1.8
Depth, (cm)	.	.	5 – 15

45.4 HIGH DENSITY POLYETHYLENE(HDPE) / POLYETHYLENE (PE)PIPESANDFITTINGS

45.4.1 SCOPE

The work under this section of the specifications includes furnishing all plant, labour, equipment, appliances, materials and in performing all operations required in connection with providing and laying of High-density polyethylene (HDPE) or polyethylene Pipes and Pipe fittings, in accordance with the Contract or as directed by the Engineer and the manufacturer's recommendations.

45.4.2 MATERIALS

45.4.2.1 General

Materials shall conform to the latest referenced specifications and/or other provisions specified herein. Materials shall be new and unused. In cases where manufacturer are specified, materials shall be of the same manufacturers. In all other cases, the Contractor shall submit the names of the manufacturer from whom he intends to buy. Other information such as diagrams, drawings and descriptive data shall be supplied as desired by the Engineer. Approval of materials under this provision shall not be construed as authorizing any deviations from specifications.

45.4.2.2 Manufacturing

The material from which the pipe is produced shall consist substantially of polyethylene, to which may be added only those additives that are needed to facilitate the manufacture of the polymer, and production of sound, durable pipe of good surface finish, mechanical strength. None of these additives shall be used separately or together in quantities sufficient to constitute a toxic hazard, or to impair the fabrication of welding properties of the pipe, or to impair its chemical and physical properties.

45.4.2.3 Pipe

Pipes shall conform to International Standards Organization (ISO) recommendations, I.S.O-447: and shall be of specified class (SDR 11) capable of withstanding the specified working pressure and test pressure, suitable for jointing with solvent welded joints for small dia. pipes. Fittings shall be conform to ISO BS5114

45.4.2.4 Quality

The pipe shall not have any deter mental effect on composition of the water flowing through them. The quantities of any toxic substances extracted from the internal wall, of the pipes shall not exceed the values specified in ISO 447:1966(E)

45.4.2.5 Fittings

Compatible fittings and specials for use with High-density polyethylene (HDPE)/ polyethylene (PE) Pressure Pipes shall be of the appropriate class and shall conform to International /National standard. Fittings and specials shall have the required shapes, and dimensions of turned ends to fit the polyethylene pressure pipes.

45.4.3 HANDLING AND STORAGE

45.4.3.1 General

The Contractor shall be responsible for proper handling, as per manufacturers recommendations, of pipes and pipe fittings etc. All the material shall be stacked in-accordance with the manufacturer's recommendations at approved places as directed by the Engineer.

45.4.3.2 Transport

Transportation of pipes shall be done in such a way that they are secure and that no more than an absolute minimum of movement can take place on the vehicle during transit. The same care is needed if pipes are to be transferred from one vehicle to another, how short the final journey may be.

45.4.3.3 Off-loading

Cranes shall be used for off-loading. Whole sequence of operations shall be carried out smoothly and without snatch. Rope or nylon slings, lifting beams with flattened hooks or scissor-dog shall be used. Hooks and dogs shall be well padded to prevent the pipe being damaged and shall be fitted with locking device. Steadying ropes are essential.

45.4.3.4 Storage

Pipes and fittings damaged during handling, transporting or lowering shall be rejected and replaced at the contractor's expense. Storage shall be under shade so that all polyethylene pipes &fittings are not exposed to sunlight and extreme heat.

45.4.3.5 Stringing and Inspection

Stringing, consists of placing pipes on the ground in line ready for laying. Care is again needed to prevent damage during this operation.

The turned ends of all pipes shall be inspected to ensure that they are free from any local irregularities which could affect the water tightness of the joint. All pipe shall also be visually inspected for evidence of impact damage. When such damage is detected, a thorough examination of internal surface in region of the pipe ends shall be made for sign of hair cracks. Damaged pipes, joints, and fittings shall be rejected and replaced at the expense of the Contractor.

45.4.4 JOINTING

Jointing hall be made by butt fusion/socket fusion using plain/socket ended polyethylene fittings except for joining of valves and appurtenances.

45.5 LOW DENSITY POLYETHYLENE(LDPE) WATER TANKS

45.5.1 SCOPE

The work under this section of the specifications includes furnishing all plant, labour, equipment, appliances, materials and in performing all operations required in connection with providing of Low-density polyethylene (LDPE) water tanks, in accordance with the Contract or as directed by the Engineer and the manufacturer’s recommendations.

45.5.2 MATERIALS

45.5.2.1 General

Tanks shall conform to the latest referenced specifications and/or other provisions specified herein. Tanks shall be new and unused. In cases where manufacturer are specified, tanks shall be of the same manufacturers. In all other cases, the Contractor shall submit the names of the manufacturer from whom he intends to buy. Other information such as diagrams, drawings and descriptive data shall be supplied as desired by the Engineer. Approval of water tank under this provision shall not be construed as authorizing any deviations from specifications.

45.5.2.2 Manufacturing

The material from which the water tank is produced shall consist substantially of polyethylene, to which may be added only those additives that are needed to facilitate the manufacture of the polymer, and production of sound, durable pipe of good surface finish, mechanical strength. None of these additives shall be used separately or together in quantities sufficient to constitute a toxic hazard, or to impair the fabrication of welding properties of the pipe, or to impair its chemical and physical properties.

45.5.3 ASTM standards

LDPE Water tanks shall conform to ASTM D1998 - 13

45.5.4 HANDLING AND STORAGE

45.5.4.1 General

The Contractor shall be responsible for proper handling, as per manufacturers recommendations. The water tanks shall be stored in-accordance with the manufacturer's recommendations at approved places as directed by the Engineer.

45.5.4.2 Transport

Transportation of water tanks shall be done in such a way that they are secure and that no more than an absolute minimum of movement can take place on the vehicle during transit. The same care is needed if tanks are to be transferred from one vehicle to another, how short the final journey may be.

45.5.4.3 Storage

Water tanks if damaged during handling, transporting or lowering shall be rejected and replaced at the contractor's expense. Storage shall be under shade so that polyethylene tanks are not exposed to sunlight and extreme heat.

45.5.5 JOINTING

Jointing hall be made by butt fusion/socket fusion using plain/socket ended polyethylene fittings except for joining of valves and appurtenances.

45.6 MEASUREMENT AND PAYMENT

45.6.1 Composite Rate

The measurement and payment for the items of the work of Tube-well& Water Supply hereof shall be made corresponding to the applicable item as provided in drawings and shall constitute full compensation, for procurements, transportations, testing and commissioning /performance in all respect and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

Note:-Item description will be written in detail by the Design Consultant and drawing will show basic requirements.

Pay Item No.	Description	Unit of Measurement
45.6 a	Boring for tube well (Working/Testing) with percussion in all types of soil, from ground bed to 50m depth, including sinking and withdrawing casing pipe & disposal of excavated material within 100ft (30m)	
	i. 3" (75 mm) inner dia.	LM
	ii. 6" (150 mm) inner dia.	LM
45.6 b	Boring for tube well (Working/Testing) with straight rotary in all types of soil, gravel boulder and rock, from ground bed to 50m depth, including sinking and withdrawing casing pipe & disposal of excavated material within 100ft (30m)	
	i. 6" (150 mm) inner dia.	LM
	ii. 8" (200 mm) inner dia.	LM
	iii. 10" (250 mm) inner dia.	LM
	iv. 12" (300 mm) inner dia.	LM
	v. 15” (374 mm) inner dia.	LM
	vi. 18” (450 mm) inner dia.	LM
	vii. 24” (600 mm) inner dia.	LM
45.6 c	Boring for tube well (Working/Testing) with straight rotary in all types of soil, gravel boulder and rock, from 50m to 100m depth, including sinking and withdrawing casing pipe & disposal of excavated material within 100ft (30m)	
	i. 6" (150 mm) inner dia.	LM
	ii. 8" (200 mm) inner dia.	LM
	iii. 10" (250 mm) inner dia.	LM
	iv. 12" (300 mm) inner dia.	LM
	v. 15” (374 mm) inner dia.	LM
	vi. 18” (450 mm) inner dia.	LM
	vii. 24” (600 mm) inner dia.	LM
45.6 d	Boring for tube well (Working/Testing) with straight rotary in all types of soil, gravel boulder and rock, from 100m to 150m depth, including sinking and withdrawing casing pipe & disposal of excavated material within 100ft (30m)	
	i. 6" (150 mm) inner dia.	LM
	ii. 8" (200 mm) inner dia.	LM
	iii. 10" (250 mm) inner dia.	LM
	iv. 12" (300 mm) inner dia.	LM
	v. 15” (374 mm) inner dia.	LM
	vi. 18” (450 mm) inner dia.	LM
	vii. 24” (600 mm) inner dia.	LM
45.6 e	Boring for tube well (Working/Testing) with straight rotary in all types of soil, gravel boulder and rock, from 150m to 200m depth, including sinking and withdrawing casing pipe & disposal of excavated material within 100ft (30m)	

	i.	6" (150 mm) inner dia.	LM
	ii.	8" (200 mm) inner dia.	LM
	iii.	10" (250 mm) inner dia.	LM
	iv.	12" (300 mm) inner dia.	LM
	v.	15” (374 mm) inner dia.	LM
	vi.	18” (450 mm) inner dia.	LM
	vii.	24” (600 mm) inner dia.	LM
45.6 f	Boring for tube well (Working/Testing) with straight rotary in all types of soil, gravel boulder and rock, from 200m to 250m depth, including sinking and withdrawing casing pipe & disposal of excavated material within 100ft (30m)		
	i.	6" (150 mm) inner dia.	LM
	ii.	8" (200 mm) inner dia.	LM
	iii.	10" (250 mm) inner dia.	LM
	iv.	12" (300 mm) inner dia.	LM
	v.	15” (374 mm) inner dia	LM
	vi.	18” (450 mm) inner dia.	LM
	vii.	24” (600 mm) inner dia.	LM
45.6 g	Providing and installing Mild Steel Bail Plug 1.5 ft (450 mm) long in tube well borehole.		
	i.	6" (150 mm) inner dia.	LM
	ii.	8" (200 mm) inner dia.	LM
	iii.	10" (250 mm) inner dia.	LM
	iv.	12" (300 mm) inner dia.	LM
45.6 h	Providing and installing Mild Steel strainer in tube well borehole complete in all respect.		
	i.	6" (150 mm) inner dia.	LM
	ii.	8" (200 mm) inner dia.	LM
	iii.	10" (250 mm) inner dia.	LM
	iv.	12" (300 mm) inner dia.	LM
45.6 i	Providing and installing Stainless Steel strainer in tube well borehole complete in all respect.		
	i.	6" (150 mm) inner dia.	LM
	ii.	8" (200 mm) inner dia.	LM
	iii.	10" (250 mm) inner dia.	LM
	iv.	12" (300 mm) inner dia.	LM
45.6 j	Providing and installing PVC (class C) strainer in tube well borehole complete in all respect.		
	i.	6" (150 mm) inner dia.	LM
	ii.	8" (200 mm) inner dia.	LM
	iii.	10" (250 mm) inner dia.	LM
	iv.	12" (300 mm) inner dia.	LM
45.6 k	Providing and installing Mild Steel blind pipe (wall thickness 6mm)in tube well borehole complete in all respect.		
	i.	6" (150 mm) inner dia.	LM
	ii.	8" (200 mm) inner dia.	LM
	iii.	10" (250 mm) inner dia.	LM
	iv.	12" (300 mm) inner dia.	LM
45.6 l	Providing and installingPVC (class C) blind pipe in tube well borehole complete in all respect.		
	i.	6" (150 mm) inner dia.	LM

	ii. 8" (200 mm) inner dia.	LM
	iii. 10" (250 mm) inner dia.	LM
	iv. 12" (300 mm) inner dia.	LM
45.6 m	Mobilization/De-mobilization of Boring Rig including loading and unloading of complete assembly.	
	i. Up to 25 kms	NO
	ii. 25 kms to 50 kms	NO
	iii. Each km beyond 50 kms	NO
45.6 n	Cleaning and washing of tube well with air compressor in all sizes and depth, 8" dia. and above.	Hr.
45.6 o	Testing and developing of tube well with DNT unit 8" dia. and above complete as per specifications.	Hr.
45.6 p	Shrouding with graded pea gravel 3/8" (10mm) to 1/8" (3mm) around tube well in bore hole complete as per specification.	LM
45.6 q	Water Pressure Test including drilling and testing for calculation of water losses in bore-hole 0 to 30m.	LM
45.6 r	Electrical log (self potential resistivity both short and normal) of test bore holes, as specified by the Engineer.	NO
45.6 s	Providing and fixing hand pump 20' long 1" dia outlet and 2.5" dia bore hole, including all accessories, complete in all respect, as shown in drawings and as directed by the Engineer.	NO

Note:- Size and capacity of pumps shall be selected from Section 40 of this Part

SECTION 46 SINKING OF WELL

46.1 SCOPE

The works to be done under Well Sinking, consist of all such related works which extend below the ground specified in the Contract or as directed by the Engineer-in-Charge. Those works shall include constructing brick masonry reinforced brick masonry wells with reinforced concrete well curbs and steel angle cutting edges including bottom and top concrete plugs and sand filling as shown on the Drawings and specified herein. The works to be done shall include constructing reinforced concrete well curbs with steel cutting edges, brick masonry walls (Unless reinforced brick Masonry has been specifically specified or directed by the Engineer-in-Charge) dredging and sinking the wells, placing the bottom and. top concrete plugs and sand filling, and all incidental operations required to construct and sink the well foundations as shown on the Drawings or specified herein.

46.2 GENERAL

a) All operations of the Contractor for well sinking and all materials used shall be subject to the approval of the Engineer-in-Charge.
b) The Contractor shall sink the well at the designated locations in accordance with the lines and grades shown on the Drawings or established by the Engineer-in-Charge.

46.3 MATERIAL AND WORKMANSHIP

The Contractor shall furnish all materials for the complete construction and sinking of the wells and all materials and workmanship shall meet the following requirements.

a) Brick masonry shall conform to the applicable requirements of Section 11-Brick Work.
b) Concrete shall conform to the applicable requirements of the Section 5, Plain & Reinforced Concrete.
c) Reinforcement for Concrete shall be as shown on drawings and shall conform to Sub-Section 5.4, Plain & Reinforced Concrete.
d) Sand filling shall be approved unprocessed river bed sand or, at the option of the Contractor approved river bed gravel, cobbles or brick bats mixed with sufficient river bed sand to completely fill the interstices in the coarser material.

46.4 CONSTRUCTION

The wells shall be constructed and sunk as open caissons as specified herein. Unless otherwise authorized by the Engineer-in-Charge, the Contractor will not be permitted to sink the well by any method which does not utilize the dredging and sinking principle substantially as follows:

a) The area at which the well is to be sunk shall be excavated to the approximate top elevation of the completed well foundation, In case spring level is higher than the top elevation of the completed well, the excavation shall be maintained in a dry condition by utilizing cofferdams and un-watering methods.
The excavation shall comply with provision of Section 3 - Earthwork.
b) The well curb shall be constructed in place in the proper position, or if a pre-cast curb is used it shall be set in proper level position at the surface below which well sinking is to be carried. If a precast curbs is used it shall be set in proper level position. Precast curb shall not be handled until they have been cured for at least 14 days. The vertical bars for masonry reinforcement (wherever reinforced brick work has been specified or specially directed by the Engineer-in-Charge) shall be attached to the steel angle cutting edge by means of nuts and washers as shown on the Drawings.

c) After placing of precast curbs; or not earlier than three days after placing of Concrete fore cast-in-place curbs, brick Masonry walls with an approximate height of 1.5 meters shall be constructed on the curbs as shown on the Drawings. Two straight edges as approved by the Engineer-in-Charge shall be rigidly attached to each of the outside faces of the well for the purpose of ensuring that the brick masonry courses are laid truly plumb and level and to provide a means by which the departure of the well from plumb and the drift of the well from its correct position during sinking may be determined, The well height in decimeters above the cutting edge as well as the level of each course of masonry shall be marked on the straight edges, Wherever reinforced brick masonry walls have been specified or directed by the Engineer-in-Charge, vertical reinforcing and horizontal bond steel flats shall be embedded in the masonry as shown on the Drawings, Splices in the vertical reinforcing bars shall be made by welding or the screwing of sleeve nuts. Each strip shall be in place and drilled or punched to permit vertical reinforcing bars to pass through) horizontal bars,

d) The well shall be sunk by dredging (defined as removal of material from inside the well) until the top of the masonry is approximately 0.7 meters above the ground, whereupon straight edges for another lift of masonry shall be set and a second lift of masonry up to 3 meters in height constructed. Care shall be taken that the exterior faces of succeeding masonry lifts are constructed parallel to the axis of the well rather than plumb so as to indicate any uneven sinking of the well and permit remedial action to be taken. Each successive lift of masonry shall be allowed to set for three days before sinking of the well is resumed. In caser spring level is high, and then operation shall be maintained in a dry condition using coffer dams and dewatering methods.

e) Dredging shall be accomplished in such a manner that the hole within the well shall not be extended below the cutting edge by more than 1.25 meter and that, when the well is sunk to its final position, the material outside of the well will not have been disturbed. Except when specifically authorized by the Engineer-in-Charge, explosives shall be used in conjunction with dredging. Dredged material shall be used for backfill or placed in spoil banks adjacent to the locations of work as approved by the Engineer-in-Charge.

f) Each well shall be frequently checked for plumb by means of plumb lines and mason's level or other approved means. Corrective action, consisting of dredging from the high side until the well rights itself, shall be taken immediately if the well is found to be sinking unevenly. If required, weights shall be added at the top of the well masonry on the high side or the Contractor may be required to employ shoring or tension rigging on the upper body of the well foundation to assist in plumbing the well foundation. The corrective force shall be applied concurrently with sinking of the well. Completed well foundations shall not depart from plumb by more than 2.5 cm in 1.27 m which shall be the only deviation allowed from the true position of the well as shown on the Drawings. .

g) Each well shall also be frequently checked for longitudinal and lateral drift during sinking by the use of a suitable sighting device, or other means approved by the Engineer-in-Charge, and by establishing satisfactory control points a safe distance from the construction so as to remain undisturbed, from which the straight edges outlined in sub-clause (b) above may be clearly sighted. The longitudinal and lateral centerlines of the top of any well foundation shall not deviate from the centerlines established on the Drawings by an amount greater than an equivalent tilt of 2.5 cm in 1.27 m. The vertical distance used to establish the equivalent tilt shall be the vertical distance from the level shown on the Drawings to the top of the well. The deviation may consist of tilt. Drift or combination thereof; however, the completed well shall not depart from plumb by more than 2.5 cm in 1.27 m.

h) If the well does not sink as the dredging is advanced, a greater height of masonry, weighting or running shall be employed. Running, defined as the practice of removing water from within the well to reduce buoyancy and thereby increase the effective weight of the well, shall not be employed without. The approval of the Engineer-in-Charge

i) If for any reason a well is cracked either vertically or horizontally, the masonry shall be removed insofar as practicable to eliminate the crack and rebuilt. A crack or portion thereof, which cannot be eliminated practicably by' rebuilding in the opinion

of the Engineer-in-Charge, shall be grouted to the satisfaction of the Engineer-in-Charge.

j) When a well has been sunk to its indicated elevation, the bottom interior of the well shall be carefully sounded to detect the presence of any material within the space to be occupied by the bottom plug, and any material so detected shall be removed. The false masonry if constructed to increase the weight for sinking shall also be removed.

2. Where specified:

a) Without un-watering, the bottom plug concrete shall be placed by means of a tremie, bottom dump buckets, or other approved means which will preclude any free fall of the concrete in the water. The concrete shall be worked under the masonry corbelling and carried at least to the height indicated on the Drawings.

b) After the bottom plug concrete has set at least one day, and without un watering the well, the sand filling shall be placed in lifts not exceeding one meter in depth and with a 24-hour elapse of time between placements of the lifts to permit settlement of the fill.

c) After the sand filling is placed to the demarcated elevation within the well, the top plug concrete shall be placed and screeding level at the elevation of the top of the brick masonry, If the well is titled within the permissible limits, the masonry at the top of the well shall be constructed, so that the top surface of the masonry around the perimeter of the well meets the specified elevation.

46.5 LOG RECORD OF EXCAVATION

The Contractor shall furnish to the Engineer-in-Charge log of the Sinking of each well. The log record the day and hour at which sinking commenced, suspended, resumed and completed, a description of materials dredged; time during which each lift of brick masonry is built; the height of the lift; the daily record of sink age obtained, deviation of the well from plumb position and description of action. To plumb the well, and any unusual occurrences or data as is required to document the progress of well sinking. The form of the log shall be approved by the Engineers-in-Charge.

46.6 ALTERNATIVE PROCEDURE FOR SINKING

Sinking of the well by any other of the so called traditional methods employed in Pakistan may be utilized when approved by the Engineer-in-Charge provided the essential requirements of these Specifications are met.

46.7 MEASURMENT AND PAYMENT

46.7.1 COMPOSITE RATE

The measurement and payment for the items of the work of Well Sinking hereof shall be made corresponding to the applicable CSR item as provided in Contract Agreement and shall constitute full compensation, for procurements, transportations, performance in all respect and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

46.7.2 LABOUR RATE

The measurement and payment for the items of the work of Well Sinking hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurements transportations, performance in all respect and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

Pay Item No.	Description	Unit of Measurement
46.7 a	Excavate well in dry & dispose of soil within 50m in ordinary soil or sand.	
	i. Up to 5ft (1.5m) depth	CM
	ii. 5ft to 10ft (1.5m to 3m) depth	CM
	iii. 10ft to 15ft (3m to 4.5m) depth	CM
	iv. 15ft to 20ft (4.5m to 6m) depth	CM
46.7 b	Excavate well in dry & dispose of soil within 50m in hard soil.	
	i. Up to 5ft (1.5m) depth	CM
	ii. 5ft to 10ft (1.5m to 3m) depth	CM
	iii. 10ft to 15ft (3m to 4.5m) depth	CM
	iv. 15ft to 20ft (4.5m to 6m) depth	CM
46.7 c	Excavate well in dry & dispose of soil within 50m in hard strata like shingle and gravel.	
	i. Up to 5ft (1.5m) depth	CM
	ii. 5ft to 10ft (1.5m to 3m) depth	CM
	iii. 10ft to 15ft (3m to 4.5m) depth	CM
	iv. 15ft to 20ft (4.5m to 6m) depth	CM
46.7 d	Dry sinking of well & disposal of soil within 50m in ordinary soil.	
	i. 10ft to 15ft (3m to 4.5m) depth	CM
	ii. 15ft to 20ft (4.5m to 6m) depth	CM
	iii. 20ft to 25ft (6m to 7.5m) depth	CM
	iv. 25ft to 30ft (7.5m to 9m) depth	CM
	v. 30ft to 35ft (9m to 10.5m) depth	CM
	vi. 35ft to 40ft (10.5m to 12m) depth	CM
	vii. 40ft to 45ft (12m to 13.5m) depth	CM
	viii. 45 ft (13.5m) to any depth	CM
46.7 e	Dry sinking of well & disposal of soil within 50m in hard soil.	
	i. 10ft to 15ft (3m to 4.5m) depth	CM
	ii. 15ft to 20ft (4.5m to 6m) depth	CM
	iii. 20ft to 25ft (6m to 7.5m) depth	CM
	iv. 25ft to 30ft (7.5m to 9m) depth	CM
	v. 30ft to 35ft (9m to 10.5m) depth	CM
	vi. 35ft to 40ft (10.5m to 12m) depth	CM
	vii. 40ft to 45ft (12m to 13.5m) depth	CM
	viii. 45 ft (13.5m) to any depth	CM
46.7 f	Dry sinking of well & disposal of soil within 50m in hard strata like shingle and gravel.	
	i. 10ft to 15ft (3m to 4.5m) depth	CM
	ii. 15ft to 20ft (4.5m to 6m) depth	CM
	iii. 20ft to 25ft (6m to 7.5m) depth	CM
	iv. 25ft to 30ft (7.5m to 9m) depth	CM
	v. 30ft to 35ft (9m to 10.5m) depth	CM
	vi. 35ft to 40ft (10.5m to 12m) depth	CM
	vii. 40ft to 45ft (12m to 13.5m) depth	CM
	viii. 45 ft (13.5m) to any depth	CM
46.7 g	Wet sinking of well, in cohesive soil (value of C up to 5), for depths below	

	spring level, as per specification, including charges of machinery, shoring, kentledge and removal of excavated spoil within 30m.	
	i. Up to 5ft (1.5m) depth	CM
	ii. 5ft to 10ft (1.5m to 3m) depth	CM
	iii. 10ft to 15ft (3m to 4.5m) depth	CM
	iv. 15ft to 20ft (4.5m to 6m) depth	CM
	v. 20ft to 25ft (6m to 7.5m) depth	CM
	vi. 25ft to 30ft (7.5m to 9m) depth	CM
	vii. 30ft to 35ft (9m to 10.5m) depth	CM
	viii. 35ft to 40ft (10.5m to 12m) depth	CM
	ix. 40ft to 45ft (12m to 13.5m) depth	CM
	x. More than 45ft (13.5m)	CM
46.7 h	Wet sinking of well, in cohesive soil (value of C more than 5), for depths below spring level as per specification, including charges of machinery, shoring, kentledge and removal of excavated spoil within 30m.	
	i. Up to 5ft (1.5m) depth	CM
	ii. 5ft to 10ft (1.5m to 3m) depth	CM
	iii. 10ft to 15ft (3m to 4.5m) depth	CM
	iv. 15ft to 20ft (4.5m to 6m) depth	CM
	v. 20ft to 25ft (6m to 7.5m) depth	CM
	vi. 25ft to 30ft (7.5m to 9m) depth	CM
	vii. 30ft to 35ft (9m to 10.5m) depth	CM
	viii. 35ft to 40ft (10.5m to 12m) depth	CM
	ix. 40ft to 45ft (12m to 13.5m) depth	CM
	x. More than 45ft (13.5m)	CM
46.7 i	Wet sinking of well, in shingle or gravel etc. for depths below spring level as per specification, including charges of machinery, shoring, kentledge and removal of excavated spoil within 30m.	
	i. Up to 5ft (1.5m) depth	CM
	ii. 5ft to 10ft (1.5m to 3m) depth	CM
	iii. 10ft to 15ft (3m to 4.5m) depth	CM
	iv. 15ft to 20ft (4.5m to 6m) depth	CM
	v. 20ft to 25ft (6m to 7.5m) depth	CM
	vi. 25ft to 30ft (7.5m to 9m) depth	CM
	vii. 30ft to 35ft (9m to 10.5m) depth	CM
	viii. 35ft to 40ft (10.5m to 12m) depth	CM
	ix. 40ft to 45ft (12m to 13.5m) depth	CM
	x. More than 45ft (13.5m)	CM

PART-3
ELECTRICAL WORKS

PLANNING AND DEVELOPMENT DEPARTMENT GOVT OF AJK

GENERAL SPECIFICATIONS (Electrical Works)

Table of Contents

GENERAL REQUIREMENTS OF ELECTRICAL WORKS

G.1 GENERAL

The Contractor shall furnish all material at site conforming to relevant specifications laid down in British Standards, the Pakistan Standards Institute or as specified herein below for flameproof and other installations.

The specifications indicated herein are not limited to complete details of construction and materials and equipment required to be furnished under this contract, but only broadly indicate the type and functioning of the same. A schedule of technical particulars of major equipment, however, is included along with a schedule of the owner supplied items.

The contractor shall make his own survey to ascertain and confirm the layout and exact location of distribution and lighting equipment as shown on the drawings. He shall in case of variation revise the layout and submit that drawing for approval of the Consultant & the cost of such checking and confirming the location and layout of the schemes shall be deemed to be included in his rate.

Bidders shall submit their quotation on the form and in order outlined herein and are required to fill in all columns. The bid shall include certified copies of suppliers offer/consent for the supply of the material involved and period of time covering their entire delivery period, as evidence that delivery schedules claimed by the bidder shall be met and the supplier's offer is based on the specifications included in the bid.

G.2 SCOPE OF WORK

These specifications cover providing of materials and equipment and performing all works to produce and complete functioning of electrical system as shown on the electrical drawings and shall generally include:

i) Distribution equipment comprising of Lighting and Power DB'S & Power Cables as per bill of quantities.

ii) Exterior and interior lighting and power wiring including all branch circuits, feeders, connection to all lighting and power outlets etc.

iii) All general lighting fixtures and appliances as given in bill of quantities.

iv) Earthing system to effectively earth all fixtures and appliances.

v) Optional items of work as given in the Bill of Quantities.

vi) Testing, commissioning and energizing.

The whole electrical work is to be carried out in accordance with the BS 7671:2001 as issued by the Institute of Electrical Engineers London and the Pakistan Electricity Rules and IEE requirements of electrical installations 16th (or later) edition.

SECTION 55 MATERIAL & WORKMANSHIP

All materials shall be in accordance with the types and manufacturer as described in the specifications, approved manufacturers' list, Bill of Quantities and as shown on relevant drawings. Where the Contractor desires to use materials differing from those described he shall obtain the approval of the Engineer In-charge in writing before tendering.

Materials shall accord with appropriate Pakistan and British Standard Specifications. The rights are reserved to inspect materials on site at reasonable times and to reject any material not complying with the specifications. The cost of any dismantling and re-erection of the installation occasioned by the removal of rejected materials shall be borne by the Contractor.

During the time of the contract and before final approval of the electrical installation, six copies of descriptive literature, maintenance and operation data and parts list of each item of electrical equipment installed under this contract should be submitted to the Engineer In-charge.

i) All electrical materials shall be new and shall meet the requirements of British Standard Specifications. As soon as practicable, and within thirty days after the official award of contract and before any materials or equipment are ordered, the Contractor shall submit for approval, one complete list of materials, apparatus and equipment in triplicate, giving the manufacturer's name, address, descriptive, certified analysis, catalogue numbers, etc. and when called upon to do so, complete specifications and cut or drawing of such item, of whole or portion of list, as required, which he proposes to use or install.

ii) Samples of conduits, wire, wiring devices, finished plates, and any other item as may be required by the Engineer In-charge shall be submitted for approval.

iii) Wherever hereinafter the words "for approval", or "approved" (Make, type, size, arrangement, etc.) are used, especially with regards to manufactured specifications etc., or wherever it is desired to substitute make or type of apparatus for that specified, all information pertinent to the adequacy and adaptability of the proposed apparatus shall be submitted to the Engineer Incharge and his approval secured before the apparatus is ordered or installed.

iv) The work throughout shall be executed in the best and most thorough manner under the direction of and to the utmost satisfaction of the Engineer Incharge. Rights are reserved to reject any work and materials which are not in full accordance with the drawings and specifications and he shall have the power to reject any work and materials which in his judgment, are not in full accordance therewith.

v) This contractor shall have on file, for ready access and reference, a set of drawings indicating all work as actually installed incorporating in it all changes and additions. Upon the completion of the contract, he shall prepare a set of tracings thereon of the Electrical Work as actually and finally installed. These tracings shall be handed over to the Engineer In charge.

vi) The plans as drawn are based upon architectural plans and details and show conditions as accurately as it is possible to indicate them in scale. The plans are diagrammatic and do not necessarily show all fittings etc. necessary to fit the buildings conditions. The locations of outlets, apparatus and appliances shown on the plans are approximate. The Contractor shall be responsible for the proper location in order to make them fit with architectural details and instructions given to him at the site.

SECTION 56 IDENTIFICATION OF CIRCUITS

Switch panels, fuse boards and similar distribution units shall be designated in accordance with the reference letters or numbers used in the specifications and/ or shown on the drawings but the legend and description shall clearly spell out the full name of the equipment.

i) All distribution boards shall be provided a substantial circuit sheet fixed to the inside of the front cover. The function of each circuit shall be clearly printed on the chart under the respective column. Spare branch ways shall not be printed "Spare" but left blank.

ii) On AC systems the phase sequences shall be maintained throughout the installation and all phase connections shall be in the order Red, Yellow, Blue from top to bottom and / or left to right. Neutral connections shall be below or to the right side of the phase connections and shall be links or busbars.

iii) The particular phase connected to a fuse bank and busbar shall be clearly indicated by marking with appropriate colour.

iv) Where medium voltage exists, a label shall be fitted externally on the equipment with the words "DANGER 400 VOLTS", engraved in one inch letters.

v) Contractor, starters, switches, outlets, pull boxes etc. shall be located so as to provide easy access for operation, repair and maintenance and if concealed, access doors shall be provided.

SECTION 57 CUTTING FLOOR, WALLS & CEILING

The Contractor shall keep pace with the Civil and any other specialist Contractor and shall keep the Engineer In-charge informed of his programming and progress at site.

Contractor should work out, positions of holes, channels etc. to be left by the Civil Contractor, where this is not reasonably possible cutting and chipping of walls etc. may be permitted. All cutting and chipping of walls etc. for installing material concerning electrification will be done by the Electrical Contractor who shall also repair any damage caused and will be responsible for bringing back the general finish to the position that it was before cutting and chipping was done.

Cutting, chipping, repairing, patching of plaster and finishing of carpentry work, metal work or concrete work, etc. which may be required for the electrical work shall be done by craftsmen skilled in their respective trades, when cutting is required, it shall be done in such a manner as not to weaken walls, partitions or floors and holes required to be cut in floors must be drilled without breaking out around the holes. Where patching is necessary in finished areas of the building rights are reserved to determine the extent of such patching and/ or refinishing and work should be done only upon express instructions. Sleeves through floors, plinths and walls shall be black iron pipe or R.C.C. pipes, flush with walls, ceiling or finished floors of a site to accommodate the raceway. Sleeves through outside walls shall be caulked with an approved caulking material.

SECTION 58 TESTING & INSPECTION

Upon completion of the installations the contractor shall perform field tests on all equipment, materials and system. All tests shall be conducted in presence of the Engineer. In general, all tests made by the Contractor shall be of the nature to ensure that the entire installation is sound and that all circuits, lighting and power equipment etc. will function properly and as intended.

The Contractor shall furnish all tools, test equipment, materials etc. and furnish all personnel required for carrying out complete testing.

The Contractor shall record all tests results and submit the same duly initialed by the Engineer Incharge for record.

58.1 INSULATION TESTS

The insulation resistance test shall be performed on all electrical equipment and wiring, using Megger tester or any self contained instrument such as direct indicating ammeter of the generator type. Only D.C. potentials shall be used for such testing and these shall be as follows:

Circuit under 230 volts = 500 volt test

Circuit 230- 400 volts = 1000 volt test

The minimum acceptable insulation resistance value shall be One (1) Mega ohm.

The insulation tests between all phases and between earth and each phase of circuit shall be performed. All equipment shall be tested to earth.

If the insulation resistance of the circuit under test is found less than as specified above, the cause of low reading shall be determined and removed. The corrective measures shall include dry out procedure by means of heaters if equipment is found to contain moisture but if circuit cables are found defective these shall be removed and replaced and tested again. The tests shall be carried out at least three times and the lowest reading shall not be less than 70 per cent of the average value.

58.2 EARTH RESISTANCE TEST

Earth resistance tests shall be made by the contractor on the earthing system, separately and reconnecting each earth connection as may be required.

The electrical resistance of the ECC together with the resistance of the earthing lead measured from the connection with earth electrode to any other position in the completed installation shall not exceed one (1) Ohm.

58.3 PHASE SEQUENCE TEST

The Electrical Contractor shall determine correct rotation of all motors and phase out the entire power installation before final connections to the line. Final connections of main feeder fuses to the main circuit breakers of the switch gear shall only be made after correct phase relation of power Company's primary line has been established.

In addition, the following guarantees shall be provided:

i) The Contractor shall guarantee that the electrical systems are free from all grounds and from all defective workmanship and material and will remain so far a period of one year from the date of acceptance of the work. Any defects appearing within the aforesaid period, shall be remedied by the Contractor at his own expense.

ii) The Contractor shall indemnify and save harmless the Owner and the Owner's Representative from and against all liabilities for damages arising from injuries to persons or damage to property occasioned by any act or omission of the Contractor or any of his sub-contractor including any and all expenses, legal or otherwise, which may be incurred by the Owner in the defence of any claim action or suit.

iii) The contractor shall be held fully responsible for the work of any sub-contractor, supplier or manufacturer, as it is intended that the entire electrical and allied work forming part of this contract when finally delivered to the Owner shall be ready in every respect for satisfactory and efficient operation.

iv) The Contractor shall furnish as soon as possible two un-priced copies of all orders placed on site for articles and materials to be incorporated into the work. The orders in all cases shall carry a notation to the effect that the articles or materials are subject to inspection and acceptance. The inspection may be either during manufacture and/or before delivery at the site of work. The Contractor shall furnish to the Engineer, full information as to the progress of work on said orders and shall advise in writing at least 21 days prior to the materials being ready for inspection at the point of origin.

SECTION 59 DRAWINGS

59.1 RECORD DRAWINGS

The Contractor shall, during the progress of the work keep a careful record of all changes where the actual installation differs from that shown on the Contract Drawings. The Contractor shall in a neat and accurate manner, make a complete record of all changes and revisions to the original design, as installed in the completed work. These drawings shall be submitted for approval. Final payment will be with-held until receipt of the approved drawings.

59.2 SHOP DRAWINGS & SAMPLES

The Contractor shall prepare and submit for approval shop drawings showing exact routes of conduits / cables / cable trays etc. with location of bends and inspection boxes, pull boxes etc. at double scale of contract drawings and cuts of all equipment, appliances and fixtures furnished. After final approval a sufficient number of copies as desired shall be furnished for distribution. Fixture and device cuts and / or catalogues shall be clearly marked to indicate the items furnished. Contractor shall not submit individual sheets, cuts, catalog drawings. For instance, lighting fixture cuts should be for all fixtures furnished, rather than for a few types.

59.3 CONTRACT DRAWINGS

The location of various items indicated on the drawings are presumed to be approximately correct, but it is to be understood, however, that the small scale drawings are necessarily diagrammatic and that such locations, as shown are subject to slight revision, as the work is installed, which may be necessary to accommodate local construction conditions. No major change shall be made, however, without approval in writing. The contractor shall examine and study the architectural scale drawings, large scale and full size details, the approved shop drawings of other trades and he shall frequently consult with the Engineer In-charge to ascertain any changes that may have been made, and he shall be guided accordingly before establishing the precise location of conduit runs, panels, pull and junction boxes, outlets, lighting, power, telephone, fire alarm sound and other systems. All outlets covered or partially covered by ducts, piping, etc. shall be extended laterally or to the underside of the same so that fixtures may be properly installed.

SECTION 60 L.T SWITCH BOARD

60.1 MATERIALS

The LT Switchboards shall be cubicle type, sheet metal cover moisture and dust proof, floor/wall mounting factory assembled ready wire with all copper connections and internal wiring for 440 Volt, 50 Hz. 3 phase 4 wire systems and rating etc. and shall be as specified in the Schedule of technical particulars and bill of quantities.

All circuit breakers/switch fuses shall be non-draw out type unless otherwise specified. Each cubicle shall be sub-divided into compartments to house switch fuse and circuit breaker panels as detailed in the bill of quantities. The compartment shall have enough space for convenient front/back access for repair/maintenance work.

Full interlock shall be provided into compartments to house switch fuse and circuit breaker panels as detailed in the Bill of Quantities. Full interlock shall be provided between cubicle doors and circuit breakers switches and contactors. The cubicle shall be so constructed that on removing the side wall, extension for any number of cubicles is possible to form a self contained unit. Each compartment shall have a name plate engraved with panel designation with 25 mm high letters. The metering and protective devices shall be provided as detailed in the schedule of technical particulars and bill of quantities. Cable termination for the sizes of cables indicated on the drawings shall also be provided.

Pedestal type switchboard when specified shall comprise angle iron pedestal with anchoring bolts for fixing to floor with sufficient clearance at the back for cable termination. The board shall be factory assembled and the fuse switches operations shall be clear of adjacent switches. The whole assembly shall be self-contained rugged and firmly supported on the floor. Suitably sized bus bar chamber shall be provided as specified from which outgoing feeder circuits shall emanate.

The Contractor shall submit before installation the manufacturer's drawing for approval showing physical dimensions, arrangement of switches, arrangement for cable termination and / or bus tie ducts.

60.2 INSTALLATION OF LT SWITCHES

The Electrical Contractor shall provide all labour, equipment and tools necessary for complete installation as well as shimming of the supporting floor steel that may be required to set the switch gear in level position. The equipment shall be fixed firmly on the floor according to the manufacturer's recommendations. All outgoing and incoming cable connections shall be made and special care should be taken in fixing cable and boxes and cable connections so that no danger of leakage during operation is possible. Earthing connection shall be made according to the earthing instructions, as per relevant drawings.

60.3 **MATERIAL RATE**

Pay Item No.	Description	Unit of Measurement
60.3 a	Supply, Installation, Testing & Commissioning of Recessed Mounting Distribution Box, 16 SWG steel sheet, powder coated with approved color back box comprising one incoming MCCB-TP/63A and 3 No. of 10 amp, 3 no. of 6amp & 3 no. of 20 Amp outgoing single/double pole MCB, Complete in all respects.	NO
60.3 b	Supply, Installation, Testing &Commissioning of Recessed Mounting Distribution Box, 16 SWG steel sheet, powder coated with approved color back box comprising 1 no. of incoming MCCB-TP/100A and outgoing single/double pole 3 No. of 10 amp, 3 no. of 6amp & 3 no. of 20 Amp MCB, Complete in all respects.	NO

SECTION 61 DISTRIBUTION BOARD

61.1 MATERIALS

The distribution board shall have incoming comprising of a load break switch, fuse switch, switch fuse of MCCB/MCB and for the distribution HRC cartridge type fuse links of MCBs as required for the outgoing circuits in accordance with the Distribution Boards' Schedule. It shall be factory assembled ready wired having front hinged door.

The distribution boards shall be mounted flush in the wall at specified locations. The board shall include all equipment with necessary interlocks, control and wiring terminal lugs and shall be solder less mechanical type. The enclosure should have a door which can be well secured and has dust protecting gaskets, interface barriers should be provided. All steel work should be rust proofed prior to the application of high quality enamel finish or powder coating of a colour to be advised by the Engineer at the time of finishing to match with the environments. Cover shall be flush with the surface on wall.

61.2 INSTALLATION OF DB

The electrical Contractor shall provide all labour equipment and tools necessary for complete installation to set the distribution boards in level position. The equipment shall be fixed firmly on the walls according to the manufacturer's recommendations. All outgoing and incoming cable connections shall be made and special care should be taken in cable connections so that no danger of leakage during operation is possible. Earthing connections shall be made according to the earthing instructions, given on relevant drawings. The distribution board will be accommodated inside the LT Switchboard if so specified.

61.3 MATERIAL RATE

Pay Item No.	Description	Unit of Measurement
61.3 a	Supply, Installation, Testing & Commissioning of Recessed Mounting Distribution Box,18 SWG steel sheet,18"x24" powder coated with approved color back box comprising one incoming MCCB-TP/100A & outgoing single/double pole 3 No. 6/10/20 amp MCB,include earth wiring nuteral link Complete in all respects	NO
61.3 b	Supply, Installation, Testing & Commissioning of Recessed Mounting Distribution Box, 18 SWG steel sheet, powder coated with approved color back box comprising one incoming MCCB-TP/150A and outgoing single/double pole 4 no. of 6,10 & 20 amp MCB, Complete in all respects	NO

SECTION 62 L.T. CABLES

62.1 MATERIAL

Copper conductor shall be of minimum 99.90% purity and shall comply with ASTM B49. Copper or Aluminum conductor shall comply with IEC 60228, armored or un armoured, single or multicore as indicated in the Bill of Quantities and shown on drawings.

i. Wiring Cables, 300/500 Volts.

Wiring cables shall be single core, colour red, black or green 300/500 volts grade copper conductor complying with BS 6004.

ii. Un-armored Power Cables 600/1000 Volts.

The PVC insulated cables shall be 4 core, 600/1000 PVC insulated and PVC sheathed. The thickness of PVC insulation and sheath shall conform to BS 6746 and having properties complying with BS 6346.

iii. Armored Power Cables 600/1000 Volts.

The PVC insulated cables shall have number of cores as shown on drawings and in the bill of quantities and should be taped, steel wire armored and extended PVC sheathed overall, manufactured in accordance with BS 6746 and BS 6346.

iv. Copper Conductor Cables.

The conductor shall be stranded plain annealed copper wire of high conductivity complying with BS 6360.

v. Aluminum Conductor shall be stranded complying with BS 6791.

vi. Cable Terminations:

All PVC cables shall terminate in approved pattern metal boxes fitted with suitable glands for securing the armor wires and incorporating a packing ring for exclusion of water and moisture. The cables shall be secured at the requisite spacing by means of cable cleats or hangers and where multiple runs occur, they shall be accommodated on heavy gauge galvanized perforated metal trays.

The cores of multi-core cable shall have colours in conformity with the BS Specifications in order to provide easy identification. Each cable core shall be seated solid at the midway point in the box and the cores then continued to the terminals of the equipment. These cores shall be insulated by sufficient layers of Empire tape for the voltage concerned.

Boxes shall be thoroughly cleaned and dried prior to filling with compound of the best quality. Boxes shall be finally topped up to make up any voids caused by shrinkage of compound.

62.2 INSTRUCTIONS FOR LAYING LT CABLES

1. The cables sizes are specified to accord with the IEE Regulations in respect of voltage drop, but if for any reason the sizes are not given for a particular run the cable shall be of sufficient cross- sectional area to carry the full load without exceeding a voltage drop of one (1) volt plus 2% of the supply authority declared voltage between the main service termination and any part of the installation, except that in the case of motors running under normal condition the permissible maximum voltage drop at the motor terminals is 7.5 % of the declared supply voltage.

2. The depth of the trenches shall be such that top surface or the cable shall not be less than 900 mm from the finished ground level, it will be contractor's responsibility to obtain trench levels for this purpose.

3. Indicated routes shall be followed for excavating trenches unless otherwise specified, where change of direction is necessary the radius of the bend may not be less than twice the dia LM of the cable drum or 20 times the dia LM of the cable whichever is greater.

4. At cross roads the cables shall pass through 150 mm dia. asbestos / R.C.C. pipes, the mouth of which shall be sealed after drawing the cables. The Contractor shall provide the conduit at no extra cost to the Owner.

5. The road cuts shall be filled first with min. 60 mm crushed stone ballast up to 150 mm below the road level and after consolidating it properly 150 mm of PCC (1:2:4) shall be laid over it.

6. The cushion of sand to be provided must not be less than 225 mm deep i.e. 75 mm below and 150 mm above the cable. Over the final layer of sand, cable marking tiles/bricks 2" thick and 300 x 150 mm size of approved make shall be placed end to end along the whole length of the cable. The rest of the trench shall be filled up with earth which will be compacted in layers of 150 mm each

7. No trenches shall be dug or holes shall be left unprotected in the open state at any time and for any length of time without completing the job and refilling them in satisfactory manner.

8. Where trenches are left open by oversight and where roads are being cut in the day or night the contractor shall exhibit suitable danger signals, such as banners, red flags and red lamps at his own cost.

9. All the trenches shall be watered and compacted properly before final dressing. The same applies to lawns but here in place of ballast and PCC filling some manure of good quality shall be utilized. The turf shall be carefully removed prior to work and stored in a suitable place. It shall be replaced after completion of work and watered till complete maturity.

10. One end of the cable shall be terminated on respective switch board and other end shall be terminated on the LM board or service connector or at respective connection point as indicated in the drawings.

62.3 MATERIAL RATE

Pay Item No.	Description	Unit of Measurement
62.3 a	Straight Run Feeder for Sandwich bus bar trunking with Aluminum Conductors, System-415V, 3Phase, 5-Wire with internal earth, IP54, Complete in all respect Rating: 2000A	NO
62.3 b	Elbow 90 degree for Sandwich bus bar trunking with Aluminum Conductors,System-415V, 3Phase, 5-Wire with internal earth, IP54, Complete in all respect Rating: 2000A	NO
62.3 c	Flendge End for Sandwich bus bar trunking with Aluminum Conductors,System-415V, 3Phase, 5-Wire with internal earth, IP54, Complete in all respect Rating: 2000A.	NO
62.3 d	Flexible Connection for Sandwich bus bar trunking with Aluminum Conductors,System-415V, 3Phase, 5-Wire with internal earth, IP54, Complete in all respect Rating: 2000A	NO
62.3 e	Supply, laying, commissioning & Testing of Armoured 1-C,Cable 350/500 & 600/1000 Volt grade PVC Sheathed & PVC Insulated, copper conductor cables as specified, complete in all respects. Rating:	
	A) Single Core Cables (Armored, Cu/Al, Standard/Flexible)	
	i. 4.0 sq.mm cable.	LM
	ii. 6 sq.mm cable.	LM
	iii. 10 sq.mm cable.	LM
	iv. 16 sq.mm cable.	LM
	v. 25 sq.mm cable.	LM
	vi. 35 sq.mm cable.	LM
	vii. 50 sq.mm cable.	LM
	viii. 70 sq.mm cable.	LM
	ix. 95 sq.mm cable.	LM
	x. 120 sq.mm cable.	LM
	xi. 240 sq.mm cable	LM
	B) Double Core Cables (Armored, Cu/Al, Standard/Flexible)	
	i. 1.5 sq.mm cable	LM
	ii. 2.5 sq.mm cable	LM
	iii. 4.0 sq.mm cable.	LM
	iv. 6 sq.mm cable.	LM
	C) 3.5 Core Cable (Armored, Cu/Al, Standard/Flexible)	
	i. 50 sq.mm cable.	LM
	ii. 75 sq.mm	LM
	D) 4 Core Cable (Armored, Cu/Al, Standard/Flexible)	
	i. 6 sq.mm	LM
	ii. 10 sq.mm	LM
	iii. 16 sq.mm	LM
	iv. 20 sq.mm	LM
	v. 25 sq.mm	LM
	vi. 35 sq.mm	LM
	vii. 50 sq.mm	LM

62.3 f Supply, laying, commissioning & Testing of UN-ARMOURED 1-C, Cable 350/500 & 600/1000 Volt grade, PVC Sheathed & PVC Insulated, copper conductor cables as specified, complete in all respects. Rating:

A) Single Core Cables (Non-Armored, Cu/Al, Standard/Flexible)

i.	1.5 sq.mm cable.	LM
ii.	2.5 sq.mm cable.	LM
iii.	4.0 sq.mm cable.	LM
iv.	6 sq.mm cable.	LM
v.	10 sq.mm cable.	LM
vi.	16 sq.mm cable.	LM
vii.	25 sq.mm cable.	LM
viii.	35 sq.mm cable.	LM
ix.	50 sq.mm cable.	LM
x.	70 sq.mm cable.	LM
xi.	95 sq.mm cable.	LM
xii.	120 sq.mm cable.	LM
xiii.	240 sq.mm cable	LM

B) Double Core Cables (Non-Armored, Cu/Al, Standard/Flexible)

i.	1.5 sq.mm cable	LM
ii.	2.5 sq.mm cable	LM
iii.	4.0 sq.mm cable.	LM
iv.	6 sq.mm cable.	LM
v.	10 sq.mm cable.	LM
vi.	16 sq.mm cable.	LM

C) 3.5 Core Cable (Non-Armored, Cu/Al, Standard/Flexible)

i.	16 sq.mm cable	LM
ii.	20 sq.mm cable	LM
iii.	25 sq.mm cable.	LM
iv.	35 sq.mm cable.	LM
v.	50 sq.mm cable.	LM
vi.	75 sq.mm	LM
vii.	95 sq.mm cable.	LM
viii.	120 sq.mm cable.	LM

D) 4 Core Cable (Non-Armored, Cu/Al, Standard/Flexible)

i.	6 sq.mm	LM
ii.	10 sq.mm	LM
iii.	16 sq.mm	LM
iv.	20 sq.mm	LM
v.	25 sq.mm	LM
vi.	35 sq.mm	LM
vii.	50 sq.mm	LM

E) Earth Conductor

i.	14 SWG (3.2 sq.mm)	LM
ii.	12 SWG (5.4 sq.mm)	LM
iii.	10 SWG (8.7 sq.mm)	LM
iv.	8 SWG (13 sq.mm)	LM
v.	6 SWG (19 sq.mm)	LM
vi.	4 SWG (27 sq.mm)	LM
vii.	1/0 SWG (53 sq.mm)	LM
viii.	2/0 SWG (61 sq.mm)	LM
ix.	3/0 SWG (70 sq.mm)	LM

F) 3 phase 500V, 800 Amps, L.T.. Bus-tie duct for connection between transformer L.T and L.T. switch board

i.	With 1200A bus tie duct.	LM

	ii.	With 1600A bus tie duct.	LM
	G)	**3-Phase, Oil Immersed, Indoor, power transformer**	
	i.	3 core(Aluminum) 95 Sq.mm 11 KV, cross link polythene insulated shielded, armoured and PVC jacketed cable	LM
	H)	**shealed and earth wire**	
	i.	Single pair	LM
	ii.	2 pair	LM
	iii.	3 pair	LM
	iv.	4 pair	LM
	v.	6 pair	LM
	vi.	8 pair	LM
	vii.	10 pair	LM
	viii.	15 pair	LM
	ix.	20 pair	LM
	x.	30 pair	LM
	xi.	50 pair	LM
	I)	**cable for communication of data**	
	i.	RJ-5	LM
	ii.	RJ-6 (Coaxial Cable)	LM
	iii.	RJ-7	LM
	iv.	RJ-11	LM
	v.	Coaxial Cable	LM
	vi.	Cat 5 Cable	LM
	vii.	Cat6 Cable	LM
	viii.	Cat7 Cable	
62.3 g	Supply, installtion, Testing & Commissioning of Fexbile Cable 1-C, PVC Sheathed, PVC Insulated, complete in all respects.. Rating:		
	i.	Fexible cable 1-c 1.0 sqmm	LM
	ii.	Fexible cable 1-c 1.5 sqmm	LM
	iii.	Fexible cable 1-c 2.5 sqmm	LM
	iv.	Fexible cable 1-c 4.0 sqmm	LM
	v.	Fexible cable 1-c 6 sqmm	LM
	vi.	Fexible cable 1-c 10 sqmm	LM
	vii.	Fexible cable 1-c 16 sqmm	LM
	viii.	Fexible cable 1-c 25 sqmm	LM
	ix.	Fexible cable 1-c 35 sqmm	LM
	x.	Fexible cable 1-c 50 sqmm	LM
62.3 h	Supply, installtion, Testing & Commissioning of Fexbile Cable 2-C PVC Sheathed, PVC Insulated, complete in all respects.		
	i.	Fexible cable 1-c 0.5 sqmm	LM
	ii.	Fexible cable 1-c 1.0 sqmm	LM
	iii.	Fexible cable 1-c 1.5 sqmm	LM
	iv.	Fexible cable 1-c 2.5 sqmm	LM
	v.	Fexible cable 1-c 4.0 sqmm	LM
	vi.	Fexible cable 1-c 6 sqmm	LM
	vii.	Fexible cable 1-c 10 sqmm	LM
	viii.	Fexible cable 1-c 16 sqmm	LM
	ix.	Fexible cable 1-c 25 sqmm	LM
	x.	Fexible cable 1-c 35 sqmm	LM
	xi.	Fexible cable 1-c 50 sqmm	LM
62.3 i	Supply, installtion, Testing & Commissioning of Fexbile Cable 3-C PVC Sheathed, PVC Insulated, complete in all respects.		
	i.	Fexible cable 1-c 0.5 sqmm	LM
	ii.	Fexible cable 1-c 1.0 sqmm	LM

	iii.	Fexible cable 1-c 1.5 sqmm	LM
	iv.	Fexible cable 1-c 2.5 sqmm	LM
	v.	Fexible cable 1-c 4.0 sqmm	LM
	vi.	Fexible cable 1-c 6 sqmm	LM
	vii.	Fexible cable 1-c 10 sqmm	LM
	viii.	Fexible cable 1-c 16 sqmm	LM
	ix.	Fexible cable 1-c 25 sqmm	LM
	x.	Fexible cable 1-c 35 sqmm	LM
	xi.	Fexible cable 1-c 50 sqmm	LM
	xii.	Fexible cable 1-c 70 sqmm	LM
62.3 j	Supply, installtion, Testing & Commissioning of Fexbile Cable 4-C PVC Sheathed, PVC Insulated, complete in all respects.		
	i.	Fexible cable 1-c 0.5 sqmm	LM
	ii.	Fexible cable 1-c 1.0 sqmm	LM
	iii.	Fexible cable 1-c 1.5 sqmm	LM
	iv.	Fexible cable 1-c 2.5 sqmm	LM
	v.	Fexible cable 1-c 4.0 sqmm	LM
	vi.	Fexible cable 1-c 6 sqmm	LM
	vii.	Fexible cable 1-c 10 sqmm	LM
	viii.	Fexible cable 1-c 16 sqmm	LM
	ix.	Fexible cable 1-c 25 sqmm	LM
	x.	Fexible cable 1-c 35 sqmm	LM
	xi.	Fexible cable 1-c 50 sqmm	LM
	xii.	Fexible cable 1-c 70 sqmm	LM

SECTION 63 CIRCUIT WIRING

63.1 CABLES

The cables for circuit wiring shall be as described under power cables and shall be of copper conductor of minimum size 2.5 sq mm for lighting circuits and 4.0 sq mm for power outlets. These shall emanate from the specified single phase device in the distribution fuse board and serve a group of light or power points. The circuits shown on the drawings are designated according to phase distribution e.g. with a numerical prefix of phases R-Y-B to show the circuit, while the numerical suffix indicating the number of the switch on the room switch board.

Circuits will run independently in separate conduits and the neutral shall not be run common for any circuit. A neutral link will be provided in the distribution fuse board corresponding to the number of ways envisaged in the distribution board.

63.2 BUS BARS AND CONNECTIONS

Busbar trunking is utilised within building and industrial applications to deliver power to electrical loads. It is an alternative to traditional cabling and provides numerous advantages to the installer and client including saving on space, time and cost.

The busbar is housed in an aluminium casing which also acts as an earth. A set of four bus bars, three for phases and one for neutral, made of copper having 98% IASC conductivity shall be provided. The bus bars in panels and chambers shall be tin plated, air insulated having minimum clearance of 80 mm between phase to phase and 25 mm between phase to earth. The neutral bar shall be of the same section. All the bus bars shall be mounted on insulators at suitable intervals and should be extensible on both ends. The marking and arrangement of bus bars, main connections and small wiring shall conform to BS 159. Bus bars and bus bar connections shall also conform to BS 159.

63.3 STANDARDS

It should be manufactured in a certified management system environment where Quality ISO 9001, Safety OHSAS 18001 and Environmental ISO 14001 standards are applied. It should be manufactured accordance with IEC 61439-1 and IEC 61439-6.

63.4 TYPE TESTS

- Verification of Strength of material and parts
- Verification of Degree of protection of enclosures
- Verification of Clearance and Creepage distances
- Verification of Protection against electrical shock and integrity of protective circuits
- Verification of Dielectric properties
- Verification of Temperature rise limits
- Verification of Short-circuit withstand strength

63.5 INSTALLATION OF CABLES

The installation of cables shall be as described in section 1.8 (b) and shall be as follows:

From Distribution Boards.

- Circuits for room switchboards = 2.5 sqmm / 4sqmm

- Circuits for 15 Amps sockets. = 4.0 sqmm / 6sqmm

The lighting circuits shall be run in conduits generally laid in roof slabs while those for power outlets in the floor and the risers/downs shall be in the walls, columns, etc. unless otherwise specified and shown on the drawings.

63.6 CONDUIT AND CONDUIT ACCESSORIES

i) Metal Conduit

All conduits supplied by the Contractor shall be un-used standard manufactured length of machine welded 16 SWG steel threaded type protected inside and outside by black enamel coating and shall be tested according to B.S. 81. The coating shall be of heavy enamel which should not flake or crack from bending or rough usage over a Lead Oxide anti-rust coating on the outside surface. Each length of conduit shall bear the maker's trade mark / stamp.

ii) PVC Conduit

Where so specified, heavy duty PVC conduits shall be installed in the same sizes as metal conduit. The fittings including boxes shall be made of fiber or other insulating material to provide completely insulated and non- inflammable system. All fittings are to be fitted with suitable jointing solution. The covering of pipe with concrete or plaster should not be less than 2" all around.

iii) Flexible Conduit

Flexible conduit shall be furnished and installed where required or indicated on the drawings for connections to equipment subject to vibration or where necessary for convenient dismantling, Flexible conduit for use in dry location shall be of spiral interlocked steel strip construction zinc coated. The water tight flexible metal conduit shall be spiral interlocked steel strip construction, zinc coated, with rubber or plastic covering overall. In all instances the tubing shall be terminated in the approved type glands by being screwed and finally soldered into the same. Flexible tubing will not be permitted in lieu of sets and bends in the rigid conduit system.

iv) Conduit Accessories

The Contractor shall furnish all conduit fittings bushings, elbows couplings, bends, inspection boxes, pull boxes, solid plugs, check nuts etc. that are required for a complete conduit installation. Soft metal bushes with round edges shall be used at conduit termination ends in order to save wire insulation from damage due to sharp conduit edges in cable pulling operations. Flexible conduit fittings shall adapt the conduit to threaded connections and shall have an inside diameter not less than the corresponding size of the heavy gauge steel conduit.

v) Weather / Fire Proof Conduits

- Connecting terminal made from ceramic with resistance to high temperatures.
- IP 66 using AKMF cable glands, please order separately

- Intrinsic fire resistance in accordance with DIN 4102 Part 12 (German standard) in combination with function-retaining cables
- Screw anchors enclosed can be used for concrete C20/25, limestone blocks KSV 12, building bricks MZ 12 and clinker bricks KS 12
- For normal environment and protected outdoor
- Cable junction boxes approved for intrinsic fire resistance, degree of protection IP 65 / IP 66
- Box made of Thermoplast, orange RAL 2003
- No toxic or corrosive emissions
- intrinsic fire resistance according to DIN 4102 part 12 (German standard) in connection with function-retaining cables of 1.5-16 mm2.

Conduit Type	Range
Weather Proof	1.5 mm^2 to 50mm^2
Fire Proof	1.5mm^2 to 16mm^2

63.7 INSTALLATION OF CONDUIT

i) Concealed Conduit.

The conduit shall be concealed in ceiling, floor, slabs, columns wall etc. and changes in conduit direction shall be made with sweep bends using bending tools. Standard conduit elbows, and bends may be used to facilitate installation and where conduit turns out of the slabs. Where conduit is to be concealed in R.C.C. work the laying of conduit shall be complete in all respects before pouring of concrete. The conduit shall be laid above the bottom reinforcement of the slab and shall be firmly secured by tying to the reinforcing steel. In order to avoid being disturbed during the pouring of concrete. After pouring of concrete the concealed conduit shall have a covering of 38 mm to 50 mm; junction boxes, pull boxes, outlet boxes etc. shall be held firmly and shall be flushed with the soffit of the slab or beam and keeping this in view the depth of outlet boxes, junction boxes etc. shall be appropriate. Conduit pointing upward or downward shall be properly plugged, in order to prevent foreign matter from entering in it. All openings through which concrete may leak shall be carefully plugged and boxes themselves shall be suitably protected against filling with concrete.

Conduit crossing expansion joints in concrete slabs shall be provided with expansion fittings to compensate for the building expansion or construction. Where conduits have to be concealed in R.C.C. work after pouring of concrete or in brick work chases shall be first made with appropriate tools not to dig unduly deeper than required. The conduit shall be firmly fixed into the recesses made previously and it shall be covered to have at least 1.1/2" cover before plastering. The work of cutting in the R.C.C. work or brick work shall be coordinated with the civil work and the contractor shall get approval for the route etc. to suit the site conditions, before starting changing and cutting.

Where conduit passes through the wall, hole just enough to pass the conduit shall be made with special tools. Conduits shall be run at least 6 inches from the pipes and the Contractor shall ensure that his selected routes will enable the other Service Lines to use their sleeves. Conduit systems shall be so designed that the wiring can be readily inserted after whole of the conduit installation has been erected and all wall, ceiling and floor finishes have been completed.

ii) Conduit on Surface.

Exposed runs of conduit on surface of walls, ceiling or column shall be as indicated on drawings. The conduit and accessories shall be firmly held with the surface of wall by means of saddle clamps, brackets, etc. Speed plugs such as Rawl Plugs or Phil plugs must be used for fixing clamps, saddle etc. in the wall to support the conduit. In cases where the use of such plugs are not feasible due to the consideration of wall structures, wood plugs, may be used, but in all cases these shall not be fixed at more than 2.1/2' feet intervals. The straight runs of conduit shall not be more than 1.1/2 to 2 ' feet below the ceiling level and where hindrance is met on the route the conduit shall be taken around, above or below the hindrance neatly and then run at the same height.

The exposed conduit and its accessories including clamps and supports shall be given anti-corrosion paint of approved standard before and after the installation.

In all areas where the conduit is exposed to damp conditions brass screws must be used for fixing. In no case shall conduit to be mounted directly on the surface of walls and ceiling, a minimum spacing of 1/4" to the back of the conduit being required. Where the conduits pass across the ceiling beams, plain saddles shall be used. Proper made fixing clips and brackets may be necessary in certain portions of the building and the Contractor shall be deemed to be aware included for the supply and fixing of same in his quotation.

Holes shall not be drilled in any structure steel work or pre-stressed concrete without first obtaining the approval of the Engineer Incharge.

iii) Cleaning

The entire conduit system shall be essentially completed before wiring is installed. Conduits shall be tested for continuity and obstructions. Any obstruction found shall be cleared by use of a cutting mandrel or other approved device and the conduit be cleaned out before the installation of cables.

63.8 MATERIAL RATE

Pay Item NO	Description	Unit of Measurement
63.8 a	Providing& Installation of Light circuit concealed wiring with length upto 32 feet (10 mtr). from d.b to switch board with 2-1C, 2.5sqmm copper cable, run in appropriate size of heavy duty PVC conduit along with 1.5 mm sq. PVC insulated copper wire as earth, including all material and accessories as per specifications and as per drawings complete in all respects	NO
63.8 b	Providing & Installation of Light circuit concealed wiring with length upto 32 feet (10 mtr). from d.b to switch board with 2-1C, 1.5sqmm copper cable, run in appropriate size of heavy duty PVC conduit along with 1.5 mm sq. PVC insulated copper wire as earth wire, including all material and accessories as per specifications and as per drawings complete in all respects	NO
63.8 c	Providing & Installation of Light circuit concealed wiring with length upto 75 feet (23 mtr). from d.b to switch board with 2-1C, 2.5sqmm copper cable, run in appropriate size of heavy duty PVC conduit along with 1.5 mm sq. PVC insulated copper wire as earth wire, including all material and accessories as per specifications and as per drawings complete in all respects	NO
63.8 d	Providing & Installation of Open batten wiring with length upto 75 feet (23 mtr). from d.b to switch board with 2-1C, 2.5sqmm copper cable, run in appropriate size of heavy duty duct puttee along with 1.5 mm sq. PVC insulated copper wire as earth wire, including all material and accessories as per specifications and as per drawings complete in all respects	NO
63.8 e	Providing & Installation of Open batten wiring with length upto 32 feet(10 mtr). from d.b to switch board with 2-1C, 2.5sqmm copper cable, run in appropriate size of heavy duty duct puttee along with 1.5 mm sq. PVC insulated copper wire as earth wire, including all material and accessories as per specifications and as per drawings complete in all respects..	NO

SECTION 64 POINT WIRING

64.1 MATERIALS

i) Cables

For lighting and power outlet points the minimum cable conductor size shall be 1.5 sq. mm and 4 sqmm respectively and for flexible cords the minimum size shall be 0.75 sqmm. Flexible cords connecting into light fittings shall be of "Butyl" rubber.

ii) Switches

Switches controlling light and fan points shall be single pole, suitable for 250 volt, 50 cycle circuits. These shall be made of bakolite or plastic and suitable for flush mounting on the room switchboard as called for in Schedule of Quantities. Where more than one switch is to be installed at one location the switches are formed in gangs. A gang of switches may be formed by two, three, four or six switches on one common board, and shall be of PPI make or approved equivalent.

iii) Room Switch Boards

Room switchboards shall be made from 18 SWG sheet steel to house the specified gang of switches, fans regulators, convenience outlets etc., and shall be installed on surface / concealed in walls generally on the right side of the door opening and the bottom edge shall be at least 4 feet from the finished floor level. The board shall have sufficient number of openings on the sides for the conduits laid for point wiring.

64.2 INSTRUCTIONS FOR WIRING

i) The installation of wires and cables in conduit or G.I. pipes shall be done with care to prevent damaging the cables. To facilitate pulling cable lubrication only as recommended by the cable manufacturer may be used for decreasing friction. Under no circumstances shall soap or oil of any kind be used. The manufacturer's specification for minimum bending radius, pulling speed and maximum pulling tension on cables as also number of cables in a conduit shall govern the cable pulling operations, where several cables or wires are to occupy the same conduit, they shall be pulled together.

ii) Pull boxes shall be installed in conduit runs to limit the pulling length of cables. The drawings are diagrammatic and do not indicate the locations of pull boxes, however, they should be installed in conduit runs to limit pulling length to the following:

Straight runs - not more than 100 feet

Runs with one 90 bend - not more than 50 feet.

iii) The minimum length of all inspection boxes shall be equal to not less than four times the cable diameter, or the manufacturer's recommended bending radius of the cable. On all AC supplies, care must be taken to ensure that both the live load and the neutral are contained in the same conduit, and that every single-pole switch and circuit breaker in a 2- wire circuit derived from a 3- wire or 4-wire circuit or supply must be fitted in the phase conductor of the supply.

iv) Earth Continuity Conductor

Circuit and sub-main wiring shall have an earth continuity conductor half the size of the phase conductor but not less than 14 SWG run along with it and bent to all the fittings as well as other metal work not intended to carry current.

The maximum continuity resistance from any point of the installation including the earth continuity and earthing lead to the earth electrode shall not exceed one (1) Ohm.

64.3 MATERIAL RATE

Pay Item NO	Description	Unit of Measurement
64.3 a	Providing & Installation of Concelaed wiring for one light/fan point controlled by one switch and length from switches to point is 32 feet (10 mtr). with 3x1.5sqmm S/C. cable in appropriate size of good quality P.V.C. conduit including ceiling rose and 5A-220 SP Switch, complete in all respect.	NO
64.3 b	Providing & Installation of Concelaed wiring for one light/fan point controlled by one switch and length from switches to point is 75 feet(23 mtr). with 3x1.5sqmm S/C. cable in appropriate size of good quality P.V.C. conduit including ceiling rose and 5A-220 SP Switch, complete in all respect.	NO
64.3 c	Providing & Installation of Open batten wiring for one light/fan point controlled by one switch and length from switches to point is 32 feet(10 mtr). with 3x1.5sqmm S/C. cable in appropriate size of good quality duct puttee including ceiling rose and 5A-220 SP Switch, complete in all respect.	NO
64.3 d	Providing & Installation of Open batten wiring for one light/fan point controlled by one switch and length from switches to point is 75 feet(23 mtr). with 3x1.5sqmm S/C. cable in appropriate size of good quality duct puttee including ceiling rose and 5A-220 SP Switch, complete in all respect.	NO
64.3 e	Providing and wiring of 32 feet (10 mtr). 3-Pin 20A-250V switch socket unit (All Ranges) with 2 x 4mm2 S/C PVC cable 1 x 2.5 mm sq. as earth cable in appropriate size of conduit concealed in walls slab etc. complete in all respect.	NO
64.3 f	Providing and wiring of 75 feet(23 mtr). 3-Pin 20A-250V switch socket unit (All Ranges) with 2 x 4mm2 S/C PVC cable 1 x 2.5 mm sq. as earth cable in appropriate size of conduit concealed in walls slab etc. complete in all respect.	NO
64.3 g	Providing and wiring of 32 feet (10 mtr). 3-Pin 20A-250V switch socket unit (All Ranges) with 2 x 4mm2 S/C PVC cable 1 x 2.5 mm sq. as earth cable in appropriate size of PVC duct puttee. complete in all respect..	NO
64.3 h	Providing and wiring of 75 feet (23 mtr). 3-Pin 20A-250V switch socket unit (All Ranges) with 2 x 4mm2 S/C PVC cable 1 x 2.5 mm sq. as earth cable in appropriate size of PVC duct puttee complete in all respect.	NO

64.3 i	Providing and Wiring of 32 feet (10 mtr). 3/5-pin 5A-220 volt switch socket (All Ranges) away from switch board with 2 x 2.5sqmm +1 x 1.5sqmm S/C (as earth cable),cable complete in all respects.	NO
64.3 j	Providing and Wiring of 75 feet (23 mtr). 3/5-pin 5A-220 volt switch socket (All Ranges) away from switch board with 2 x 2.5sqmm +1 x 1.5sqmm S/C (as earth cable),cable complete in all respects.	NO
64.3 k	Providing and Wiring of 32 feet(10 mtr). 3-pin 5A-220 volt switch socket (All Ranges) away from switch board with 2 x 4sqmm +1 x 2.5sqmm S/C (as earth cable),cable in appropriate size of PVC duct puttee complete in all respects.	NO
64.3 l	Providing and Wiring of 75 feet (23 mtr). 3/5-pin 5A-220 volt switch socket (All Ranges) away from switch board with 2 x 4sqmm +1 x2.5sqmm S/C (as earth cable),cable in appropriate size of PVC duct puttee complete in all respects	NO
64.3 m	Providing and wiring of 1 Gang Television outlets with coaxial cable RJ7 in heavy duty PVC conduit from sub TV. JB with back box of approved manufacturer complete in all respect.	NO
64.3 n	Providing and wiring of 1GANG Television outlets with coaxial cable RJ7 in PVC duct puttee from sub TV. JB with back box of approved manufacturer complete in all respect	NO
64.3 o	Providing and wiring for 32 feet(10 mtr). one light/fan point control by two way switch (All Ranges) with 3x1.5sqmm S/C. cable in appropriate size of good quality P.V.C. conduit concealed in slab, including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	NO
64.3 p	Providing and wiring for 75 feet (23mtr). one light/fan point control by two way switch (All Ranges) with 3x1.5sqmm S/C. cable in appropriate size of good quality P.V.C. conduit concealed in slab, including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	NO
64.3 q	Providing and wiring for 32 feet (10 mtr). one light/fan point control by two way switch (All Ranges) with 3x1.5sqmm S/C. cable in appropriate size of PVC duct puttee including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	NO
64.3 r	Providing and wiring for 75 feet (23 mtr). one light/fan point control by two way switch(All Ranges) with 3x1.5sqmm S/C. cable in appropriate size of PVC duct puttee including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	NO
64.3 s	Providing and wiring for 32 feet(10 mtr). two light/fan point control by one switch (All Ranges)	NO

	with 3x1.5sqmm S/C. cable in appropriate size of good quality P.V.C. conduit concealed in slab, including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	
64.3 t	Providing and wiring for 75 feet(23 mtr). two light/fan point control by one switch (All Ranges) with 3x1.5sqmm S/C. cable in appropriate size of good quality P.V.C. conduit concealed in slab, including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	NO
64.3 u	Providing and wiring for 32 feet(10 mtr). two light/fan point control by one switch (All Ranges) with 3x1.5sqm S/C. cable in appropriate size of PVC duct puttee including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	NO
64.3 v	Providing and wiring for 75 feet(23 mtr). two light/fan point control by one switch (All Ranges) with 3x1.5sqmm S/C. cable in appropriate size of PVC duct puttee including ceiling rose and 5A-220 SP Switch, with back box complete in all respect.	NO
64.3 w	Providing and wiring of 2 Gang Television outlets with coaxial cable RJ7 in heavy duty PVC conduit from sub TV. JB with back box of approved manufacturer complete in all respect..	NO
64.3 x	Providing and wiring of 2 Gang Television outlets with coaxial cable RJ7 in PVC duct puttee from sub TV. JB with back box of approved manufacturer complete in all respect.	NO

SECTION 65 SWITCH & SOCKET OUTLETS

65.1 MATERIALS

i) Socket and Switch Units

Socket unit with plug shall be 3 pin rated for 15 Amps. at 250 volts as specified in the Schedule of Quantities. These shall be made of bakolite and suitable for mounting flush with wall or column or for surface mounting as called for in the Schedule of Quantities. Each socket shall have its control switch by the side of it on a common board and the complete unit specified in Schedule of Quantities shall comprise switch, socket and plug and shall be PPI or approved equivalent.

Where socket and switch units are installed in a damp wet area, they shall be weather proof type. The switch socket outlet and plug shall be as selected by the Engineer and appropriate samples of outlets and plates shall be submitted prior to purchase of devices. Heavy duty receptacle outlets shall be as indicated on the drawings.

ii) Switch & Socket Boxes

Switch and socket outlet boxes shall be of the size suitable to the dimension of switch and socket unit. Gang outlets boxes shall be used where two or more devices are grouped in one location.

These outlets boxes shall be made of 16 SWG sheet steel with protective black enamel paint coating inside and outside the box. Before applying black enamel the cleaned surface of sheet steel box shall be given lead oxide anti rust coating inside and outside the box. The cover of such outlet box shall be approved masonite, tufnol, bakolite or plastic as specified in the Schedule of Quantities for mounting the switches or switch socket units.

iii) Position of Outlets

Centre all outlets with regard to paneling, furring, trim etc. where several outlets occur in a room, they shall be symmetrically arranged. Outlets improperly located or installed shall be satisfactorily corrected. Outlets shall be set with the finished surface of the wall without projecting beyond the same. Receptacles, switches etc. shown in wood trim cases or other fixtures, shall be set with the long dimension of the plate horizontal, or ganged in them.

65.2 **MATERIAL RATES**

Pay Item NO	Description	Unit of Measurement
65.2 a i	Providing and installing fan controller of approved quality (EU/JAPAN/USA). In already installed conclead conduit including face plate including face plate. Complete in all respects	NO
65.2 a ii	Providing and installing 3 pin 20amp switch socket of (EU/JAPAN/USA) quality. In already installed conclead conduit including face plate. Complete in all respects.	NO
65.2 a iii	Providing and installing 3/5 pin 5amp switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects.	NO
65.2 a iv	Providing and installing of 10 amp 1gang 1way switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects	NO
65.2 a v	Providing and installing 10 amp 2gang 1way switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects.	NO
65.2 a vi	Providing and installing of 10amp 3gang 1wayswitch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects.	NO
65.2 a vii	Providing and installing of 10amp 4gang 1way switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects.	NO
65.2 a viii	Providing and installing of 10amp 5gang 1way switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects.	NO
65.2 a ix	Providing and installing of 10amp 6gang 1way switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects	NO
65.2 a x	Providing and installing 10 amp 3/5 pin 16amp switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects.	NO
65.2 a xi	Providing and installing fan controller of approved quality (LOCAL). In already installed conclead conduit including face plate. Complete in all respects	NO
65.2 a xii	Providing and installing 3 pin 20amp switch socket of local quality. In already installed conclead conduitg including face plate. Complete in all respects.	NO
65.2 a xiii	Providing and installing of 10 amp 1gang 2way switch socket of approved quality. In already installed conclead conduit including face plate. Complete in all respects..	NO

SECTION 66 MOUNTING HEIGHTS

Mounting heights of various fittings, fixtures, switch boxes etc. above finished floor for the below- named items shall be as follows: unless otherwise shown on drawings of indicated during constructions:

EQUIPMENT	HEIGHT IN FEET
Pendant fluorescent light fittings.	9-0
Switch board mounted single or multiple flush switches.	4-0
Telephone outlets on wall.	0.75
Bell Push outlets.	4.0
Bell indicators and similar single device	6.0
Fire alarm break glass station	5-0
Fire alarm bell.	7-0
Wall bracket lights.	7-0
Distribution Boards.	4-0

SECTION 67 MOTOR CONNECTIONS

67.1 INTRODUCTION

Connect the motor starting devices for all motors except where otherwise specifically provided for under other contracts, furnish all necessary connections between controllers and motors in conduit and leave motors ready to start. The power supply leads to the motors from the controllers shall be the same size as the feeders indicated on the drawings.

The heating, ventilating and other contractors, except as otherwise noted or specified will supply and deliver all controllers to the Electrical Contractor who shall erect and connect up same complete.

The Electrical Contractor will be responsible unless otherwise specified for the exact location of the motor controllers and motors as far as wiring is concerned. He shall obtain the contractor equipment from the various Air conditioning. Plumbing and other Contractors and shall ascertain the location of the controllers and motors in each case before installing the circuit work.

The Electrical Contractor shall do all the necessary wiring in connection with the motor starting and remote control equipment furnished by other Contractors. Where control or starting equipment is sent to the job dis-assembled, it shall be assembled wired up complete and left ready for operation by the Electrical Contractor.

For all fans and pumps the contractor shall furnish and install all necessary conduit, wire and fittings to make the installation complete. Control and starting equipment, including float and thermostat switches magnetic and remote push button switches will be delivered to this Contractor by other.

67.2 Material Rate

Pay Item NO	Description	Unit of Measurement
67.2 a	Providing and Installation of 3/4 hp Single Phase motor with pump & motor control unit, complete in all respect..	NO
67.2 b	Providing and Installation of 3 hp Single Phase motor with pump, motor control unit, complete in all respect.	NO
67.2c	Providing and Installation of 1 hp Single Phase motor with pump & motor control unit, complete in all respect.	NO
67.2 d	Providing and Installation of 2 hp Single Phase motor with motor control unit, complete in all respect.	NO
67.2 e	Providing and Installation of 5.5 hp Three Phase Motor with 2"x1.25" pump size, 100 ft height & Motor Control Unit, complete in all respect.	NO
67.2 f	Providing and Installation of 10 hp Three Phase Motor with 2.5"x1.5" pump size, 100 ft height & Motor Control Unit, complete in all respect.	NO
67.2 g	Providing and Installation of 30 hp Three Phase Motor with 5"x4" pump size, 100 ft height & Motor Control Unit, complete in all respect	NO

SECTION 68 LIGHT FITTINGS & FIXTURES

68.1 MATERIALS

i) Fluorescent light Fittings

The fluorescent light fittings shall house all accessories of first class quality and shall be completely pre-wired for ready connection, the chokes shall be high efficiency polyester filled, starters shall be spring loaded rotor and shall also have built-in capacitors for improving power factors to 0.95.

All fittings shall be supplied complete with cool day light lawns, unless otherwise specified. The luminaries and mounting channels of fluorescent tube fittings shall be painted with white impact resisting coating of synthetic resin enamel over an undercoat of corrosion resisting paint. A certificate would be required from the light fitting manufacturer confirming that these requirements have been complied with.

Lighting fixture details are given in the Schedule of Quantities. If a definite manufacturer's type of lighting fixture has been specified, any approved equal type may be substituted, if that particular type is not available in the market, and after approval has been obtained in writing. The determination of quality will be based on certified photometry data, covering the co-efficient of utilization, average brightness date etc. as well as equivalent of construction material, finishes etc.

ii) Incandescent Light Fittings:

Lighting fixtures to be manufactured especially shall, in all respects, conform to high standards of engineering design and workmanship, perform and function as specified and will meet the quality level requirements. The drawings produced for such fixtures forming part of the tender only show the outline drawing for the mechanical work involved shall be obtained from the manufacturer and produced by the contractor for approval. After the approval of the drawings a sample of final approval shall be produced before these fittings are installed.

iii) Decorative and Special Purpose Light Fittings

Special Decorative lights are required and shown on drawings will be subject to approval before installation. Light fittings for highlighting architectural features and facade illumination shall be outdoor type watertight fixtures the location of which shall be determined in a demonstration to achieve the desired effect prior to their permanent installation.

Generally each door leading out of a public area shall have a luminous exit sign. The directional sign shall also be provided specially in public areas as shown on the drawings and as decided. The type, general appearance and location of these directional signs shall be subject to approval at site and no extra will be permitted on any account.

iv) LED Light Fixtures

The LED light fixtures shall be installed on the surface of ceiling or wall, such that their back finish flush with the surface for exposed conduits and flush with outlet box for concealed conduit system. Wherever convenient, screws for fixing light fixtures shall be screwed into the holes of the outlet box. The light on false ceiling shall be installed in a manner as described for fluorescent light fixture.

68.2 INSTALLATION OF LIGHTING FIXTURES

All pendant type light fittings shall be suspended from the ceiling at a height as called for in the drawings or general requirements or as instructed by the Engineer. All fixing accessories such as ceiling rose, twin flexible cord, lamp holder, suspension and or chain shall be provided and installed. The surface mounting fittings shall be mounted with the back flush with the ceiling surface, and for fixing methods manufacturer's directions shall be followed. In conduit wiring system ceiling roses shall not be used for pendant or surface type fitting.

Fluorescent light fixtures mounted in rows shall have special end plates provided for forming a continuous row without a break. The internal wiring for fluorescent light fixture shall not hang outside the fixture.

Outdoor light fittings shall be weather proof type. The connection to these fittings shall be taken from a weather proof cast metal type junction box complete with cover. Gasket size shall be determined by the number of wires entering the box. All accessories for mounting outdoor fittings shall be provided and insulated.

68.3 MATERIAL RATE

Pay Item NO	Description	Unit of Measurement
68.3 a	Providing installation and Connecting of Conventional Tube Light complete in all respect.	
	i. 40W Conventional Tube Light with Choke and Tube Patti	NO
	ii. 40 W with industrial reflector, Choke and Tube Patti	NO
	iii. Tube Light 2 No. 40 W with industrial reflector, Choke and Tube Patti	NO
	iv. 40 W with acrylic plastic louver, Choke and Tube Patti.	NO
	v. 2 No. of Ceiling mounting incandescent light fixture 60W	NO
	vi. 4 No. of 20W Conventional Tube Light with Choke and Tube Patti	NO
	vii. 4 No. of Conventional Tube Light 20 W with acrylic plastic louver, Choke and Tube Patti	NO
68.3 b	Providing installation, connecting, testing and commissioning of the following LED Tube light fixtures as per Engineer's approval.	
	I. 9 W	NO
	II. 18 W	NO
68.3 c	Providing installation, connecting, testing and commissioning of the following decorative lighting fixtures as per Engineer's approval (including lamps).	
	i. 10 W up-down Led light	NO
	ii. 15 W up-down Led light	NO
	iii. 14 W Bulk Head Led Light	NO
68.3 d	Wall bracket light with LED, Indoor type complete in all respect as per approval of the Engineer.	
	i. 9 W	NO
	ii. 18 W	NO
68.3 e	LED Down Lighter Surface / Ceiling Mounted or approved equivalent complete in all respects.	
	i. 10 W	NO
	ii. 20 W	NO

68.3 f	Providing installation and Connecting of LED Panel Light Fixtures.	
	i. 18 W	NO
	ii. 36 W	NO
68.3 g	Providing installation and Connecting of LED Track Light Fixtures	
	i. 20 W	NO
	ii. 30 W	NO
68.3 h	Providing installation and Connecting of LED Linear Light Fixtures.	
	i. 18W	NO
	ii. 48 W	NO
68.3 i	Supply and installation of decorative Bollard with Required Watts energy savers / LED. Including foundation, complete in all respect as per approval of the Engineer.	
	i. 15 W - 1 ft high	NO
	ii. 20 W - 3 ft high	NO
68.3 j	Supply & Installation of ceiling mounted incandescent light fixture with glass cover & 2nos. 60W lamps, complete in all respect.	NO
68.3 k	Supply & Installation of wall mounted incandescent light fixture with 60W lamps, complete in all respect.	NO
68.3 l	Supply & Installation of recessed mounted incandescent light fixture with 100W lamps, complete in all respect.	NO
68.3 m	Supply & installation of globe light with PVC CI base, with 24 W energy saver, complete in all respect.	
	i. 10” dia	NO
	ii. 12” dia	NO
	iii. 14” dia	NO

SECTION 69 FANS

69.1 MATERIALS

i) Ceiling Fans

AC ceiling fans capacitor type of 56" or 48" sweep shall be installed as indicated on drawings. The fans shall have a displacement of 10,000 and 8,000 CFM of air respectively with a tolerance of 10%. The fan regulator shall be suitable for flush mounting or surface mounting on room switchboards on walls with sufficient steps to give proper speed regulation. The name plates both on fan and regulator, shall indicate voltage and frequency.

ii) Exhaust Fans

The exhaust fans will have satirically and dynamically balanced blade wheel at specified operating speed. The motor should be split phase capacitor type with low starting torque and the bearing should be permanently lubricated sleeve type. A strong and suitably finished fixing frame should be provided with protecting guard on motor on discharge side, with gravity operated heavy duty balanced shutters etc.

iii) Bracket Fans

The bracket fans will have satirically and dynamically balanced blade wheel at specified operating speed. The motor should be split phase capacitor type with low starting torque and the bearing should be permanently lubricated sleeve type. A strong and suitably finished fixing frame should be provided with protecting guard on motor on discharge side, with gravity operated heavy duty balanced shutters etc.

69.2 INSTALLATION OF FANS

All ceiling fans shall be suspended by hooks or clamps having double nuts with double bolts and the size of the clamp rod shall be as called for in the schedule of quantities. All joints in the suspension rod shall be screwed and further secured by means of split pins. Fan hooks of 5/8" dia M.S. bars of approved shape shall be tied to the roof slab reinforcement before concreting.

Each fan shall be controlled by a separate switch regulator. The regulator shall be mounted with the switch and, if concealed, shall have the steps clearly indicated on the sheet covering on the switch and regulator box.

All exhaust fan frames shall be securely fixed in the opening foreseen for the exhaust fan in the wall, after installation of which the wall surfaces will be brought to their original finish. The louver shutters and metal screens will then be installed in the external surface.

69.3 MATERIAL RATE

All exhaust fan frames shall be securely fixed in the opening foreseen for the exhaust fan in the wall, after installation of which the wall surfaces will be brought to their original finish. The louver shutters and metal screens will then be installed in the external surface.

Pay Item NO	Description	Unit of Measurement
69.3 a	Supply and Installation of Deluxe model 56" ceiling fan, copper winding of approved quality complete in all respect.	NO
69.3 b	Supply and Installation of Deluxe model 36" ceiling fan, copper winding of approved quality complete in all respect.	NO
69.3 c	Supply and Installation of Deluxe model 48" ceiling fan, copper winding of approved quality complete in all respect	NO
69.3 d	Supply and Installation of metal body / Plastic Body (Square, round) Shape, exhaust fan of approved quality complete	
	i. 10" size	NO
	ii. 12" size	NO
	iii. 8" size	NO
69.3 e	Supply and Installation of 14" metal body / Plastic Body (Square, round) Shape, exhaust fan of approved quality complete	NO
69.3 f	Supply and Installation of 16" metal body / Plastic Body (Square, round) Shape, exhaust fan of approved quality complete	NO
69.3 g	Supply and Installation of ceiling fan, copper winding of approved quality complete in all respect.	
	i. High Standard (Classic model)48"	NO
	ii. Super Deluxe (Fancy model) 42"	NO
	iii. Economy model 36"	NO
69.3 h	Supply and Installation of ceiling fan, copper winding of approved quality complete in all respect.	
	i. High Standard (Classic model) 36"	NO
	ii. Super Deluxe (Fancy model) 48"	NO
	iii. Economy Model 56"	NO
69.3 i	Supply and Installation of ceiling fan, copper winding of approved quality complete in all respect.	
	i. High Standard (Classic model) 56"	NO
	ii. Super Deluxe (Fancy model) 52"	NO
	iii. Economy Model 48"	NO

SECTION 70 EARTHING SYSTEM

70.1 EARTHING SET

Earthing of all equipment and appliances shall be carried out in accordance with the provisions of Rules 54 and 57 of the Indian Electricity Rules as adopted in Pakistan with latest amendments.

The earthing set shall comprise of 3/4" dia 10' long copper rod to be lowered in 4" dia bore holes 3' below water table or as specified in Bill of Quantities, 70mm^2 copper conductor shall be clamped to the rod and brought to the ground level in 1-1/2" dia G.I. Pipe with watering chamber. The scope of earthing set also includes making bore holes in the natural ground, excavation and back fill. The earthing set shall be at least 6' away from the nearest foundation.

Number of earthing electricity to be provided would be governed by Rules No. 54 and 57 of the Indian Electricity Rules, 1937, as adopted in Pakistan.

The earthing lead should comprise of HDBC conductor of not less than No. 8 SWG for installations up to 50 Amps. per main conductor, for installation of larger size than this two earthing leads of not less than No. 8 SWG each or one lead of not less No. 4 SWG copper conductor should be used.

70.2 EARTHING CONDUCTORS

Earthing continuity conductors shall be of electrolytic copper of the sizes as specified in schedule of quantities shall be provided and installed as specified herein and shall comply with the latest IEE Regulations. Earth continuity conductors shall be laid along with the length of conduit. This should preferably be installed at the time of laying of conduits and shall be connected using earthing clips between the ends of conduit where conduit enters or leaves elbows, Joints and outlet boxes etc. to ensure good earth continuity. All material parts of switch gear, boards and clamps shall be connected to earth continuity conductor by means of thimbles or lugs duly soldered at the end of copper earth continuity conductor. All nuts bolts, washers etc. shall be electrode galvanized. The earth pin or sockets shall be connected with the earth continuity conductor. The earth continuity conductor should form a continuous path from any point of installation to the earthing sets, when the earthing sets are provided for the mains, these shall be at least 20 feet apart. The earthing lead shall be taken up to the earthing electrode in a suitable size G.I. Pipe and shall be efficiently bounded to the earth electrode by a permanent and positive connection with the earthing. The other end of the earthing lead shall be swatted into a cable lug of a correct size for the wire for its connections to the mains or apparatus to be earthed.

70.3 MATERIAL RATE

Pay Item No.	Description	Unit of Measurement
70.3 a i	Providing & Installation of The earthing comprise of 3/4" dia, 10' long copper rod to be lowered in 4" dia bore holes 3' below water table or as specified in Bill of Quantities, 70mm2 copper conductor shall be clamped to the rod and brought to the ground level in 1-1/2" dia G.I. Pipe with watering chamber. The scope of earthing set also includes making bore holes in the natural ground, excavation and back fill(to be taken from Civil rate analysis). The earthing set shall be at least 6' away from the nearest foundation. Complete in all respects.	NO
70.3 a ii	Providing & Installation of The earthing comprise of 2'x2', 3mm thickness copper plate to be lowered 16' below natural ground or as specified in Bill of Quantities, 70mm2 copper conductor shall be clamped to the plate and brought to the ground level in 1-1/2" dia G.I. Pipe with watering chamber. The scope of earthing set also includes making bore holes in the natural ground, excavation and back fill, (to be taken from Civil rate analysis). The earthing set shall be at least 6' away from the nearest foundation. Complete in all respects.	NO
70.3 a iii	Supply and installation of strip/rope & rod type lightning arrestor system, copper strip/rope & rod 3mm thick and 25mm width with clamps, Cu Bolts & Screws, Cu strip socket, Cu T-joints, etc., Complete in all respects.	LM

SECTION 71 FIRE ALARM SYSTEM

71.1 SYSTEM OPERATION

The fire alarm system shall be suitable for operation at 24 V DC supply and shall include a control cabinet of specified zones along with fire alarm initiation stations of heat/smoke detectors and break glass unit. Operation of any unit shall energize a relay in the control cabinet to give “zone” and “fire” indication and sound the supervisory buzzer. The bells will not be silenced unless corresponding push buttons on the control cabinet are operated.

A key operated fire alarm initiating point for all zones, can be operated if ringing of the bells in all zones is required to give a general evacuation signal, sound intensity shall be such that an audible signal will be heard clearly throughout the structure when all bells are ringing. Circuits shall be so arranged that a signal ground or a signal break in a conductor will neither occur in loss of an audible signal from any alarm bell in the building upon operating of any fire alarm initiating point, nor prevent functioning of any manual alarm box, except that a false alarm caused by a short circuit in an open circuit system will be permitted.

Wiring will be by means of 1.5 sqmm PVC insulated cable 300/500 Volt grade laid in concealed, or surface conduit system. The system shall operate on 24 Volt DC being supplied from a power supply unit consisting of a battery charger and Nickel Cadmium cells.

Equipment and accessories furnished under the terms of this specification shall be the standard products of a single manufacturer. Manufacturer’s name, catalogue numbers and model designations which appear herein are included to indicate design quality and type of materials as well as required operating characteristics. Items of equipment as manufactured by other manufacturers may be substituted if approved.

71.2 FIRE ALARM CONTROL PANEL

The control panel shall comprise of single/multi zone indicators as indicated on the drawings, as specified. The panel shall also have a power unit comprising rechargeable Ni-Cd batteries and a battery charger. The panel shall be of solid state, modular design with integral static protection. All indicating lamps shall be solid state. All light emitting diodes (LEDs) or dual filament lamps. Failure of any filament shall cause an audible and visual trouble signal.

71.3 ACCESSORIES

i) Break Glass Units

Manual Stations shall be of rugged, die-cast construction designed for semi-flush mounting. Stations shall be of the break-glass design and must be opened to be reset. It shall not be possible to close a station without first resetting it. It shall be possible for testing purposes, to initiate an alarm without breaking the glass rod. Stations shall include auxiliary contacts for operating remote enunciator performing remote control functions as per the plans. To assure long term operation, alarm contacts shall be gold plated and the minimum rating for dry circuitry applications shall be 3mA at 5V DC.

ii) Alarm Bells

Alarm bells shall be of the vibrating type. All bells shall be 24V DC polarized with six inch gongs, except as noted in the plans. The minimum sound output at ten feet shall be 90 DB or the greater. Bells shall be semi-flush mounted, except as noted on the plans.

iii) Alarm Horns

Alarm horns shall be suitable for indoor or outdoor application with the appropriate 4 x 4 inch electrical box. All horns shall be 24V DC polarized. The minimum sound level shall annual Stations shall be of rugged, die-cast construction designed for semi-flush mounting. Stations shall be of the break-glass design and must be opened to be reset. It shall not be possible to close a station without first resetting it. It shall be possible for testing purposes, to initiate an alarm without breaking the glass rod. Stations shall include auxiliary contacts for operating remote enunciator performing remote control functions as per the plans. To assure long term operation, alarm contacts shall be gold plated and the minimum rating for dry circuitry applications shall be in 3mA at 5V DC.

71.4 MATERIAL RATE

Pay Item No	Description	Unit of Measurement
71.4 a	Supply, Installation, Testing & Commissioning of 1.5mm.sq Fire Resistant cable with 3 hrs. resistance time sustainable up to 900 degree centigrade temperatures in already installed conduits, complete in all respect.	NO
71.4 b	Supply, Installation, Testing & Commissioning of Addressable Photo electric Smoke Detectors with built in isolators, complete in all respect..	NO
71.4 c	Supply, Installation, Testing & Commissioning of Addressable Photo electric Multi Detectors with built in isolators, complete in all respect..	NO
71.4 d	Supply, Installation, Testing & Commissioning of Addressable Photo electric Heat Detectors with built in isolators, complete in all respect.	NO
71.4 e	Supply, Installation, Testing & Commissioning of Addressable sounder and accessories with built in isolators, complete in all respect..	NO
71.4 f	Supply, Installation, Testing & Commissioning of Addressable break glass manual call stations with built in isolators, complete in all respect.	NO
71.4 g	Supply, Installation, Testing & Commissioning of Fire Alarm Control Panel with basic software version consisting of 02 loops capable of connecting detectors and sounder in a loop with max 200 devices per loop including battery backup and cost of all necessary accessories.	NO
71.4 h	Supply of Fire Alarm Control Panel with basic software version consisting of 04 loops capable of connecting detectors and sounder in a loop with max 200 devices per loop including battery backup and cost of all necessary accessories.	NO

SECTION 72 TELEPHONE SYSTEM

72.1 GENERAL

The scope of work under this includes all material and labour required for complete installation of the system as shown on drawings and as contained in the bill of quantities. This shall include the laying of conduit, telephone cable, outlet boxes, rosettes and telephone distribution boards, and other facilities as required for a complete installation of the system. The Contractor shall coordinate with the Pakistan Telephone and Telegraph Department in all respects, where required on behalf of the Owner.

72.2 CONDUIT AND CONDUIT ACCESSORIES

The specification for Conduits and Conduit accessories shall be same as contained in Section of these specifications.

i) Telephone Outlets

The outlet boxes shall be made of 18 SWG sheet steel and provided with earth terminal and appropriate size of nipple for conduit. On all telephone outlets a plate of 3 mm white plastic sheet shall be installed with telephone rossett jack type with male and female parts.

ii) Telephone Cables

The telephone cable shall be insulated and sheathed and of numbers of pairs as specified in the Bill of Quantities. Provided with 0.6 mm dia copper conductor cables. The cable shall be terminated in accordance with the requirements of T&T Department.

iii) **Telephone Junction Box**

The box shall be of 16 SWG (1.63mm) sheet steel with hinged cover to be fixed flushed with the wall. The copper terminal strips shall be installed on insulated material sheet inside the sheet steel box; and the number of ways shall be as described in the Bill of Quantities.

iv) Electronic Telephone Exchange (EPABX)

It shall comprise of operator console, key board, Digital switch with modules, color monitor, main distribution frame (MDF) & battery back up for 4 hours, the system shall be capable for Automatic Redial on Trunk, Remote trunk Access, Direct Inward Access, calls logging & shall have external music inter face and also provide following functions/facilities.

v) Operator Console Features

Extension call, Trunk Access, Trunk Transfer, Trunk Hold, On Screen Memo Pad, On Screen Call Logging (Time based) Display, Display of Extension Status, Display of Night Service Status, Display Dedicated Status of Ext., Abbreviated Dialing, Trunk Dialing Echo Back, On Screen Pgr. Massage Display Selective Trunk Access, Blocking of Trunk Access, Display of Trunk Status, Hand set Mute, Dial out from Telephone Dir.,

vi) Trunk Facilities

Trunk Re-dial from Extension, Trunk Call limit Control, Trunk Grouping, Dedicated Trunk-Incoming, Direct Inward Access, Trunk Hold and Transfer, Trunk Camp On, Executive Trunk Access, Dedicated Trunk-Outgoing, Trunk Prog. For One way Oper Trunk Night Service, Trunk to Trunk Transfer, Remote Trunk Access, Trunk to Trunk Conference.

72.3 EXTENSION FEATURES

Extension to Extension Dialing, Conference 3 Party, Camp-on-No Reply, Flexible Numbering Scheme, Ext./ Ext. call transfer, Grouping, Grouping, Group Call Pickup, Incoming Call beep on busy, Abbreviated # Bank, Telephone Lock out, Mail Box Message Handling, Trunk Access Blocking, NWD Blocking, Camp-on-Busy Operator Access, Break in, Reminder Call, Diversion, Executive Trunk Access, Extension Ring Transfer No Repl, Trunk Call Duration Limit, Do Not Disturb, Immediate Call Back, Extension Hot Line Normal, ISD Blocking, Extension Telephone Lockout, Outgoing Call Logging, Extension Hunting, Extension Hot Line Priority, Call Parking, Out Going Call Logging, Mail Box Facility, Extension Reminder Call.

72.4 INSTALLATION

The complete telephone system i.e. conduits, cables, outlet boxes, telephone junction boxes, etc. shall be installed in the conformity with the drawings. No conduit less than 25 mm dia shall be used. For the incoming telephone feeder, a pipe of given dimensions stated on drawing shall be installed at 500 mm (Minimum) below the ground level and to be extended inside the building at a level of 150 mm above the floor level.

Identification marking shall be given on the free end of conduit both by colour or suitable approved tag tied with brass wire.

All telephone instruments shall be supplied and installed by Pakistan Telegraph and Telephone Department or any other such organization authorized by the Pakistan Telephone & Telegraph Department to carry out the work on their behalf.

72.5 MATERIAL RATE

Pay Item NO	Description	Unit of Measurement
72.5 a	Providing and wiring of Telephone outlets with 1x2 pair telephone cable in heavy duty PVC conduit from sub TJB of approved manufacturer complete in all respect.	LM
72.5 b	Providing and wiring of Telephone outlets with 1x2 pair telephone cable in PVC duct puttee from sub TJB of approved manufacturer complete in all respect.	LM
72.5 c	Providing and wiring of Telephone outlets with 1x4 pair telephone cable in heavy duty PVC conduit from sub TJB of approved manufacturer complete in all respect.	LM
72.5 d	Providing and wiring of Telephone outlets with 1x4 pair telephone cable in PVC duct puttee from sub TJB of approved manufacturer complete in all respect.	LM

SECTION 73 LIGHTNING PROTECTION SYSTEM

73.1 SYSTEM

The lightening protection system shall comprise the following:-

i) Network of Air terminals.

ii) Bends.

iii) Roof Conductors

iv) Down Conductors

v) Testing Points.

The system of lightening protection shall be installed so as to protect all the buildings against lightening conforming to CP 326, 1965, as shown on drawings.

73.2 AIR TERMINALS

The air terminal shall be cast and machined in electrolytic copper, conforming to BSS 1400, and shall be complete with single pointer rod as shown on the drawings. The base assembly shall be of high tensile brass conforming to BSS 251C, (Grade A). The complete assembly shall be of proper strength to withstand the excessive wind pressure during storms.

73.3 BENDS, ROOF CONDUCTORS AND DOWN CONDUCTORS

The bends, roof conductor and down conductors shall be of soft annealed electrolytic copper strips 1" x 1/8" conforming to BSS 899. Down conductors shall be installed each having independent testing point, earth termination lead. The earth termination lead shall also be soft annealed electrolytic copper strip of 1"x 1/8" conforming to BSS 899. All the joints made in the strips shall be riveted in accordance with CP 326. The surface before riveting shall be silver plated and soldered after riveting.

73.4 ROOF CONDUCTOR

The roof conductors shall be installed on the roof as per approved shop drawings. The copper conductor shall be firmly secured to the concrete surface by means of copper or brass clamps of approved design at a maximum interval of 1000 mm.

The roof conductor shall be connected to the copper rod by means of copper clamps. The clamp to be tightly fixed to the rod and brazed to ensure low resistance path to earth. The contact surface between copper clamp and conductor shall be cleaned, silver painted, brazed after bolting and provided with a coat of anti-corrosive paint after installation.

73.5 DOWN CONDUCTORS

The down conductor shall be installed along the shortest possible route from roof to earth electrode. It shall be secured on the surface of wall by means of clamps at a maximum interval of 1000 mm. In general, bends shall be avoided along the routes of down conductor and maximum possible bending radius will be provided at turns. All joints between conductors shall be electrically and mechanically strong and effective. Straight joints in the down conductor shall be bolted. The joint shall be given a coat of anti -corrosive paint after connection. All accessories such as nuts, bolts, washers, solder, paint etc. shall be furnished by the Contractor. For each

down conductor a removable terminal shall be provided for testing purpose at approximately 1.5 meter height. The location of testing terminals are not shown on the drawings. The Contractor must ensure that testing terminals are installed so as to facilitate testing. The testing terminals shall be bolted type and made in accordance with the specifications for straight bolted joints. The connecting earth lead from testing terminals to earth electrodes shall be continuous without any joint. All metal work, pipes etc., at the roof and within 2 meters along the route of down conductor shall be bonded to the lightning protection system. The bonding shall be effective and approval of the Engineer-in-Charge shall be obtained for the bonding method.

73.6 TESTING

i) Each down conductor shall be provided with a testing point according to CP.326 and shall be installed 7 feet above the finished floor level so as not to invite unauthorized interference but shall be convenient for use when testing. No joint or connection, other than one direct to earth plate, shall be made below the testing point. Connecting terminal of suitable capacity shall be provided.

ii) Two sets of testing electrodes conforming to CP 326. shall be installed. The connecting cables and testing electrodes shall be equipped with connecting brass lugs and terminals of suitable capacity.

iii) On completion of installation the contractor shall test the system for 'resistance to earth' and "continuity & efficiency of joints' in accordance with CP 326.101(Clause 805 and 804) respectively.

iv) The test shall be conducted in presence of the Engineer Incharge. The meters and equipment used in the test shall be supplied by the contractor and be of precision grade.

73.7 MATERIAL RATE

Pay Item No.	Description	Unit of Measurement
73.7 a	Supply, Installation, Testing & commissioning of early streamer emission (ESE) having desired specification: lightning protection system including all materials equipments, boundaries, tools, supports, accessories etc. Complete in all respect.	NO

SECTION 74 MEDIUM VOLTAGE SWITCH GEAR

The switchgear shall be 11000 volt metal clad type, of 350 MVA breaking capacity, for indoor application. It shall be triple pole and all the three poles shall be coupled so as to operate simultaneously.

The switchgear shall comprise of vacuum circuit breaker/load break switches.

The switchgear shall be supplied and tested in accordance with the following International Elector Technical Commission Publications.

IEC Publication 56-1

IEC Publication 56-1A

IEC Publication 56-1B

IEC Publication 56-2

IEC Publication 56-3

IEC Publication 56-4

IEC Publication 185-1 (Specification for current Transformers)

IEC Publication 51-(Specifications for Instruments)

The definitions given in the above IEC Publication shall apply herein.

In case the requirements laid down herein differ from those given in the IEC Publications, these requirements shall be deemed to be in additions of the requirements as laid down in IEC Publications.

All the associated equipment and accessories shall be so constructed and designed so as comply with all the requirements set out in these specifications.

The switchgear shall eb designed for indoor use and to be mounted on the floor.

The switchgear shall be supplied in the form of single panels for quick assembly at Site in the form of a switchboard.

Each panel shall comprise of a draw out type circuit breaker and all its associated equipment and accessories shall be self contained and self supporting. Each panel shall be capable of being connected to a switchboard on either side.

In each panel the circuit breaker shall be equipped with a mechanism for moving it physically between the connected and dis-connected positions and also equipped with self-aligning and self coupling primary and secondary dis-connecting devices.

All secondary circuit wiring, instruments, meters and relays etc, shall as for as possible be isolated by grounded metal barriers from all primary circuit elements with the exception of short lengths of wires such as instrument transformer terminals.

All removable components of the same type and rating in a switchboard shall be physically and electrically interchangeable.

The breaker shall have mechanical “ON”, “OF” and “EARTHS” position indicator.

Mild steel rails shall be provided at the base to guide smooth entry of the breaker carriage into the panel.

The terminals and inter-connections between parts shall be designed to ensure permanently low resistance contacts. The power carrying circuits shall be capable of carrying its rated current at rated voltage and rated frequency continually without excessive maintenance. Even after repeated fault interruption, the capability of the circuit breaker to carry its rated current continuously shall not be seriously impaired. The manufacturer's literature and technical data to prove this point shall be furnished by the Contractor.

The circuit breaker shall be capable of interrupting any current form Zero to its rated breaking current when used on any predominantly resistive and/or inductive circuits. The breaking time at all ratings less than the rated breaking current shall not exceed the rated breaking time.

The arc interrupting mechanism shall be designed with ample mechanical and electrical factors of safety in all its parts. The parts shall consist of a minimum number of assemblies arranged for convenient installation and readily removable for repair or inspection.

The mechanical strength and physical characteristics of the insulation structure shall be such that it can withstand the shocks of the circuit breaker operations within the rated capacities and reasonable strains of connecting conductors under the specified service conditions. This insulation shall be in accordance with the classification of the IEC Publication NO 85.

The rods or tubes used for raising or lowering the moving contacts of the circuit breaker shall be securely pinned at each end to prevent rotation for displacement of the contacts.

Ventilation outlets from circuit breaker shall be so arranged that any discharge of oil and/or gases or both will not cause electrical breakdown and shall be directed away from a likely palace where an operator may have to be in the cause of this ordinary duties. The construction shall be such that gas cannot collect at any point where fire can be caused during or after operation, by sparks arising from normal working of the circuit breaker or its auxiliary equipment.

A set of 6 male and 6 female silver plated self-aligning isolating contacts shall be provided for separating the breaker from the busbars. These shall be interlocked and protected by automatic shutters with locking facility. The shutters shall marked "BUSBARS" and "CABLES" and distinctly coloured. No operation shall cause exposure of the high voltage bus or equipment. The shutters shall operate with certainty upon the withdrawal and replacement of a removable portion but shall be so arranged as to permit the cover over a set or sets of live contacts to the locked by hand in the closed position while the cover over the dead contacts may be opened.

Silver plated plug contacts shall be provided between separate units to complete the secondary circuits. They shall be pressure loaded self aligning type.

The temperature rise of the main circuit of a circuit breaker shall not exceed the values given in Table-I of IEC publication 56-2. The maximum temperature of auxiliary circuits and devices when the circuit breaker is carrying the rated current and voltages and when tested in accordance with Clause II of IEC Publication NO 56-2 shall not exceed the value given in Table-I. The reference ambient temperature shall be taken as 50 degree centigrade.

These circuit breakers shall have the following characteristics:-

Sr. NO		Characteristics
1.	Current Rating	630 Amps
2.	Voltage Rating	11/12 KV
3.	Frequency	50 Cycles/Second
4.	Breaking Capacity	350 MVA
5.	Breaking Current Sym	18.4 KA/16.9 KA
	Asym	23 KA/21 KA
6.	Making Capacity	892.5 MVA
7.	Power Frequency withstand Voltage	
	i- Type Test	36 KV
	ii- Routine Test	28 KV
8.	Impulse withstand voltage	95 KV
9.	Operating duty	0-15 Cycles-Co-Cum-Co
10.	Total maximum break time	6 Cycles

The circuit breakers shall be capable of breaking any power upto their rated braking capacity. For all recovery voltages between the two rated voltages the breaking capacity ratings in amperes shall be inversely proportional to the voltage. For recovery voltages below rated voltages the breaking capacity expressed in amperes shall have a constant value corresponding to the lower rated voltage.

The operating mechanism shall be charged spring power mechanism with manual push button for closing and opening the breaker. The closing spring shall be hand charged.

The mechanism shall be trip free.

The closing mechanism shall not prevent or delay the opening of the circuit breaker beyond the standard interrupting time.

Latches shall be so designed as to not require delicate or frequent adjustments.

The mechanism shall be such as to give a minimum of 1000 operations without wear, breaking or adjustments. Each operation shall consist of complete opening and closing of the circuit breaker.

The mechanism shall be of robust construction and of rust proof materials. It shall be capable of withstanding shocks and prevent inadvertent operation, due to fault current stresses, vibrations or other causes. Convenient means of applying lubricants where needed shall be provided.

The mechanism shall be provided with means to prevent operation during maintenance.

The following routine tests shall be make on all circuit breakers and manufacturer's certificate shall accompany each breaker.

i) Temperature rise test (IEC Publication 56-2 Clause 15).

ii) Test for operating Conditions (IEC Publication 56-3 Clause 37).

iii) Power frequency dry voltage (IEC Publication 56-4 Clause 17).

iv) Tests on auxiliary circuits (IEC Publication 56-4 Clause 19).

Oil Tank leakage tests by any one of the following methods:-

i) Compressed Air Test.

ii) Oil or Water Pressure Test.

iii) Penetrating liquid without pressure.

The Contractor shall make suitable arrangements for the Engineer to witness such tests at the manufacturer's premises or any recognized test laboratory without any expense to the Owner.

Duly certified and complete test reports of tests carried out by an independent authority on one representative breaker of the same design shall be submitted by the Contractor failing which he shall arrange to carry out the following type test to be witnessed by the Engineer without any expense to the Owner.

i) Temperature rise test (IEC Publication 56-2 Clause 10).

ii) Making capacity and braking capacity rating and short time current rating test (IEC Publication 56-1 Part-III).

iii) Operation tests and mechanical endurance tests (IEC Publication 56-3 Clause 36 except that number of closing and opening operations in case of mechanical endurance test shall be 1000).

iv) Impulse voltage dry withstand test (IEC Publication 56-4 Part-4).

v) One minute Power frequency voltage dry withstand test (IEC Pub. 56-4 Part-4).

vi) One minute power frequency voltage wet withstand test (IEC Pub. 56-4 Part-4)

A set of three busbars made of 98 % I.A.S.C electrical conductivity copper of current rating of 1000 Amps shall be provided.

The busbars shall be fully covered with insulation capable of withstanding the full line voltage. These shall be supported on porcelain insulators and air insulated. The busbars shall be tinned at all joints and a drawing showing details and method of joining shall accompany the busbars.

Bracings of sufficient mechanical strength shall be provided to withstand forces of short circuit current to the extent of 23 KA.

The busbars shall be capable of extension on either side and have adequate provision for expansion and contraction due to temperature variations over a range of 80 degree centigrade.

Single pole, epoxy resin insulated, dry type self-contained indoor current transformers suitable for mounting in switchgear shall be supplied.

The current transformers shall be manufactured and tested in accordance with IEC Publication 185)1966) and particulars listed therein.

The transformation ration shall be as stated in the Bill of Quantities.

The current transformers shall have two core construction and each core shall be designed for protection and metering. Both cores shall be identical.

The minimum output on any tap for each core of current transformer shall be 30 VA for protection and 10 VA for instruments and metering. The standard accuracy class for the protective service shall be 10P and the accuracy limit factor shall be + 1 %.

The standard accuracy class for the instrument and metering service shall be + 1 %. The rated short time Thermal current ratings shall be 13.1 KA. The rated dynamic peak current which the current transformers will withstand without being damaged electrically or mechanically shall be 33.4 KA.

The insulation levels for the current transformers shall be as under:-

Highest Expected Voltage	One Minute Power Frequency Withstand Voltage (RMS)	Impulse Withstand Voltage KV peak
12 KV	34 KV	95 KV

The following routine tests shall be made in accordance with IEC Publication 185 for all ratios and at all taps:-

i) Verification of terminal markings (Clause-14).

ii) Power frequency test at primary windings (Clause-15).

iii) Power frequency test at secondary windings (Clause-16).

iv) Over voltage interturn test (Clause 17 and Clause-40 as applicable).

The following type tests shall be carried out in accordance with IEC Publication 185.

i) Short time current test (Clause 19)/

ii) Temperature rise test (Clause 20).

iii) Impulse voltage test (Clause 21).

iv) Accuracy test (Clause 29).

v) Composite error test (clause 39).

vi) Tests for instrument security current (Clause 31).

The above tests may be omitted if a complete type test result for an identical transformer carried out by an independent agency is supplied by the manufacturers.

Three phase, self-contained, indoor, draw out type voltage transformers shall be supplied as required and detailed in the Bill of Quantities. The transformers shall be epoxy resin insulate.

The rated frequency shall be 50 Hz and voltage ration shall be 11000/110 volts. The accuracy and tests shall have the above noted frequency and voltage ratio as reference.

The characteristics shall be as follows:-

i) Rated Burden VA 100 Per Phase

ii) Accuracy Limit 0.6 %

The voltage transformer shall withstand for one second the mechanical and thermal stresses resulting from short circuit on the secondary terminals with full voltage maintained on the primary terminals.

The following test shall be carried out on the voltage transformer:-

i) Dielectric test of low frequency.

ii) Impulse test on high voltage windings only.

iii) Ratio and phase angle tests at one standard burden.

iv) Temperature rise test.

v) Impedance Test.

The dielectric test voltage shall be as under;-

	Impulse Test Voltage			
Rated Primary	Low Frequency Test Voltage (rms)	Chopped Wave Crest Voltage	Min. time Flash-over	Full wave Crest
11 KV	34 KV	110 KV	1.8 microseconds	95 KV

The voltage transformers shall be equipped with fuse and fuse links in accordance with B.S. 88/1967.

Back connected dust proof, semi-flush, switchboard type protective relays with transparent removable and sealable covers shall be provided. These shall be preferably plug-in withdraw able type and all operations for removal and replacement shall be carried out from the front side of the panel.

The relays shall be suitable for climatic conditions described in these specifications and capable of 5000 electrical operations when tested at rated quantities and at a rate which will not result in overheating. The relays shall withstand a test-voltage of 2000 volts (rms).

The relays shall be three element type two for over current and one for earth fault. These shall be inverse over-current definite minimum time induction type with inverse time characteristics. These shall be either directional or non-directional as suited to the service conditions.

All relays shall be A.C. operated and provided with time and current setting adjustments with suitable range.

The relays shall be equipped with instantaneous elements with a setting range from 10 to 40 amps, adjustable continuously. It shall also have an infinity setting or look out position to make the instantaneous element in-operative.

The rated error of all the protective relays shall be not more than 7.5 % at all settings. The relay characteristics shall not change more than plus or minus 7.5 % with changes in ambient temperature of plus or minus 10 degree centigrade from the reference temperature of 25 degree centigrade and with changes in frequency of plus 2 % and minus 6 % from the rated frequency.

The following type tests shall be carried out:-

i) Limits of error.

ii) Temperature rise test.

iii) Overload.

iv) Contact rating test

v) mechanical Durability

vi) Variation characteristics with ambient conditions and frequency.

Certified test results by an independent agency on the type of relays shall be supplied by the manufacturer.

All live parts of the panel including busbars, connections, circuit breaker, isolators, voltage transformer, current transformers shall be suitably enclosed. Access for normal maintenance shall be through doors with locking facilities. The enclosure shall have hinged door in front and bolted plates in rear. However, the incoming panels will be provided with hinged doors with locks in the rear as well.

The enclosure shall be making of high grade sheet steel of minimum thickness ⅛ (3mm) except that smaller compartments may be of a lesser thickness. The steel sections shall be rigidly welded and the entire enclosure shall be self-supporting and free standing. Suitable eye bolts shall be provided for lifting each individual panel by means of slings. The enclosure shall be completely vermin proof with special regard to dangers of flashover both in service and isolated position.

The enclosure and the breaker shall be completely de-rusted and degreased. It shall be given a priming coat of zinc chromate and iron oxide or any other equivalent.

The following instruments shall be installed on the WAPDA incoming panel and it shall be manufactured as per WAPDA standard specification P44:87.

i) One voltmeter 0-12 KV range, moving iron spring controlled in a pressed steel case.

ii) One ammeter of suitable range conforming to the C.T ratio, moving iron, spring controlled in pressed steel case.

iii) One voltmeter phase selector switch.

iv) One ammeter phase selector switch.

v) One KWH meter with M.D.I.

vi) One KVARH meter.

vii) One IDMT relay.

The following instruments shall be installed on the outgoing panels for the transformers.

i) One voltmeter 0-12 KV range iron, moving spring controlled in a pressed steel case.

ii) One ammeter of suitable range conforming to the C.T. ratio, moving iron, spring controlled in pressed steel case.

iii) One voltmeter phase selector switch.

iv) One ammeter phase selector switch.

v) IDMT relay.

vi) Auxiliary relay, single pole for BUCHHOLZ relay protection.

The indicating instruments shall be flush mounted back connected, dust proof with a transparent dust proof cover. The dials shall be white with permanent, black graduations.

The instruments shall be manufactured and tested in accordance with IEC Publication 51.

The panel or the switch board as described in the Bill of Quantities shall be delivered complete at site ready wired complete with name plate, designation labels, circuit labeling the small wiring shall be tested at 2000 Volts D.C.

The following data shall appear on the name plate of each circuit breaker.

i) Manufactures name and Address.

ii) Manufacture's type, designation and serial number

iii) Year of Manufacture

iv) Owner's Identification Mark.

v) Standard to which Manufactured.

vi) Rated Voltage.

vii) Rate Frequency.

viii) Rated Normal Current.

ix) Rate Impulse Withstand Voltage.

x) Symmetrical Breaking Capacity.

xi) Asymmetrical Breaking Capacity.

xii) Rated short time Current.

xiii) Making Capacity.

xiv) Rated Operating Duty.

xv) Total Break Time at rated Breaking Current.

xvi) Control and Tripping Voltage

74.1 MATERIAL RATE

Pay Item No	Description	Unit of Measurement
74.1 a i	**MAIN LT PANEL** Supply, Installation & Commissioning of sheet metal clad totally enclosed free standing, front excess Main Panel Board (MPB) from approved manufacturer, frames fabricated from 14 SWG M.S. sheet steel de-rusted phosphate & with electrostatic paint of approved color, and suitable for system voltage 400/230,50 Hz., 3 phase & Neutral bus bars (Rated as per incoming breaker) of 99.99% electrolytic copper conductor. Earthing link, Internal wiring. Incoming breaker of 1250 Amp T.P ACB with outgoing breakers of 4-100Amp T.P MCCB, 6-250amp T.P MCCB & 3-400amp, T.P MCCB,3 no. indication lights, CT's, Voltmeter, ammeter and volt selector switch, All MCCBs shall be installed such that knobs are	NO

	projected outside the front door. The switch board shall be equipped with following air circuit breakers/moulded case circuit breakers rated at 50 ºC of specified breaking capacity ICS=ICU. Shop drawings shall be submitted by the contractor for approval before the manufacture of all distribution equipment. All breakers & instrumentation and other materials shall be of approved make. complete in all respects.	
74.1 a ii	Supply, Installation & Commissioning of sheet metal clad totally enclosed free standing, front excess Main Panel Board (MPB) from approved manufacturer, frames fabricated from 14 SWG M.S. sheet steel de-rusted phosphate & with electrostatic paint of approved color, and suitable for system voltage 400/230,50 Hz., 3 phase & Neutral bus bars (Rated as per incoming breaker) of 99.99% electrolytic copper conductor. Earthing link, Internal wiring. Incoming breaker of 630 Amp T.P MCCB with outgoing breakers of 2-100Amp T.P MCCB, 3-250amp T.P MCCB & 1-400amp, T.P MCCB.,3 no. indication lights, CT's, Voltmeter, ammeter and volt selector switch, All MCCBs shall be installed such that knobs are projected outside the front door. The switch board shall be equipped with following air circuit breakers/moulded case circuit breakers rated at 50 ºC of specified breaking capacity ICS=ICU. Shop drawings shall be submitted by the contractor for approval before the manufacture of all distribution equipment. All breakers & instrumentation and other materials shall be of approved make. complete in all respects.	NO
74.1 b	Supply, Installation, Testing & Commissioning of SF6 Outdoor type 4-way RMU Switchgear panels will be of metal clad, free standing construction, suitable for operation on 11KV 3 Ph, 50 Hz, AC earthed system and fabricated from sheet steel, with powder coat finish painting of shade RAL 7032. The RMU panel shall contain components as mentioned below, complete with busbar inter connections control wiring designation labels, caution labels, sealing and pad locking facilities and wherever necessary space provision for entry of HT cables & separate control cable from the bottom through detachable gland plates as per requirements and specifications.	NO
74.1 c	Design, Manufacture, Transport, Leading, Positioning, Erecting, Earthing, Testing and Commissioning of Outdoor type 11KV 630A Single panel VCB with necessary fixing accessories, protective devices and metering with PT & CT and suitable for bottom cable entry and as per the technical specifications.	NO
74.1 d i	Supply, Installation and Commissioning of recessed wall mounting type Distribution Boards from approved manufacturer fabricated from 16 SWG sheet steel with electrostatic paint of approved color and with back box, comprising of incoming 3 phase moulded case circuit breakers or earth leakage circuit breakers (as specified)	NO

	and outgoing single phase Miniature circuit breakers (having magnetic & thermal trip devices) as given below, complete with internal wiring earthing, neutral link, termination blocks and cable chamber at the top of the DB. Each D.B. All breakers & instrumentation and other materials shall be of approved make.	
74.1 d ii	Supply, Installation and Commissioning of recessed wall mounting type Distribution Boards from approved manufacturer fabricated from 16 SWG sheet steel with electrostatic paint of approved color and with back box, comprising of incoming 3 phase moulded case circuit breakers or earth leakage circuit breakers (as specified) and outgoing single phase Miniature circuit breakers (having magnetic & thermal trip devices) as given below, complete with internal wiring earthing, neutral link, termination blocks and cable chamber at the top of the DB. Each D.B. All breakers & instrumentation and other materials shall be of approved make.	NO
74.1 d iii	Supply, Installation and Commissioning of recessed wall mounting type Distribution Boards from approved manufacturer fabricated from 16 SWG sheet steel with electrostatic paint of approved color and with back box, comprising of incoming 3 phase moulded case circuit breakers or earth leakage circuit breakers (as specified) and outgoing single phase Miniature circuit breakers (having magnetic & thermal trip devices) as given below, complete with internal wiring earthing, neutral link, termination blocks and cable chamber at the top of the DB. Each D.B. All breakers & instrumentation and other materials shall be of approved make.	NO
74.1 d iv	Supply, Installation and Commissioning of recessed wall mounting type Distribution Boards from approved manufacturer fabricated from 16 SWG sheet steel with electrostatic paint of approved color and with back box, comprising of incoming 3 phase moulded case circuit breakers or earth leakage circuit breakers (as specified) and outgoing single phase Miniature circuit breakers (having magnetic & thermal trip devices) as given below, complete with internal wiring earthing, neutral link, termination blocks and cable chamber at the top of the DB. Each D.B. All breakers & instrumentation and other materials shall be of approved make.	NO
74.1 d v	Supply, Installation and Commissioning of recessed wall mounting type Distribution Boards from approved manufacturer fabricated from 16 SWG sheet steel with electrostatic paint of approved color and with back box, comprising of incoming 3 phase moulded case circuit breakers or earth leakage circuit breakers (as specified) and outgoing single phase Miniature circuit breakers (having magnetic & thermal trip devices) as given below, complete with internal wiring earthing, neutral link, termination blocks and cable chamber at the top of the DB. Each D.B. All	NO

	breakers & instrumentation and other materials shall be of approved make.	
74.1 e	Supply, Installation, Commissioning & Testing of Consumer Metering Panel 11KV Complete in all Respects..	NO
74.1 f	Supply, Installation & Commissioning of sheet metal clad totally enclosed free standing, front excess PFI Panel Board from approved manufacturer, frames fabricated from 18 SWG M.S. sheet steel de-rusted phosphate & with electrostatic paint of approved color, and suitable for system voltage 400/230,50 Hz., 3 phase & Neutral bus bars (Rated as per incoming breaker) of 99.99% electrolytic copper conductor. Earthing link, Internal wiring. All breakers & instrumentation and other materials shall be of approved make. as per design.	NO

SECTION 75 POWER TRANFORMER

75.1 GENERAL

Three Phase Power Transformers for indoor use having transformation ratio of 11000/400 volts at frequency of 50 Hz and KVA rating as given in the Bill of Quantities shall be supplied and erected by the Contractor.

The Transformers shall be manufactured, supplied and tested in accordance with the following standards:

i) British Standard 171/1959-Power Transformers.

ii) British Standard 358/1959-Measurement of Voltage with sphere gaps.

iii) British Standard 923/1940-Impulse voltage testing.

iv) British Standard 2757/1964-Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service.

v) I.E.C Publication 76-Recommendations for power Transformers.

vi) I.E.C Document 14 (Sec.) 53.

vii) I.E.C Document 14 (Sec.) 54.

viii) I.E.C Document 14 (Sec.) 55.

ix) I.E.C Publication 60-High Voltage test techniques.

The transformers shall be oil immersed type with core and windings immersed in natural mineral oil. The core shall be of a laminated construction make of high grade electric steel sheet rigidly packed and free of vibrations due to frequency and stresses.

The windings shall be uniformly insulated. The thermal class of insulating material shall be Class-A. Test voltages shall be based on highest of the system voltage i.e. 12 KV. Power frequency voltage shall be 28 KV and impulse voltage to be 95 KV. The wave being 1/50 micro-seconds.

The insulation to earth of the winding shall be uniform.

The limits of temperature rise above ambient of the windings, cores and oil shall be as under:-

Winding-	50 Degree Centigrade
Core -	50 Degree Centigrade
Oil-	40 Degree Centigrade

The transformer shall be designed and constructed to withstand, without damage, the effects of short circuit of magnitude equal to 25 times the symmetrical RMS value of valid current for 2 seconds.

The transformer shall be capable of withstanding, without damage on any tapings, under service conditions, the electromagnetic forces arising under short circuit conditions as determined from the symmetrical peak value of the current in the

winding which shall be taken as not greater than 2.55 times the over current derived.

The transformer shall be capable of withstanding without damage to any tapings under service conditions the thermal effects of a short-circuit at the terminals of any winding for 2 seconds.

The transformer shall be provided with regulating taps. The adjusting taping shall be +2, -1%, normal, -2.5%, -5% and -7.5%. The tapings being located on the higher voltage winding.

Tap changing shall be affected by means of an externally operated off circuit switch capable of being locked in position. It shall be accessible with safety.

When tapping are used to compensate for variation of voltage, the transformer shall be capable of operation at its rated KVA capacity on any tapping without injury. The tap changing gear shall be capable of carrying the same currents, due to external short circuit.

The method of cooling shall be natural air; the method of circulation of oil shall be by natural thermal head and would be indicated by symbol on the transformer.

The primary windings shall be “delta” connected and the secondary winding shall be “Star” connected internally. The star point shall be brought out as neutral. The internal connections shall be clearly indicated on the name plate together with tap changing connection. The vector group DY 11 of the transformer shall also be indicated one the same name plate.

The transformer tank shall be of welded construction make of high grade steel plate. It shall have either a finned external construction or tubular construction to facilitate the natural air cooling.

The tank shall be tested for any leaks by any of the following methods:-

i) Compressed Air Test.

ii) Oil Water Pressure Test

iii) Penetrating Liquid without Pressure

An oil conservator tank fitted with a dehydrating breather and oil level indicator shall be internally fitted to the transformer tank.

The complete assembled tank shall be tested to withstand without deformation or leakage a pressure of 15 psi (1.05 Kg/sq.cm).

The tank finish shall be battleship grey colour. The paint shall be highly resistant to the effects of high temperatures and shall have a ling life under the normal working conditions. As a minimum it shall consist of a priming coat and two finish coats applied after complete de-rusting and degreasing of the tank. The thickness of the paint shall not be less than 0.12 mm.

The oil level indicator shall be visual glass type with minimum oil level marking at 30 degree centigrade and with two additional marks “Empty” and “Full” to be provide. These corresponding to the upper and lower temperatures for which the transformer is required to operate on site.

Compound filled cable and boxes for 3 core P.I.L.C. or XLPE cable on H.T. side and 3-½” core PVC/SWA/PVC cable Bus Tie Duct on L.T side shall be provided for connecting the transformer to relevant switchgear. Arrangement for solidly grounding the neutral shall be make.

The following routine tests shall be carried out on the transformers in the presence of the Engineer.

i) Temperature Rise Test

ii) Impedance Test.

iii) Ratio and Phase angle test at one Standard Load.

iv) Dielectric Test of Low Frequency.

A certified copy of a complete type tests carried out on an identical transformer shall accompany each transformer failing which the Contractor shall make arrangements to carry out these tests in the presence of Engineer without any extra expense to the Owner.

The following fittings shall be provided with each transformer.

i) Rating Plate.

ii) Terminal Marking Plate.

iii) Lifting Lugs.

iv) Earthing Terminals for Tank.

v) Oil filling hole and plug.

vi) Oil level indicator.

vii) Drain value with built-in sampling device.

viii) Conservator.

ix) Air Vent.

x) Dehydrating Breather.

xi) Dial type thermometer with maximum temperature indicator.

xii) Double Float Buchholz Relay complete with auxiliary relay on the panel.

xiii) Steel Rollers with rolling direction parallel to the longer side.

The rating plate shall carry the following information:

i) Manufacturer's Name.

ii) Manufacturer's Serial Number.

iii) Year of manufacture

iv) Owner's Identification Mark.

v) Rated KVA.

vi) NO of Phases.

vii) Frequency.

viii) Rated voltage at no load (Higher Voltage/Lower Voltage).

ix) Percent impedance voltage.

x) Rated current (Higher Voltage/Lower Voltage).

xi) Winding connections and phase displacement symbols of vector diagram.

xii) Type of cooling.

xiii) Total weight of the transformer.

xiv) Total quantity and weight of the oil.

xv) Weight of core and winding assembly.

The terminal making plate shall carry the following information:-

i) Vector Group Symbol.

ii) Winding connections of high voltage and low voltage sides.

iii) Tapings with subscripts.

iv) Voltage ratios at various tapings the lower voltage being kept constant.

v) Rated Current (Higher Voltage/Lower Voltage).

Letter ABC shall be used for the high voltage side and a b c shall be used for low voltage side.

The transformers of the ratings as given in the Bill of Quantities shall be supplied, tested erected and commissioned under this Contract and shall be complete in every respect with first filling of dehydrated mineral oil specified hereinafter.

75.2 MANUFACTURER

The transformers shall be of make from approved manufacturers list.

75.3 OIL FOR TRANSFORMERS

Oil for transformers shall conform to British Standard 148.

Insulating oil shall be mineral Insulating oil obtained from fractional distillation of crude petroleum, refined specially for use as an insulating and cooling medium in oil immersed transformers.

It shall be free from water, sediments, foreign materials, and petroleum fractions which may be injurious to equipment or any of its components, such as insulation, paint, varnish and metallic or other parts. It shall be free of synthetic material of all types.

An inhibitor 2, 6-ditertiary-butyl-para-cresol (DBPC) at a concentration level of 0.2 to 0.3%, which increases substantially the resistance to oxidation at high temperatures encountered in service shall be added and the requirements of BS 148 shall be modified when inhibitor is used.

For satisfactory service of the equipment the oil dielectric strength above 40 KV will not be required when tested according to BS 148.

75.4 **MATERIAL RATE**

Pay Item No	Description	Unit of Measurement
75.4 a	Supply, installation, commissioning, and Testing of Pad Mounted Transformers 1000KVA, 415 rated volts, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detail etc. complete in all respects.	NO
75.4 b	Supply, installation, commissioning, and Testing of Pad Mounted Transformers 630KVA, 415 rated volts, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detailetc. Complete in all respects..	NO
75.4 c	Supply, installation, commissioning, and Testing of Pad Mounted Transformers 400KVA, 415 rated volt, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detail etc., complete in all respects..	NO
75.4 d	Supply, installation, commissioning, and Testing of Pole Mounted Transformers 200KVA, 415 rated volt, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detail etc. complete in all respects.	NO
75.4 e	Supply, installation, commissioning, and Testing of Pole Mounted Transformers 100KVA, 415 rated volt, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detail etc. complete in all respects.	NO
75.4 f	Supply, installation, commissioning, and Testing of Pad Mounted Transformers 1250KVA, 415 rated volt, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detail etc. complete in all respects.	NO
75.4 g	Supply, installation, commissioning, and Testing of Pole Mounted Transformers 50KVA, 415 rated volt, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detail etc. complete in all respects.	NO
75.4 h	Supply, installation, commissioning, and Testing of Pole Mounted Transformers 25KVA, 415 rated volt, 50 Hz as per WAPDA standard (Amendment-5) i/c termination kits including Earth & Foundation as per detail etc. complete in all respects.	NO

SECTION 76 EXTERNAL LIGHTING

76.1 SYSTEM

Road lighting shall be carried out with pole mounted lighting fixtures of GL/PLACE/HP/SODIUM or fluorescent tube as shown on the drawings and indicated in the BOQ. Lighting cables shall be split concentric cables/multicore armored or unarmored as shown in drawing and BOQ and shall be laid as specified in LT cables. The control gear for road lighting shall be mounted in the substation/ SMSB/DB for a three or single phase control of lighting.

76.2 Materials

76.2.1 POLES

i. Poles, mild steel tubular poles complying with ASTM-A501 shall be installed suitable for a safe load of 145 Kg and dimensions as shown on the drawings. The thickness of the bottom section shall be 5mm $\pm$ 10% while the entire pole shall have a tolerance of $\pm$ 25mm for overall length and $\pm$ 1% for outside diameters. Various stepped sections shall be welded with complete penetration and backing and shall jointed off to give a smooth surface. Provision shall be made in the bottom to house a terminal box and cable entry as shown on the drawings. Any damage to primer coat during transport shall be made good and the length to be buried shall be given a bitumen coating. Poles hall be installed in excavated holes with poured in-situ PCC 1:2:4 foundations. After installation the entire length above ground all hardware shall be given two coats of aluminium paints.

ii. If Pole is to be Galvanized by Zinc Coating, it will be coated from inside and outside as per ASTM A-53 Standard. The minimum weight of coating shall not be less than 0.55 Kg/sqm. Zinc for galvanizing shall conform with ASTM B-6

iii. Terminal box of dimensions 6”x6”x4” made of 16 SWG sheet steel with water proof cover having suitable size connection of cables, and shall have PVC connectors, & 1 NO 6 A SP MCB.

iv. LT cables as specified earlier shall be used for street lighting, of sizes as shown on drawings, while PVC/PVC three core 1.5sqmm cable shall be used to connect the lighting fixture to the terminal box.

76.2.2 LIGHT FITTINGS

i. Light fittings the road lighting fixtures shall be light weight housing having clear acrylic/glass cover, sealed with watertight cover shall be insect and vermin proof. The fittings shall be complete with all accessories like choke, starter, capacitor, holder, reflector and MERCURY/SODIUM lamps, and the housing shall be stove enameled white from inside and gray form outside, post top lamps shall be decorative GLS/HPMV lamp and all accessories as specified above with canopy, shade/globe.

ii. Control gear, road lighting shall be controlled through and installed with a photo electric switch F.P comprising incoming TP MCCB triple pole air break magnetic contactor having auxiliary contacts and continuous rating type, a test switch and control fuses.

76.2.3 INSTALLATION

The top section of the pole shall be arched to give requisite overhang and shall receive the lighting fixture directly with suitable spigot for lateral mounting. At the foot of each pole the terminal box shall be embedded in the concrete as shown on drawings suitable to receive incoming and outgoing cables and for connection to the light fittings through a 5 Amp fuse 6 A SP MCB.

Post top lamp shall be installed on G.I poles in such a manner that fitting is firmly secured on its top.

The cable shall be raised from the trench to the pole in a 20mm dia. G.I. pipe having suitable wooden bushes to prevent damage to cable by sharp edges.

76.3 MATERIAL RATE

Pay Item No	Description	Unit of Measurement
76.3 a	Supply, installation, commissioning and testing of Street light, Fixture with --- Watts LED Lamp, with all necessary fixing accessories, complete in all respects..	
	i. 30 W	NO
	ii. 100 W	NO
	iii. 120 W	NO
	iv. 200 W	NO
76.3 b	Supply installation, commissioning and testing of Flood LIGHTS, Fixture with --- Watts LED Lamp, with all necessary fixing accessories, complete in all respects	
	i. 50 W	NO
	ii. 80 W	NO
	iii. 200 W	NO
76.3 c	Supply, installation, commissioning and testing of High Bay, Fixture with --- Watts LED Lamp, with all necessary fixing accessories, complete in all respects.	
	i. 50 W	NO
	ii. 70 W	NO
	iii. 120 W	NO
76.3 d	Supply, installation, testing and commissioning of Hot dip Galvanized single Arm Step sectional Tubular / Octagonal / Hexagonal pole, pole shall installed per made RCC foundation with of all necessary fixing accessories, complete in all respects	
	i. 10 meter	NO
	ii. 12 meter	NO
76.3 e	Supply, installation, testing and commissioning of Hot dip Galvanized, double Arm Step sectional Tubular / Octagonal / Hexagonal pole, pole shall installed per made RCC foundation with of all necessary fixing accessories, complete in all respects	
	i. 10 meter	NO
	ii. 12 meter	NO
76.3 f	Supply & Installation of weather proof incandescent light fixture comprising of die-cast aluminum body with front glass cover fixed to the body by means of stainless steel screws and neoprene gasket, G.I. wire guard, 1 no, 100W lamp including all installation materials.	NO
76.3 g	Supply & installation of mercury vapor light fixture with 125W lamp, ballast starter including suspension rod with fixing arrangement, complete in all respects.	NO

SECTION 77 LIFTS / ELEVATORS

PASSENGER LIFTS SHALL HAVE THE FOLLOWING SPECIFICATIONS: FIRE RATING E-120, IN ACCORDANCE WITH EN 81.58

Type:	Passenger MR Traction Lift
Capacity:	As Specified in BOQ
Machine Room:	Above the shaft
Stops:	As per number of Floors shown in drawings/BOQ
Entrance:	In line, no. of entrances as per drawings/BOQ
Travel:	As per number of Floors and inter floor height
Overhead:	4.0 meters
Pit:	1.25 meter
Rated Speed:	1.6 m/sec VVVF
Car (Cabin) door:	One (1) fully automatic VVVF 2- panels. Size 800mm x2100mm, Central opening. The panels finish in Hairline /Mirror/ Satin /Brushed Stainless Steel, as approved by the Consultant
Landing door:	Fully automatic VVVF 2- panels. Size 800mm x 2100 mm, Central opening. The panel finishes in Hairline /Mirror/ Satin/ Brushed Stainless Steel, as approved by the Engineer.
Car (Cabin) Type:	Hairlines Stainless Steel Finish (HSS) or as per approval of the Engineer. Size 1400 mm (Width) x 1100 mm (Depth) x 2300 mm (Height).Wall Panels, Corner and Finishes in Hairline /Mirror/ Satin/ Brushed Stainless Steel. Granite Floor Tiles, Ceiling in Hairline / Mirror/ Satin / Brushed Stainless Steel. Hand Rail in HSS/MSS finish on 3 sides. Lighting indirect with fluorescent lamps. Half Height/ Full width Mirror at rear wall. Ventilation Fan. Light Curtain at car entrance, as approved by the Engineer.
Car // CW Guide Rails:	75mm x 52 mm x16 mm // 50mm x50mm x05mm
Roping:	2:1
Motor:	Imported European Union / USA / Japan make of power capacity as per manufacturer's recommendations.
Ropes // Pulley:	6 x 8 mm dia // 320 mm dia, as per manufacturer's drawing.
Controller:	Microprocessor for full collective selective operation.

SIMPLEX OPERATION. VVVF CONTROLLED

Car Operating Panel:	Column panel in HSS/MSS. Call button with call registration. Alarm Buttons. BCD display LCD indicator. Door open and close buttons. Door hold key. Overload luminous and acoustic. Fan Switch. Light Switch. Car preference key, as approved by the Engineer
Landing push buttons:	Mounted on HSS/MSS Stainless Steel. Buttons with call registration. Arrows on all floors. Dot Matrix display Indicator on all floors, as approved by the Consultant.
Additional Items:	Pit ladder, Pre-assembled Pre-wring, Expansion Bolts, Extra emergency light in the cabin. Extra Key Switch – Fire Alarm Interface, Voice Announcement, Electronic overload, 2-Tone Arrival Gong, Electronic emergency operation for Cabin and Doors (UPS system), Earthquake Sensor

77.1 GENERAL

77.1.1 RELEVANT STANDARDS

All materials and workmanship shall comply with BS 2655, BS 5655, BS 5656, the European Norms EN 81-1, ANSI and ISO 4190/ISO 7465, and other Standards stated in other clauses of this Specification, or approved equivalent. The lifts and all products shall conform to the latest techniques and standards.

77.1.2 GENERAL REQUIREMENTS

The lifts shall be fully imported brand new and composed of all brand new material and components, and shall generally conform to the Specifications and requirements given in the Schedule of Technical Particulars and will be designed to give smooth and accurate control of lift speed. Indication and finishes shall be provided as outlined, while complete details of the inside finishes shall be provided with the tender for selection and approval of the Engineer.

Lift/Elevator Wells, Walls, Pits, Floor levels, and other constructions etc. are being provided by building contractor, as per Tender drawing. It shall be the responsibility of the Lifts Contractor to check and accommodate for size, alignment or verticality accuracy; and to ensure that his installation is perfect.

77.1.3 LOCAL MATERIAL ETC.

The contractor shall also provide all local materials necessary to complete the installation like following:-

i) Cutting necessary holes in the machine room slab, in case the Contractor fails to supply for any reason the sizes and locations of holes before pouring of slab, including those for ropes.

ii) Cutting holes for fixing guide brackets.

iii) Providing & fixing of steel partition beams/Girders in the common shaft.

iv) All finishing work after fixation of doors, thresholds, panels etc.

v) All concrete foundations for buffer in the lift pit, and providing step-ladder & light.

vi) All electrical interconnections for power, control and interlocking between main switch and control panels of the lifts.

vii) All other materials including steel beam, hooks etc. for hoisting in machine room, concrete pads and foundations etc. specified in other clauses of this Specification and as required for complete installation and functioning of the lifts.

77.1.4 SPECIAL TOOLS AND INSTRUMENTS

These shall be new and of imported quality and will not be used for installation, testing, and maintenance of the lifts.

77.1.5 OPERATION AND MAINTENANCE INSTRUCTION MANUALS

The Contractor, before submitting his statement at completion for payment, shall submit 4 sets of the necessary manuals, catalogues, literature and write-up covering the operation, maintenance and trouble shooting of the lifts covered by these Specifications to enable the Employer to operate, maintain, disassemble, reassemble and adjust all parts of the lifts.

77.1.6 SCAFFOLDING, RIGGING AND HOISTING

The Contractor shall furnish fix and remove after installation all scaffolding at no additional costs to Employer as required for the installation of his work. Contractor shall either arrange with the Building contractor for any rigging and hoisting required or provide his own equipment to hoist apparatus to be installed by him into place. The Contractor shall see that any equipment too large to permit passage through normal doorways and access ways is brought to the job and set in place before the spaces are enclosed. All apparatus not delivered in this manner shall be disassembled and reassembled in the proper location. Equipment specified to be factory assembled and tested prior to shipment shall not be disassembled for shipment to and installation into the building.

77.2 SYSTEM

77.2.1 GENERAL

The lifts shall be fully automatic. The lifts should be equipped with Automatic landing feature at nearest floor with dry charge battery supplied by the manufacturer of the lifts.

Control equipment shall be suitable to operate at local conditions of temperature and humidity, which are 50^{o} C and 80% maximum relative humidity. Materials shall be as generally specified herein and shall be of best quality imported and pre-assembled.

Lift control and operation shall be suitable for 400 volt, 3 phase, 4 wire, 50 Hz AC power supply.

77.2.2 MACHINE ROOM

Machine room(s) of sizes shown on the drawing(s) has been provided vertically above the lift wells, for the lift machinery and main control and power panels. Slab above lift well is elevated to accommodate the equipment placed on top of the car. The Contractor has to accommodate the lift machinery and allied equipment in the area provided, and himself makes all arrangements of entering the equipment and hoisting it to the machine floor, and if necessary cut holes &make good, as

approved by the Engineer. All structural steel partition beams between comportments of two Lifts, or channels etc. shall be furnished by the Contractor along with necessary bearing plates and shall be securely fastened to the supports. If alternate arrangement is desired, it shall be clearly stated with the tender and no subsequent changes shall be allowed.

Other contractor will install the main power lines up to the designated point from where further distribution shall be the responsibility of the Contractor. The terminal point of the bus trunking or cable shall be coordinated at Site with other contractor. The incoming switch in the lift power panel shall be suitable to receive the required size of PVC/PVC cable. The Distribution Boards, Lift power panel and the cables interconnecting these two will be provided and installed by the Lift Contractor. However, the cable up to the designated point will be provided and installed by Employer/other contractor.

The access to the machine room shall be normally from staircase in the service core coming out on the roof. However, a trap door shall be provided above the lift well defined by the Lifts Contractor for hoisting the lift machine, of a size appropriate for the purpose, and the slab opening size shall be conveyed to the Engineer accordingly.

77.2.3 LIFT WELL AND PIT / HOISTWAY

Lift well(s) of size(s) as shown on the Tender drawing have already been provided at site. These will be divided into compartments, if more than one car is to be installed, isolated by I-Beams to be supplied and installed by the Contractor. All structural steel partition beams or channels shall be furnished by the Contractor alongwith necessary bearing plates and shall be securely fastened to the supports. The cars to be supplied by the Contractor shall have to be accommodated in lift well(s) of the size constructed. The hoist way shall be provided by the Building contractor reasonably plumb. The Contractor will, however, be responsible to carry out corrections for the purpose of installation of guide rails in perfect plumb.

Lift wells have been extended to a depth indicated on the drawings to form lift pits and shall accommodate buffers with their foundations for the car and counter weights. The Contractor shall provide the foundations, a step ladder and an inspection light point in the pit.

7.2.4 BUFFERS

Oil type Buffers for Lift(s) shall be provided in the pit under each lift car and their counterweights. The minimum total stroke of an oil buffer on 115% of the specified speed shall provide an average retardation of 9.75 m/sec2 and max. of 24.5 m/sec2. The oil buffer shall be self resetting type and any oil displacement during the operation shall be contained within the buffer. An oil level indicator shall also be provided to ascertain the presence of adequate oil in the buffer.

77.2.5 LANDING DOORS

All landing openings in the lift well(s) shall be protected by doors which shall extend the full height and full width of the opening. The top track of the landing door shall not obstruct the entrance to the lift car. Each landing shall have anti-skid toe guard embedded in the floor.

Centre opening landing doors of the sliding type, of flush panel construction, with a finish as specified or approved by the Employer/Engineer, shall be provided together with ornamental architraves, made of stainless steel or anodized to an approved colour. The landing doors shall have two points suspension hangers, prelocking safety device and will be complete with heavy threshold metal plates fixed on each landing level to support steel work. To prevent closure or determine immediate reopening of doors while closing, should a passenger be between them,

infra-red light full height photo electric cell safety device shall be installed with solid state emitter so as to be unaffected by vibrations or ambient light.

Landing doors shall be capable of withstanding a thrust of 36.76 kg applied normally at any point without causing any permanent deformation and without doors being sprung from their guides. They shall have a fire resistance rating of at least one hour.

It shall be possible to open the landing door by hand at any landing at which the car is at rest or by an authorized person by an emergency key irrespective of the position of the car in the event of failure of power operated mechanism.

77.2.6 CAR FRAME AND PLATFORM

The car frame shall be of welded or bolted steel channel construction and the walls of the car shall be of sufficient mechanical strength and rigidity so as not to suffer any permanent deformation through application of a force of 300 N at any point distributed over an area 0.0005m2 and the elastic deformation shall not be more than 1.5 mm. The car roof shall be so constructed as to withstand weight of 3 persons i.e. resist a vertical force of 2400 N at any position without any deflection. At least four renewable guide shoes, or of renewable lining or roller guides shall be provided, 2 at the top and 2 at the bottom of the car frame.

The platform shall be of structural steel securely fastened or welded together and shall be isolated from the body by rubber blocks to offer vibration free travel. The heavy duty metal floor shall be painted with fire resistant paint. Floor shall be covered with granite tiles 3/4" thick in pattern, or heavy duty S.S. metal floor acceptable to the Engineer.

The car frame shall also have at the top and bottom the following:

i) Socket outlet 3-pin 5 Amp with wiring

ii) Light point with 60 Watt GLS lamp.

Emergency trap door shall be provided on the roof having an area of at least 400x500mm. The emergency door must be provided with voluntary means of locking and must be provided with an electrical locking system. Safety switch for hoisting ropes and floor selector rope must be provided.

77.2.7 CAR BODY

The car shall be provided with walls/enclosures, roof, ceiling, doors and necessary fixtures and furnishings. Car enclosure shall be secured to car frame floor in a manner that it cannot work loose or become displaced in normal usage, and should be able to withstand a thrust of 36.76 KG applied normally to any part.

The walls shall be of Brushed Stainless Steel and Plastic laminated sheet and as shown in Schedule of Technical Particulars or as approved by the Engineer and 6" high recessed kick plate of anodized aluminium with hollow rectangular handrail of burshed stainless steel on three walls.

The suspended ceiling shall be in injection moulding polystyrene supported by a black baked enamel steel frame or in stainless steel. Depth of grid ceiling shall be 125mm below the ceiling of the car, as per approval of the Engineer.

The car shall be furnished with the following accessories:-

i) Mirror on rear wall in suitably finished frame, of full width and height of car wall above railing.

ii) Single speed fan above suspended ventilation ceiling grid to promote air movement in the car.

iii) Fluorescent lamps for sufficient illumination located above the suspended ceiling.

iv) Rounded Handrail at 3 walls of the cabin.

77.2.8 CAR DOORS

The car doors shall extend to the full height and width of the car opening. The top track of the door shall not obstruct the car entrance.

Automatic power operated doors of centre opening type of pressed sheet and hangers with polyurethane types shall be installed. The door panels shall be guided on top and bottom and the top guide shall be minimum 15mm wide and 60mm deep. The factor of safety of the door panel suspension shall be at least 8. Door operating motor shall be AC with 2 speed or DC motor with variable speed regulation. Electro-mechanical pre-locking safety shall be provided to ensure that doors do not open when lift is in motion or lift will not move if doors are open.

Every door shall be provided with electric switch which will prevent the lift car from being started or kept in motion unless all doors are closed. The contacts on such switches shall open positively independent of gravity. It shall not be possible, under normal conditions, to open a car door when the car is in motion. The car doors shall be considered in the closed position when the leading edge of the door is within 60mm of each other.

Hangers and tracks for doors together with their fixings will be of adequate strength and rigidity. Means shall be provided to prevent all sliding doors from jumping the tracks and suitable stoppers shall be provided to prevent the hanger carriage from leaving the end of the track.

In case of interruption of electric supply or breakdown in door operating circuit, provision shall be made to open the door manually with a key when the car is standing at a landing. Doors shall open automatically after the stops at a landing and close after predetermined interval of time.

77.2.9 CONTROL PANELS

A control panel inside the car shall be provided with a flush type face plate on the front panel column and shall have the following controls:

i) Illuminated push buttons for various floors with built in registration of calls.

ii) Push buttons for quick opening & closing of doors

iii) Push button for emergency stop.

iv) Alarm push button

v) Switches for light and fan.

vi) Car Call preference key switch to prefer car calls.

vii) over load device with pilot signal.

viii) Full load device with pilot signal.

ix) Speaker point (connected with public address system)

Immediately below the car panel, a telephone compartment with a face plate of the same width shall be provided. The face plate shall be 22mm thick, of stainless

steel, on which the sign of the telephone receiver shall be provided. Call buttons shall be provided for this intercom connection with the Telephone Exchange room, main lobby as well as the machine room, and necessary wiring to the three locations shall be carried out by the Contractor.

A digital indicator with directional arrows indicating the number of the floors on which car has passed/stopped should be positioned on top of the car control panel.

Each landing except to and bottom floor station shall have control panel comprising push buttons with stenciled arrow heads along with windows with illuminated arrows for initiation of up and down car demand signal. On extreme landing only one push button will be installed. On arrival of a car, the illuminated arrow in the direction of travel will extinguish itself and a concealed gong installed will simultaneously sound to announce the travel of car.

On all the floor stations, at the top on the front wall of the lift lobby, a horizontal position indicator will be installed to indicate number of floor on which car has passed/stopped. This floor shall also have the control panel for the car demand signal push buttons and illuminated arrows with gong.

The above signals and indications in the car and on landings shall be controlled from a control panel installed in the machine room. The entire electrical wiring for the indication and control shall be installed by the Contractor.

All signals displays for floors and in car shall be Digital.

77.3 ELECTRICAL FEATURES

77.3.1 LIFTING MACHINE

It shall be AC drive variable frequency and variable voltage type. An enclosed constant control of the acceleration and deceleration phases should be obtained, in addition the torque and speed in all conditions of operation giving smooth starting, suitable running speed which shall be independent of load variation, and smooth deceleration and stop with accurate leveling. The motor shall be tropicalised, insulated for Class E and suitable for operation on 400 V, 3-phase, 50 Hz AC system.

77.3.2 DOOR OPERATION

An electric contact will be provided for car door to prevent its movement unless the door is in the closed position. Car doors shall open automatically when car is stopping at a landing. Facility shall be provided to stop and reverse the door movement in case of electric failure. They should also be opening able manually from inside the car.

The door shall be fitted with an effective locking device so that it shall not normally be possible to open the door from the landing side unless the car or platform is in the landing zone. It shall also not be possible under normal operation to start the car or keep it in motion unless all doors are in the closed position locked.

The electrical and mechanical parts of all door locking devices shall be of robust construction. All door locking devices together with their associated actuating rods, levers or contacts shall be so situated or protected as to be reasonably inaccessible from the landing.

77.3.3 SELF LEVELLING

The lifts shall be provided with an automatic self-leveling feature which shall bring the car floor to level with the floor landing irrespective of the loading in the car. Details of the arrangement provided for the purpose shall be stated clearly by the tendered in the tender together with the extent of its operating efficiency.

77.3.4 CONTROLLER

A micro processor controller shall be installed to control the starting, stopping and the speed of the motor automatically and apply brake if any of the safety device operates. Shoe type brake of adequate dimension and strength shall be provided and shall be balanced by pressure adjustable springs under compression. The brake should be released by an electromagnet.

All control circuits shall be protected by MCCBs or MCBs and at no place blow-out type fuses are to be used. The motor should not be able to be energized against one or more phase failure or phase reversal. All contactors for reversing direction of car travel shall be electrically and mechanically interlocked.

The opening of the circuit to stop the elevator at the terminal floor shall not be dependent upon the direct operation of any spring or upon the completion of another circuit. No control system shall depend upon the completion or maintenance of an electric circuit for the interruption of the power supply to the hoisting motor and the application of the machine brake to stop the car either at the terminal floor or when an emergency stop switch or other safety device is operated.

The control circuit shall operate at 230 volts 1-phase AC and so arranged that an earth fault or open circuit or the discharge/failure of a capacitor shall not result in an unsafe condition.

No readily flammable material shall be used for the controller panel. All control wiring shall be of fire retardant type.

77.3.5 TERMINAL STOPPING AND FINAL LIMIT SWITCHES

The terminal stopping and final limit switches shall control at least two separate and independent contactors, two of which shall he closed to complete the motor and brake circuits for each direction of travel, unless the final limit switch opens the motor and brake circuit and its contacts are directly opened mechanically.

When mounted on the car frame or in the elevator well, switches shall be securely mounted in such a manner that the movement of the switch levers to open the contacts is in a direction approximately at right angles to a line drawn between the faces of the car guides.

Any cam used for operating these switches shall be of metal of sufficient length and so arranged that the switch is held in the open position when the elevator car is in contact with the overhead structure or is resting on the fully compressed buffers. The contacts of all terminal stopping switches shall be opened by positive mechanical means. Arrangements in which a spring or gravity or both opens the contacts by the withdrawal of a cam or similar device shall not be used.

Terminal stopping switches shall be arranged to stop the elevator car automatically from any speed attained in normal operation within the top clearance and bottom over travel, independently of the operating device, the floor stopping switch, the final limit switch and the buffers. An automatic safety switch shall be provided which will stop the machine should the tape, chain, rope or other similar device mechanically connecting the stopping device to the elevator car fails.

Final limit switches shall be arranged to stop the elevator car within the top clearance and bottom over travel independently of the operating device, the floor stopping switch and the terminal stopping switch.

Final limit switches shall be arranged to operate with the elevator car as close to the terminal floors as practicable without interfering with the normal operation of the lifts. When spring buffers are employed, the final limit switches shall be arranged to open their contacts before the buffer is engaged. Final limit switches shall be operated by the movement of the elevator car.

77.3.6 OPERATION

While an elevator car is travelling to a given landing it shall not be possible to interfere with its journey by pressing any landing button, except that with collective forms of control it is permissible to so stop the elevator car at any intermediate landing for the reception or discharge of passengers. Provision shall be made for a reasonable time lag between the stopping of the elevator car and its being restarted.

Electric operating devices whether mounted in or on the lift or in the elevator well shall be enclosed. No such button or switch that is intended to render the landing lock circuit ineffective shall be installed in the elevator car.

77.4 GENERAL SAFETY FEATURES

Notwithstanding anything contained to the contrary in this Specification elsewhere, following main Safety Features must be adhered to:

77.4.1 PROTECTIVE DEVICES

Following protective devices conforming to British Standards or equivalent shall also be installed.

i) A floor self-leveling mechanism to bring the car automatically to floor level by correcting the over-travel, under-travel or rope stretch.

ii) Buffers in lift well bottom to bring the car and counterweight to rest from governor tripping speed.

iii) Speed governor of centrifugal type to operate safety mechanism when the car speed is exceeded by 40% or when ropes slacken or break.

iv) Safety gear and governor ropes attached to car for excessive travel speed.

v) All cars when fully loaded shall by-pass intermediate calls.

vi) Emergency door opening from the shaft doors with special key/tool.

vii) Emergency door opening from inside car when within the landing zone.

viii) Car moveable from machine room to nearest landing in case of electricity failure.

77.4.2 SAFETY DEVICES

Following protective devices will also be installed;

i) incoming feeder to have a TP MCCB with adjustable thermal overload and instantaneous short circuit tripping and single phasing prevention features.

ii) All outgoing feeders to have automatic magneto-thermal switches and fuses for over current tripping device.

iii) Electromechanical locking device for landing door safety; safety bolt operated by a sliding shoe mounted on the car.

iv) Switch to enable manual operation during inspection and maintenance.

v) Intercom facility between the car and machine room (or as specified) having independent power source with necessary wiring and intercom sets.

vi) Emergency switch in car control panel and above car cage to stop car in emergency.

vii) Emergency exit/trap door on car top with interlock for car travel.

viii) Emergency light suitable for half hour with chargeable battery.

ix) Overload weighing device under floor with buzzer and interlock for door closure till load adjusted.

x) Door closing force limited by adjustable torque of door drive, along with retractable safety edge device and infra-red light barrier.

xi) A phase reversal protection relay will also be provided.

xii) An automatic Rescue Drive (ARD) shall be provided to allow the lift to travel to the nearest floor stoppage and lifts door would open automatically, in case of power failure.

77.5 MATERIALS SPECIFICATIONS

Materials used for construction of all components shall be of the best grade, free from any defect or imperfection, conforming to the latest specified standards. For all material purchased or fabricated by outside sources, the lift manufacturer shall ensure that these products are of recognized reputable manufacturers. The material and components shall generally comply with the following requirements:

77.5.1 MATERIALS

All materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused and of the classification and grades designated, conforming to the requirements of the latest issue of the appropriate Standard Specification cited herein. If the manufacturer desires to deviate from the Standards or Specifications designated or furnish material under equivalent standards and classifications, he shall submit a statement of the exact nature of the deviation, or equivalent standards, and shall submit for the approval of the Engineer complete Specifications for the materials which he proposes to use. All materials, supplies, and articles not fabricated by the manufacturer shall be the products of recognized reputable manufacturers. Unless otherwise specified the materials and components shall be in conformity with the following general requirements.

i) **STRUCTURAL STEEL**

Structural steel for structures not requiring welding shall conform to the requirements of ASTM Designation A7-66. Structural steel for structures requiring welding shall conform to the requirements of ASTM Designation A36-66T.

ii) **SHEET STEEL**

Sheet steel requiring welding shall conform to the requirements of ASTM Designation A366-62T, Specification for cold rolled carbon steel sheets, commercial quality, or to A415-64, Specification for hot rolled carbon steel sheets, commercial quality where no welding is required.

iii) **STAINLESS STEEL**

Where stainless steel is specified it shall be Austenitic 18-8 type, 304 type, with a content of 17% to 19% chrome, 8% to 10% nickel and maximum carbon content of 0.11%, Stainless steel shall be free from scale and all surfaces shall be polished to # 14 commercial finish, or to special finish as selected by Engineer.

iv) **GALVANIZED IRON**

Where galvanized iron is called for, it shall be galvanized on an 8% copper bearing alloy sheet, with an approved hot pure zinc galvanizing. Where galvanized iron has been welded, all seams shall be cleaned and scale removed and finished with a prime coat of aluminium paint. Galvanized structural steel, welded into sections of framing, racks, shelves, etc., shall be hot dipped after fabrication.

v) **WHITE METAL**

Where white metal is specified, a white metal commercially known as nickel silver casting is intended. Such metal to be of corrosion resistant quality to contain not less than 30% nickel. All castings shall be rough ground, polished and buffed to a bright lustre, free from pits, cold runs, checks, burrs or other surface imperfections. In lieu of 30% nickel alloy white metal casting herein specified, 18/8 stainless steel castings will be acceptable.

vi) **IRON PIPE**

Where iron pipe is called for, it shall be genuine wrought iron, fully galvanized. All threads are to be cleaned and coated with rust-resistant coating.

vii) **STAINLESS STEEL PIPE AND TUBING**

Wherever stainless steel pipe or tubing is specified it shall be seamless or welded, of gauge specified and of true roundness. Seamless tubing shall be thoroughly and properly annealed, pickled, ground smooth and finished to match adjacent work. Welded tubing shall be thoroughly heat treated, properly quenched to eliminate carbide perceptions, then drawn true to size and roundness and ground as required. All tubing where exposed to view, shall be given a final grind of not less than 180 grit emery.

viii) **STRUCTURAL STEEL SHAPES**

All angles, tees, channels or other structural shapes used for framing may be of local manufacture, uniform and ductile in quality, free of hard spots, runs, checks, or cracks or other surface defects. Where such sections are specified and galvanized or tinned, they shall be galvanized or tinned by the hot dip process, with all fluxes removed and in the case of galvanized, excess splatter blisters, uncoated or scaly patches.

ix) **CASTINGS**

a) STEEL CASTINGS

Steel castings shall conform to the requirements of ASTM Designation A148, specifications for High Strength Steel Castings for Structural purpose, Grade 80-50, or to the requirements of ASTM Designation A 27, Specifications for Mild to Medium Strength Carbon-Steel Casting for General Application Grade 70-40 or approved equivalent.

b) IRON CASTINGS

Iron castings shall conform to ASTM Designation A 48, Specifications for Gray Iron Castings, Class 50 or approved equivalent.

c) CORROSION RESISTING STEEL CASTINGS

Corrosion Resisting Steel Castings shall conform to ASTM Designation A296-72, Grade CE-3M, Specifications for Corrosion Resistant Iron - Chromium, Iron-Chromium-Nickel, and Nickel base Alloy Castings for general specification or approved equivalent.

x) **STEEL FORGINGS**

Except as otherwise specified for gears, all steel forgings shall conform to the requirements of ASTM Designation A 235, Specification for Carbon Steel Forgings for General Industrial Use, or to ASTM Designation A237, Specification for Alloy Steel Forgings for General Industrial Use. For gears, forgings shall conform to the requirements of ASTM Designation A290, Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears, or ASTM Designation A291, Specification for Carbon and Alloy Steel Forgings for Pinions and Gears for Reduction Gears or approved equivalent.

xi) **BRONZE**

Bronze for bushing, sleeve-type bearings and other lubricated wearing parts will conform to the requirements of ASTM B22, Specification for Bronze Castings for Bridges and Turntable, Copper Alloys No. 913, 911, 937 or 905 or approved equivalent.

xii) **ANTI-FRICTION BEARINGS**

Anti-friction (ball and roller) bearings shall be of standard type most suitable for the respective application and shall have both inner and outer races and shall conform to the current Standards of the Anti-Friction Bearings Manufacturers Association (AFBMA) or equivalent. The Manufacturer's published ratings for loads and speeds shall be used in determining the bearing capacity.

77.6 INSTALLATION AND OPERATION

7.6.1 INSTALLATION

The installation shall be carried out in accordance with the manufacturer's instructions. The Contractor shall submit for the approval of the Engineer all the working drawings, complete Technical Data Sheets and Maintenance and Service Instructions book before commencing the installation work.

Any recesses, placing of concealed conduits, outlet boxes etc. shall be carried out in the form-work before pouring of concrete so that chiselling of concrete structure is avoided. For this purpose the lift supplier will keep himself informed about the progress of work of other contractors.

The electrical wiring shall be carried out by licensed electrician and shall conform to IEE/UK regulations and Pakistan Electricity Rules. The switchgear shall be installed at a convenient location in the machine room. All non-current carrying cladding of current carrying components shall be effectively earthed through the earthing system of the building.

77.6.2 PAINTING

All exposed metal parts other than Stainless Steel finish or as required by Engineer shall be given two coats of rust-proof paint of approved quality and colour after which the final finishing coats shall be applied.

77.6.3 CUTTING AND PATCHING

The Contractor shall notify the Engineer sufficiently ahead of construction of any floor, walls, ceiling, roofs, etc., of the openings which will be required for his Work as also regarding inserts, door frames, thresholds etc. He shall also see that all required sleeves or inserts for his Work are set properly and at proper times so as not to hold up the progress of the Work.

Any cutting and patching required to be done because of lack of proper coordinations shall be done by the Contractor at his own cost. He, however, shall not cut any structural members without first having received written permission from the Engineer.

77.6.4 TESTING

The testing of the completed installation shall be done in accordance with the British Code of Practice CP 407, 1972 and/or BS 2655-I Section III 1986 and NSI Code latest edition in the presence of the representatives of both the Employer and the Engineer. Any other test prescribed shall also be carried out by the Contractor at his own cost and risk.

The test results shall be submitted to the Engineer for his approval. Any defects found during the testing shall be rectified by the Contractor without any extra cost. The entire installation shall be tested for insulation resistance which shall not be less than 0.5 magaohms when measured at 500 volts.

77.7 GUARANTEE / WARRANTY

The Contractor shall provide Manufacturer's Warranty which shall cover all imported equipment against material, fabrication, workmanship performance and all other associated deficiencies for a period of 24 months from the date of shipment. The Contractor, however, shall also Warranty the entire installation for a period of 12 months from the date of issue of completion certificate by the Engineer, inclusive of the manufacturers Terms of Warranty for free replacement of any component, accessories or parts having become defective during the period, and as per Conditions of Contract, Part-II, Conditions of Particular Application.

The Guarantee / Warranty would be given in the form given below duly executed for all imported equipment and shall form an essential part of the Shipping Documents.

"We hereby guarantee that the stores and equipment supplied are produced new in accordance with approved drawings and contract specifications and that the material used whether or not of our manufacturer are in accordance with the appropriate standards (latest editions) and as specified in contract, and we shall replace free of cost all stores or parts thereof which before use shall be found defective and not in accordance with the contract, provided, however, a period not exceeding 18 months from the date of shipment from our factory of the parts covered by this guarantee has not elapsed. We will also replace free of cost every part thereof in use for a period not exceeding 12 calendar months after it has been taken over on completion of installation which would be found defective due to material or faulty workmanship or in any way not in accordance with the contract Specifications."

77.8 DRAWINGS

77.8.1 ENGINEERING DRAWINGS:

The Manufacturer's arrangement drawings to be generally followed should meet the Specifications, Schedule of Technical Particulars & Contract requirements. These drawings shall be submitted before supply or shipment.

77.8.2 SHOP DRAWINGS:

The Contractor shall submit to the Engineer for review six copies of all shop and erection drawings along with the complete data of equipment and material applying to the Contract. One copy will be returned to the Contractor after review/approval.

Review/approval by the Engineer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory and the Engineer's review will not relieve the Contractor of any of his responsibilities under the Contract.

Contractor shall submit in time installation drawings, Drawings of Machine Floor with all loading, openings, levels etc; as also all drawings of inserts, fixings, door frames or thresholds to be cast in civil works to the Engineer. Contractor shall be responsible for accurate & proper fixing and protection of all such inserts and fixtures.

One copy of the Drawings shall kept by the Contractor on the Site and the same shall at all reasonable times be available for inspection and use by the Engineer or the Employer.

77.8.3 AS-BUILT DRAWINGS:

Contractor shall submit, within one month of completion of Test runs, complete 2 sets of "As-built" drawings for the complete Works along with 1 set of sepia (reproducible) prints. These drawings shall show all equipment, and will include full details of all plant together with wiring diagrams and Interconnection diagrams as appropriate, as also all the details that are necessary for the ultimate maintenance of the project. Final payment of the Contractor will be withheld till all As-built drawings are verified and approved by the Engineer and are complete to his satisfaction.

77.9 MATERIAL RATE

Pay Item No.	Description	Unit of Measurement
77.9 a	Supply, Installation & Commissioning of Passenger Lift 630 KG including distribution board of required specification, Complete in all Respect	NO
77.9 b	Supply, Installation & Commissioning of Passenger Lift 800 KG including distribution board of required specification, Complete in all Respect	NO
77.9 c	Supply, Installation & Commissioning of Passenger Lift 1000 KG including distribution board of required specification, Complete in all Respect	NO

SECTION 78 KNX AUTOMATION SYSTEM

78.1 SCOPE OF WORK

The work under this section consists of design, manufacturing, fabricating, supplying, installing, testing, energizing, operation and commissioning of all material and services for the complete proposed KNX Automation system as specified herein, as shown on Drawings and stated in the CSR and as directed by the Engineer-in-Charge. The system shall fully comply with the general requirements for automation system.
The Contractor shall discuss the layout of the proposed KNX Automation system with the Engineer-in-Charge and co-ordinate at site with other services/systems for exact route, location and position of various equipments of the proposed system.

78.2 GENERAL

KNX automation can be used for all applications in home and Building control and is fit for use in different kind of buildings. KNX supports different Configuration Modes and also supports several communication media (TP, PL, RF and IP). KNX can be coupled to other systems and is independent from any hard- or software technology.

78.3 APPLICABLE STANDARDS / CODES

The latest editions of the following standards / codes shall be applicable for the materials covered within the scope of this section.

i) CENELEC, EN50090
ii) CEN, EN13321-1/2
iii) ISO/IEC, ISO/IEC14543-3
iv) SAC, GB/Z20965
v) ANSI/ASHRAE, US ANSI/ASHRAE standard 135

78.4 MATERIAL

78.4.1 KNX I-BUS SYSTEM

A bus system for the interconnection of electrical installation devices using a twisted pair of Wires as a transmission medium. As bus cable a twisted pair of wires (2x)2x0,8 is used. The bus cable may and shall be installed in parallel and close to the mains cables. The KNX devices are connected “electrically in parallel" to the bus cable, via the bus cable the information is transmitted and the KNX-devices are supplied with power (29V DC). Open bus topology, no end-of-line resistors, length of a bus line including stubs max. 1,000 m. The bus cable is laid in the form of a line, a tree or a star structure (a connection resistor is not necessary). Transmission speed: 9,600 bit/s. Bus access method: CSMA/CA. Symmetrical transmission, high common mode rejection by transformer coupling. Application program and addresses in the EEPROM of the bus coupling units. Programming by the Engineering Tool Software ETS. The topological configuration includes lines and areas. A line is the smallest unit. Up to 64 devices can be connected to a line. At most 15 lines can be combined via line couplers to one area. A bus system can be extended up to 15 areas (approx.15,000 devices). Each participant gets an individual (physical) address, by which it can be parameterized and polled. The functional assignment between each single participant (object) is achieved by the assignment of group addresses. A participant consists of a BUS Coupler Unit (BCU)

and a BUS Device (BD). The programming of the I-bus KNX participants is effected by a USB interface or network gateway which can be installed somewhere in the BUS System.

78.4.2 ETS

ETS (Engineering Tool Software) is the unique manufacturer independent Tool Software to design and configure intelligent home and building control installations made with the KNX system.

78.4.3 POWER SUPPLIES SV/S - SU/S

i) With choke
ii) Current: 160, 320 mA and 640 mA
iii) Uninterruptible Power Supply:
iv) Up to two 12 V DC sealed lead acid batteries
v) connectable in parallel (up to 16 hours,
vi) depends on battery capacity and output current)

78.4.4 BUS COUPLERS

For connecting operating elements such as

i) Push button
ii) Dimmer/shutter switch
iii) Motion sensor
iv) Room thermostat
v) RS 232/USB interface
vi) Infrared interface
vii) LCD display

78.4.5 SWITCH ACTUATOR SA/S (6A, 10A, 16A AND 20 A)

i) 2-, 4-, 8- and 12-fold devices
ii) With current detection
iii) Manual operation
iv) 6 mm² terminals with Combi Head Screw
v) For inductive and capacitive loads and
vi) Fluorescent lamps

78.4.6 SHUTTER ACTUATOR JA/S

i) 2-, 4- and 8-fold devices
ii) Manual operation
iii) 24V DC / 230 V AC
iv) SMI-drives

78.4.7 SWITCH-/DIM ACTUATOR SD/S

i) 2-, 4- and 8-fold devices with independent channels for switching and dimming (Fluorescent lamp with dimmable electronic ballast; 1-10 V interface)
ii) 1-10V control outputs each used for maximal 100mA control load
iii) Independent, potential free relays outputs
iv) 6 mm² terminal with universal head screws for load outputs
v) Rated current 16A – AX1, 10 AX (acc. IEC 60947 and IEC 60669)

78.4.8 LIGHT CONTROLLER LR/S WITH SENSOR LF/U

i) Light Controller with 2 / 4 independent outputs for switching and dimming (Fluorescent lamp with dimmable electronic ballast; 1-10V)
ii) 16A – AC1, 10AX
iii) 1-10V Control Output max. 100mA, max. 100m cable length
iv) 2 / 4 inputs for LF/U 2.1, max. 100m shielded Cable
v) Supplied via KNX
vi) Manual Operation and Indication of Relay Position

78.4.9 UNIVERSAL DIM ACTUATOR UD/S

i) Universal Dim Actuator for automatic load detection (halogen lamps, electronic or inductive transformer)
ii) 2 channels
iii) 2 to 300 W output power per channel up to 45 °C ambient temperature
iv) Up to 500 W if only one channel is operated
v) Low power loss: max. 4.5 W on maximum power and max. 500 mW when switched off

78.4.10 BINARY INPUT BE/S

i) 4- and 8-fold devices
ii) Input: 180...265 (0...120) V AC/DC

9...32 (0...4) V AC/DC

Contact scanning 32 V pulsed

iii) Input ports: 4-fold: 2 input with common base

8-fold: 8 independent inputs

iv) Manual operation button per channel

78.4.11 UNIVERSAL DIM ACTUATOR UD/S

i) 2-, 4- and 12-fold devices
ii) For the connection of push-buttons or LED's
iii) Each channel can be parameterized separately
iv) For the installation behind operating boards
v) Wires, appr. 30cm, can be extended up to 10m
vi) Channel configured as Input (Scanning voltage 20 V pulsed) or as Output (Output voltage 5 V DC, max. 2 mA limited via a series resistor)

78.4.12 METER INTERFACE MODULE ZS/S

i) Quick and easy installation
ii) ABB meters DELAplus, DELTAsingle and ODIN can be connected/read out
iii) Automatic assembling of IR-communication with monitoring
iv) Instrument values such as Current, Voltage and Frequency can now be sent
v) Perfect for subsequently installations
vi) No approvals required
vii) Provide meter data for visualization, displaying, billing, energy optimizing

78.4.13 APPLICATION UNIT ABL/S AND ABZ/S

Logic Time 254 I0 application

a. Automation functions in buildings
b. Functions of a PLC, e.g.: logic operations, gate, timing element, staircase lighting function
c. Parameterisation via graphical interface

Times Groups/2 application

a. Real-time clock for date and time
b. Parameterisation software PZM2

78.4.14 TELEPHONE GATEWAY TG/S

i) The Telephone Gateway informs about events and alarms automatically
ii) Voice message
iii) SMS
iv) E-Mail

78.5 MATERIAL RATE

Pay Item No.	Description	Unit of Measurement
78.5 a	KNX Automation System(As per Requirement)	NO

SECTION 79 HVAC SYSTEM

All Heating, Ventilation & Air Conditioning Services shall be completed, tested and commissioned as per drawings, specifications and as per instruction of Client & Consultant. Unloading, rigging, lifting, installation, testing and commissioning of (VRF) multi split type air conditioning units of different capacities complete in all respects, ready to operate including supply of supports, brackets, branch distributor rubber isolator, flashing, gas charging, control wiring & power wiring (connection) in G.I. for external / PVC for internal from outdoor unit to indoor unit complete in all respects ready to operate as per specification, drawings and as per instruction of Consultant.

79.1 MATERIAL RATE

Pay Item NO	Description	Unit of Measurement
79.1 a	Supply and Installation of H.V.A.C System. Electric Air Cooled Ducted Package type unit Refrigerant. R-22 (10 HP) 4 units Electricity: 380 x 3Ph x 50Hz Local Complete in All Respect.	NO
79.1 b	Supply and Installation of 1 ton Split A.C Unit inverter with all type supporting material, etc. Complete in all respect.	NO
79.1 c	Supply and Installation of 1.5 ton Split A.C Unit inverter with all type supporting material, etc. Complete in all respect.	NO
79.1 d	Supply and Installation of 2 ton Split A.C Unit inverter with all type supporting material, etc. Complete in all respect.	NO

SECTION 80 GENERATORS

Supply, Installation, commissioning and testing Diesel Generator having 50 kVA to 2 MVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor, including earthing sets with resistance less than 1 Ohm, complete in all respects.

Engine Make / Model:
Alternator Make/Model :
Specifications:

- **380/415 V, 50 Hz, 3-phase, 4-wire, 1500 RPM, power factor 0.8**
- **Industrial silencer (supplied loose)**
- **Oil & radiator drains piped to base frame**
- **Engine mounted battery-charging alternator**
- **Engine mounted fuel/water separator**
- **Easily extendable exhaust outlet pipe**
- **Coupling mounted on heavy duty steel frame with anti-vibration oil proof**

rubber mounts between generator & base.

- **Water cooling radiator**
- **Electronic Governor**
- **Circuit Breaker**
- **AVR**
- **12V × 2 batteries with battery charger**
- **Built in fuel tank**
- **Genset Panel comprises of:**

– One No Electronic Module
– One AC ammeter with selector switch
– Frequency Meter
– Hour Run Meter
– One AC Voltmeter with selector switch
– Electrical oil pressure gauge
– Battery voltmeter, manual key start
– Moulded case circuit breaker
– Automatic shutdown device with indication lamps for LOP/HWT

80.1 **MATERIAL RATES**

Supply, Installation, commissioning and testing Diesel Generator having 50 kVA to 2 MVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor

Pay Item NO	Description	Unit of Measurement
80.1 a	Supply, Installation, commissioning and testing Diesel Generator having 100 kVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor, including ATS Panel, earthing sets with resistance less than 1 Ohm & Sound Proof Canopy, complete in all respects.	NO
80.1 b	Supply, Installation, commissioning and testing Diesel Generator having 200 kVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor, including ATS Panel, earthing sets with resistance less than 1 Ohm & Sound Proof Canopy, complete in all respects..	NO
80.1 c	Supply, Installation, commissioning and testing Diesel Generator having 500 kVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor, including ATS Panel, earthing sets with resistance less than 1 Ohm & Sound Proof Canopy, complete in all respects.	NO
80.1 d	Supply, Installation, commissioning and testing Diesel Generator having 630 kVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor, includingATS Panel, earthing sets with resistance less than 1 Ohm & Sound Proof Canopy, complete in all respects.	NO
80.1 e	Supply, Installation, commissioning and testing Diesel Generator having 1000 kVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor, including ATS Panel, earthing sets with resistance less than 1 Ohm & Sound Proof Canopy, complete in all respects.	NO
80.1 f	Supply, Installation, commissioning and testing Diesel Generator having 15 kVA Prime Power at 1500 RPM, with output 380-415 V, 50 Hz, 3-Phase, 0.8 Power Factor, including ATS Panel, earthing sets with resistance less than 1 Ohm & Sound Proof Canopy, complete in all respects.	NO

SECTION 81 CCTV SECURITY SYSTEM

81.0 GENERAL

The CCTV system shall be used for security purpose. The specification covers the supply & installation of CCTV system. The vendor shall study the specification and satisfy himself thoroughly and shall take full responsibility of the smooth, reliable and safe working. All items of instrument shall be completed in all respects and any instrument not covered in the specification but essential for proper installation, operation and maintenance of the instrument shall be included by the vendor in his offer and the reasons for such inclusion shall be clearly stated.

81.2 SCOPE OF WORK

The scope of work includes supply & installation of CCTV System as specified in this specification. Supply of necessary spares. Packaging, forwarding, transport, loading, unloading, precaution against damage during transit etc.

i. Performance Guarantee.
ii. Two sets of operation and maintenance manuals.
iii. Test Certificate: Vendor shall provide all necessary test certificates.

81.3 SAFETY

All equipments items shall be complete with approved safety devices, wherever a potential hazard to personnel exists, and with provision for safe access to personnel to and around the instrument for operational and maintenance functions.

81.4 TEST AND INSPECTION

Inspection of the equipment will be done at PICO HMC. The vendor shall demonstrate all the features of the equipment mentioned in the technical specification. The vendor is solely responsible for installation, system operational at PICO.

81.5 OPERATION CONDITIONS

All equipment shall be designed for smooth, efficient and trouble free operation in tropical humid climate of 45℃ ambient and a humidity of 90%. In cases where the offer deviates from the specification, the vendor shall indicate clearly in his offer the specification proposed by him along with details thereof and the reasons for the deviation. Each exception to the specification or other parts of the tender document shall be listed separately by the vendor. If exceptions are not clearly listed they will not be considered by the Purchaser later.

81.6 DOCUMENTS

The vendor shall supply the hard and soft copy of Operation and Maintenance manual in duplicate. All necessary literature giving complete technical details shall be provided. He should also provide the test certificates given by manufacturer. The vendor shall provide the original DVD/CD of the software. The vendor shall furnish a list of users in Pakistan to whom the similar equipment was supplied.

81.7 INSTALLATION

It is to be noted again that supply & installation of the system with all accessories, auxiliaries, and any item not covered in the specification but essential for proper installation, operation and maintenance of the CCTV System shall be included and executed by the vendor. The supply will not be deemed complete until the commissioning trial of the whole system is carried out by the vendor at PICO successfully

81.8 MATERIAL RATES

Pay Item No.	Description	Unit of Measurement
81.8 a	Supply, Installation, commissioning and testing of Network CCTV camera, 1 /2.7 inch CMOS, 1MP to 4MP, 2.7 – 12mm, 4 High Power IR Leds, PoE, 128 GB max micro SD card, H.264, Gray, IP66, Ul, CE, FCC Listed, Indoor / Outdoor Type complete in all respect as per Engineers requirement.	NO
81.8 b	Supply, Installation, commissioning and testing of NVR / DVR 16ch to 64ch, 2HDD to 8HDD, 16 PoE, 4K H.265, 0TB, Raid5&6, complete in all respects	NO

SECTION 82 UPS & VOLTAGE STABILIZERS

82.1 UN-INTERRUPTED POWER SUPPLY

UPSs shall be installed at the Respective Power Centre for the necessary provision of no-break in power during mains failure. The UPS(s) shall be rated as stipulated in the Bills of Quantities. The UPSs shall be of the 12-pulse type, suitably rated to handle harmonics generated from the non-linear load equipment. The UPS shall incorporate active or passive filtering to handle the harmonics. The system(s) configuration shall be the parallel redundant type with reverse transfer and designed for capacity expansion by addition of parallel modules on site with minimum downtime. The UPS design shall conform to IEE 519 standards. The UPSs shall be located at the different location as described in the Bills of Quantities.

82.2 TECHNICAL SPECIFICATIONS

The UPS shall be rated as shown on contract drawings and shall maintain output voltage within the specified limits at any load from full load to no-load.

The UPS shall incorporate the following:

I. Batteries: - Lead acid sealed type with a performance life of 5 years minimum.
II. Automatic transfer switches (Both manual and static).
III. 100% galvanic isolation between the incoming supply and the UPS supply.
IV. 15 Minutes Autonomy.
V. Each module shall have its own batteries and charger system with an output circuit breaker.
VI. The batteries shall be installed on racks and shall be interconnected with double insulated cables and shrouded terminals. The cables shall be color coded to distinguish between negative and positive leads. Each battery system shall be wired as dual string to allow maintenance to be undertaken.

Rated Power (kVA/kW)	10/10 15/15 20/20* 30/30* 40/40*
Normal AC supply input	
Input Voltage (V)	380/400/415 V (Three-phase + Neutral)
Frequency (Hz)	45 – 65 Hz
Input Power Factor	Up to 0.99
THDI	<3% for 10kVA UPS, <4% for 15-40kVA UPS
Input Voltage Range	304 V to 477 V at full load
Dual Mains Input	Yes (default: single main input)
Output	

Nominal Output Voltage (V)	3:1 (coming soon) – 220/230/240 V 3:3 – 380/400/415 V
Efficiency: Double Conversion Mode	Up to 96%
Efficiency: Eco Mode	Up to 99%
Overload Capacity in Utility Operation	125-130% for 10 minutes and 130-150% for 1 minute
Output Voltage	Tolerance +/-1.5% static
Communication and management	
Communication Interface	RS232, RS485, USB, Dry contact, Mod bus TCP/IP, optional Network Card
Control Panel	Multi-function LCD, status and display console

82.3 AUTOMATIC VOLTAGE REGULATOR

The stabilizer shall comprise the following major units

a) A transistorized servo amplifier
b) A geared reversing motor
c) A continuously adjustable auto-transformer
d) A fixed ratio auxiliary transformer

The stabilizer shall conform to the following requirements:

i.	Nominal input :	415V, three phases
ii.	Supply frequency :	50Hz
iii.	Input voltage Correction range:	
iv.	Selectable taps	
v.	Output Voltage :	415V
vi.	Output Accuracy :	Better +0.5 Zero to full load
vii.	Current rating	
viii.	Wave Distortion :	None
ix.	Effect of load power Factor :	None
x.	Nominal Power rating	
xi.	Speed of Correction :	39.5V/Sec
xii.	Temperature coefficient :	0.025% per℃
xiii.	Environment:	Max. Temperature 31.5℃
xiv.	Minimum Temperature : 5.2℃	
xv.	Humidity :	48% - 93%
xvi.	Altitude:	1675m above sea level.

82.2 MATERIAL RATES

Pay Item No.	Description	Unit of Measurement
82.2 a	Supply, Installation, commissioning and testing of Smart-UPS, 230V including 2 No. of 200 Amp Acid type batteries complete in all respect as per Engineers requirement Engineers requirement.	
	i. 1000VA	NO
	ii. 3000 VA	NO
	iii. 5000 VA	NO
	iv. 10000 VA	NO

PART-4
IRRIGATION & DRAINAGE WORKS

PLANNING AND DEVELOPMENT DEPARTMENT GOVT OF AJK

GENERAL SPECIFICATIONS (Irrigation and Drainage Works)

Table of Contents

GENERAL: IRRIGATION AND DRAINAGE WORKS

INTRODUCTION AND SCOPE

G.1 PREAMBLE

Most of the items appearing under Part-4 (Irrigation and Drainage Works), relate to Special Works to appear under Special Provision as sketches are essential to explain the work items.

Some of the other items to be used in works of Irrigation are already described in detail in Civil Work (Part-1) of Specifications. The designer has to relate the specifications of such items to the existing items of specifications, like concrete, bricks, tiles, steel etc.

For any other item not being used internationally cannot be described in these specifications, as no Standard of American Society for Testing and Material (ASTM), British Standards (BS) European Norm (EN) or Deutsches Institute für Normung (DIN), appear for reference

G.2 STANDARDS

The General Specifications standards are to be referred from American Society for Testing and Material (ASTM), British Standards (BS) European Norm (EN) or Deutsches Institute für Normung (DIN), where applicable for routine construction items.

G.3 SCOPE

G.3.1 CONTRACT WORKS

As most of the items appearing in this part are Specialized Items, used for irrigation purpose. Hence, these will become special items to be described in Special Provisions.

Priority of documents will be same, as described under Para G.3.1 of Part-1 (Civil and Allied Works) Specifications.

SECTION 90 LINING OF CANALS

90.1 SCOPE OF WORK

This Section covers lining of earthen canals with a layer of any of the followings materials, as specified on drawings and approved by the Engineer-in-Charge:

a) Asphalt/Bitumen spray

b) Clay Bricks or Clay Tiles

c) Concrete of Defined Class

The Contractor shall perform all associated works as specified.

90.2 ASPHALT/BITUMEN MEMBRANE

90.2.1 MATERIALS

a) Asphalt/bitumen grade60/70 or as otherwise specified. The asphalt/bitumen is sprayed in place, to form the impervious membrane.

b) Protective material to be used like earth, gravel etc.

90.2.2 FORMATION OF MEMBRANE

i. The thickness of Asphalt/bitumen membrane shall be as specified on drawings.

ii. The canal bed on which membrane is to be placed should be over excavated to allow the placement of membrane and protective material.

After rough excavation, the, surface is prepared for the application of asphalt by light dragging and rolling to obtain a relatively smooth surface, in order to facilitate the laying of a uniformly thick material and impermeable membrane. The rougher the sub-grade, the greater the quantity of asphalt required for satisfactory coverage.

iii. The special asphalt used for the membrane is prepared by the catalytic blowing of asphaltic materials. It has very low temperature susceptibility, a high degree of toughness, a resistance to tearing or breaking, and a long life. After the asphalt has been heated to approximately 400 ˚F, it is applied to the sub-grade under about 50 pounds pressure through spray nozzles, using either hand sprays or multiple spray bars mounted on the distributor. Holes or rough areas in the sub-grade can be adequately covered by the hand spray, though this method is somewhat slower. On the other hand, the distributor method is faster, and. therefore, more economical but can be applied satisfactorily only to reasonably smooth sub-grades.

iv. The hot-applied asphalt cools quickly and is soon ready for the application of the cover material. In fact, a few minutes after the application, the surface may be walked over by the construction personnel in covering operations. Since the purpose of the cover material is to hold the membrane in its place, and to protect it from the sunlight, water, wave wash, or livestock damage the kind and depth of cover material depend on factors like wave-action, water turbulence and velocity. Where water velocities are below one foot and a half per second, the soil removed from the canal in over-excavation may be used provided it isof reasonable stability. If soil from canal excavation is not suitable, material with greater cohesiveness (clay contents) and stability may be borrowed. In canals with very high water velocities, gravel blankets (usually of pit-run material) may

be placed over the soil cover to depths between 3 and 6 Inches. Riprap is often used for areas below check structures or where turbulence is severe. Compaction of the cover material is not ordinarily required but may be advisable in some instances. The life of an asphalt-membrane lining largely depends on the maintenance of the cover which is subject to breaching and weeds growth. (Breaching may be defined as the erosion of the canal bank at the water surface resulting primarily from wave-action.)

v. The burled asphalt membrane lining with cover operates essentially as an unlined canal, plans for the location and extent of such treatment can be altered on new construction without affecting the design of the canal or structures. Accordingly final decisions on these matters may be deferred till sub-grade conditions are exposed by excavation.

vi. The membrane lining can be satisfactorily done both in cold and wet weather.

90.3 BRICK OR TILE LINING

The work to be done under brick or tile lining consist of constructing brick lining or tile lining according to the locations, dimensions and details shown on drawings or directed by Engineer-in-charge in accordance with these specifications and Engineer's instructions.

90.3.1 MATERIALS

All bricks or tiles, sand, cement and other materials required in constructing the brick or tile lining shall be furnished by the Contractor and be approved by the Engineer-in-Charge before use. Specifications shall be same as mentioned under Part-1 these Specifications. Bricks, tiles, and mortar required in constructing the lining, and all operations of the Contractor in constructing brick lining, shall be in complete conformity with the applicable provisions set forth in the Section – 11 'Brickwork'.

90.3.2 FORMATION, DRESSING & PREPARATION OF SUB-GRADE

i. The Contractor shall prepare the surfaces of the sub-grade in manner that will provide a smooth and firm foundation for the brick/tile lining. The bottom and side slopes, including the surfaces of compacted embankments, shall be finished accurately to the lines, grades and dimensions shown on the Drawings or established by the Engineer-in-Charge.

ii. All excavation of the sub-grade beyond the lines of the underside of the brick lining shall be filled with suitable material, moistened if required, and thoroughly compacted to the prescribed lines and grades in accordance with the requirements of the Section-3 "Earthwork" or the Contractor may fill the over-excavated portion of the sub-grade with a mortar bedding consisting of one part Portland cement and six to ten parts sand, as approved by the Engineer-in-Charge.

iii. The entire surface on which, brick-lining is to be placed shall be sprinkled with water till the optimum moisture content for compaction is attained as determined by the Engineer-in-charge or his authorized representative. It shall be compacted by rolling. Rolling shall be performed by using a smooth cylindrical roller. Minimum of two passes of the roller over the sub-grade shall be required.

Unless otherwise specified or directed by the Engineer-In-charge, the width of a roller drum shall not exceed 4 feet. The weight of the roller drum when fully loaded shall not be less than 50 pounds per linear inch of drum width. A roller may, consist of two adjacent drum units, provided that a flexible coupling between drums is used, and that the space between drums shall not exceed 12 inches. Single drum rollers shall overlap each roll by one half the width of the

roller, and two drum rollers shall overlap each roll by one half widths of the roller plus one foot. No earth filling shall be permitted after the rolling of the sub-grade, and over-excavated or low portion shall be filled with mortar at the expense of the Contractor.

iv. After compaction, the entire area to be brick lined shall be thoroughly sprinkled with water till the finished sub-grade has been penetrated to a depth of 6 inches. The water shall not be applied at the rate which will cause the sub-grade to be muddy or soft. The finished sub-grade shall be duly approved by the Engineer-In-charge or his authorized representative before any brick-lining is laid.

90.3.3 PROFILE WALL

Unless otherwise specified or directed in writing by the Engineer-In-charge, profile walls shall be constructed 15 feet centre to centre at right angle to the centre line of the channel on the side slopes and at 30 feet centers on the bed. A profile wall shall also be constructed parallel to the centre line at each toe of the canal side slopes. The final excavation, trimming and compaction of the section may be performed before or after the completion of the walls.

The profile wall shall be laid by means of a theodolite. The excavation of trench in bed and on slopes for construction of profile including disposal of excavated material shall be made in accordance with applicable provisions of Section 3 – Earthwork.

A cement sand mortar as specified shall be laid as plaster over finally finished surface in accordance with applicable provisions of Clause 15.1.5 – Plastering. The wall shall be constructed in accordance with the Provisions of the Section 11 - Brickwork.

90.3.4 PLACING OF LINING

Unless otherwise specified, the placing of lining shall follow the sequence as given below:-

i. A layer of 1:10 cement sand hand mixed mortar shall be plastered over the finally finished sub-grade, having an average thickness of ½ inch for making up inequalities in the section.

ii. Immediately over it a 1-½ inches thick layer of 1:6 cement sand machine mixed mortar shall be laid. (The mortar used shall have a slump of ½ inch to ¾ inch) To ensure that the correct ,thickness of 1-½ inches is laid over the whole surface, precast cubes 1:6 cement sand mortar having each side of 1-½ inches shall be placed on 1:10 plaster at 4 ft centre to centre along the centre line and at right angle to the channel and at 4 ft.intervals. The cubes shall be left embedded in the mortar with their tops flush with the surface.

iii. The 1:6 mortar layer shall be lightly rammed with wooden rammer and then troweled to level out irregularities in the surface. The surface shall be rammed again with wooden rammer having ½ inch long spikes with round ends to make indentations.

iv. A 3/8 inch thick layer of 1:3 cement sand machine mixed mortar shall be placed over the 1:6 cement sand base. (The mortar used shall have a slump of 2 inch). To ensure an even thickness, the 1:3 mortar shall be laid in strips 4 feet wide with the help of thin laths 1-½" x 3/8" and about 90 feet long laid on the 1:6 cement sand base. The 1:3 mortar shall be spread with a trowel and leveled with a straight edge flush with the top of the lath. A day after the mortar is laid, it shall be lightly scraped with the wire brushes.

v. The next and final layer shall consist of the brick/tiles. The courses shall be marked on the profile walls and the string shall be stretched to keep them straight. Brick tiles to be laid on slopes shall be laid from bottom to the top of side slopes. The laying of the brick/tiles shall commence from the profile wall at the tangent point. The bricks/tiles shall be laid in the 1:3 cement sand machine mixed mortar. The thickness of the mortar bedding under the bricks/tiles shall be 1/8 of an inch and the vertical joints between the bricks/tiles shall be ¼ of an inch thick. All the joints shall be properly filled and to achieve this, the mason shall apply mortar to the sides of the bricks/tiles already laid, lay the next brick/tiles 1 inch to 2 inch away and then press it towards the first brick/tile squeezing out the mortar which would indicate that that joint has been filled. Before the bricks/tiles are laid they shall be soaked in water for at least 24 hours in soaking tanks. The mason shall have with him kerosene oil tin containing water, and the bricks/tiles from soaking tanks shall be placed in these tins. The mason shall use bricks/tiles only from these tins for his immediate requirements. Strict supervision shall be exercised to see that no un-burnt bricks/tiles are placed in the soaking tank and used.

vi. The joints of the work done on the previous day shall be tested with a broad chisel pointed 5/8 inch diameter iron bar. The hollow joints shall be marked with coal tar raked out and filled with the 1:3 cement sand mortar immediately. The brickwork shall be finally brushed and cleaned.

90.3.5 **CURING**

Curing of each layer of the following work is necessary .

a) Profile Wall

b) Sub-grade 1-½ inch thick cement sand 1:10 mix

c) Sub-grade 1-½ inch thick cement sand 1:6 mix

d) Sub-grade 3/8 inch thick cement sand 1:3 mix.

During summer, curing shall be start three hours after the completion of each layer and during winter the very next day. Curing can be done by covering the sprinklers, porous hoses or pucca drains constructed along the top of the bank.

The overflow of water shall be affected by a man going along the drain and pushing water by a wooden rod, dipped in the drain: The watering of work shall be carried out on the following lines:

i. Profile Walls:

A day after the walls are built, they shall be covered with jute cloth which is soaked by sprinkling water by hand, till curing can be started from the drain when ready.

ii. Cement Sand Plaster 1: 10:

A day after the mortar is laid, it shall be kept wet by sprinkling water by hand, till it is covered by the 1:6 cement sand base.

iii. Cement Sand Base 1:6:

A day after the 1:6 cement sand base is laid, the drain on its top shall be ready and the layer shall be kept thoroughly wet by overflow from this drain. Prior to the completion of the drain and putting it into operation the layer shall be kept wet by sprinkling water by hand.

iv. Cement Sand Mortar 1:3:

A day after the 1:3 cement sand mortar is laid. It shall be kept soaking wet by water being made to overflow from the drain.

v. Brick Masonry:

A day after the masonry is laid it shall be kept wet for 28 days by water being made to overflow from the drain.

90.4 CONCRETE LINING

The work to be done under concrete lining, consists of constructing concrete lining according to the detail and as per locations shown on the drawings or designated by Engineer-in-charge in accordance with these specifications and the Engineer-in-charge's instruction.

90.4.1 GENERAL

i. Prior to the laying of concrete for canal lining: whether with precast orcast in-situ Concrete, the Contractor shall ensure that the bottom and sides of the excavated canal section are well compacted, trimmed and ready for the lining operation. In the event of failure to do so; any defects resulting in settlement, slips or bulges of concrete, the Contractor shall rectify the same at his own expense' by removing the concrete lining, compacting, trimming and relining the canal to the satisfaction of the Engineer-in-Charge.

ii. Profiles and concrete lining shall be constructed to the best standards of workmanship obtainable, and any objectionable irregularities, fins and offsets in the lining shall be removed by the Contractor.

iii. All bends in canal alignments shall be affected by means of smooth curves, the radius at the center-line of which shall not be less than twice the bed width of the canal.

iv. The concrete for canal lining shall be unreinforced 1:3:6 (3000 psi 6 inch x 12 inch cylinder strength).Where in-situ concrete lining will be as shown in the contract Drawings to be reinforced, a layer of steel fabric reinforcement shall be laid prior to the placing of the concrete.

90.4.2 MATERIALS

a) Specifications shall be same as mentioned under Part-1 these Specifications. Sand, cement, coarse aggregates and water conforming to provision of Section-5 Plain and Reinforced Concrete required in constructing concrete lining shall be furnished by the Contractor and be approved by the Engineer-in-Charge.

b) Cement, Sand and aggregate used in constructing the lining shall be furnished by the Contractor in accordance with the provisions of and complete conformity with the stipulations and requirements specified in the Section 5 – Plain & Reinforced Concrete. Bricks and mortar required in constructing the profile walls and all operations of the Contractor in constructing those shall be in complete conformity with the applicable provisions set forth in the Section 11 – Brickwork.

90.4.3 FORMATION, DRESSING & PREPARATION OF SUB-GRADE

i. Common Soils.

Although the same specifications and precautions shall apply as described in case of brick lining, however, the sub grade shall be compacted to 95% of Laboratory maximum dry density determined by Standard Proctor test or the 70% relative density depending upon type of material. The compacted Sections should extend not less than 2 feet below the final grade measured perpendicular to the surface of canal prism.

ii. Special Soils

In case of special soils, following further clauses shall apply

a) PREDOMINANTLY SANDY REACHES

When canal is in cutting in predominantly sandy reaches, compaction of sub-grade shall be done as follows:

Consolidation of the bed shall be done by over-saturating the bed by flooding it with water before lining is laid; Consolidation of sides shall be done by over cutting the sub-grade by 6 inches and refilling it. With granular material stabilized with not less than 50% cement (measured by volume) and compacted by vibro-compaction.

b) EXPANSIVE SOILS.

When dry bulk density of natural soil is less than 1.89 kg/cm3 (68 lbs/in3) or the soil is of expansive nature, any of the practices detailed below shall be adopted (depending on swelling properties of the soil encountered).

If the expansive clay is in a thin layer or is in small pockets in an otherwise suitable sub grade, it shall be over excavated and replaced with a selected granular material properly compacted to a depth of 40 cm. If swelling of the clay encountered can be controlled by loading the surface with a non-expansive soil or gravel, the expansive clay bed shall be over excavated to depth of about 40 cm and filled to the grade of underside of the lining with good drainage material leading away the seepage water from the canal, to be released in to the canal again, through suitable pressure relief valves. The excavated surface of expansive clay shall be covered by polythene sheeting to prevent the entry of water into the clay.

c) SOILS WITH HIGH GYPSUM CONTENTS.

If Gypsum ($CaS0_4.2H_20$) is in high percentage in the soil and comes in contact with water, it dissolves causing cavities in the soil and damage to the structures by differential settlements.

Effective protective measures shall be taken to prevent gypsum coming in contact with water for making the concrete lining water proof, either by plastering the surface or placing a compacted layer of selected clay material under the lining or provide a flexible type membrane of Butyl or PVC etc,. Efficient drainage system may also be required to rapidly remove water that gets under the lining. The work shall be carried out as per the drawings and direction of the Engineer-in-Charge.

The Contractor shall rework the areas which fail to meet specification requirement as above for common and special soils.

iii. Tolerance limits of Sub-grade

The previously compacted ground and embankments shall be trimmed within the following tolerances from given alignment.

a) + 20 mm on straight sections.

b) + 50 mm on tangents and partial curves.

c) + 100 mm on 90 degree curves.

d) + 20 mm from established grade.

e) After trimming, the sub grade shall be kept moist by intermittent fine spraying with water, prior to the lining operation. The period between trimming and lining shall not exceed 72 hours.

iv. Sub-grade Plaster

Unless otherwise specified 13 mm thick plaster cement sand mix (1:10) shall be carried out on well prepared sub-grade. The plastered surfaces shall be subjected to curing with water for 24 hours before concrete lining is done. Sub grade preparation and the cement plastering above it shall be performed for enough length in advance, as directed by the Engineer-in-Charge, to avoid delay of the lining operations. The surface of sub grade shall be true to level and according to the specified cross section (of the canal) to form a firm compacted bed for lining, However, if at any point, material of sub grade has been excavated beyond the neat lines required to receive lining, the excess excavation shall be filled with material to be specified/directed by the Engineer-in-Charge to make it compatible with sub grade material and thoroughly compacted. After compaction, the entire area on which concrete lining is to be laid shall be thoroughly sprinkled with water till the finished sub grade has been penetrated to a depth of nearly 150 mm Then finished sub-grade shall be duly approved by the Engineer-in-Charge.

90.4.4 THE CONCRETE MIX.

The concrete in principle shall be produced in accordance with applicable provisions of Section 5, Plain & Reinforced Concrete.

The concrete mix shall conform to the mix design specified in the Drawings. Concrete used in Canal Lining, as a general principle, shall be so mixed that it is firm enough to stay in place on the side slopes. The net water-cement ratio of the concrete (exclusive of water within or absorbed by the aggregates) shall range from 0.53 to 0.58 based on the climatic temperature. Temperature of concrete when it is placed shall not be more than 32 degree C and not less than 5 degree C. Tests of the concrete shall be made by the Engineer-in-Charge, for the purpose of checking workability, density, impermeability, durability and strength. The Contractor shall maintain arrangements for testing of concrete.

Thickness

Unless otherwise specified, the thickness of concrete shall conform to the approved design/drawings.

90.4.5 PLACING CONCRETE

a) General

Before Commencement of Operations of Concrete Lining of Canal, the Contractor shall submit a complete method statement for performance of the work.

b) Conventional Method

i. Placing of concrete shall be started after all formwork, installation of parts to be embedded and preparation of surfaces upon which concrete is to be laid, have been completed. All absorptive surface against which concrete is to be laid shall be moistened thoroughly so that moisture shall not be withdrawn from freshly placed concrete, the surfaces, however shall be free from standing water and mud. The concrete shall unless otherwise approved by the Engineer-in-Charge be mixed in a mechanical mixer.

ii. Concrete shall be placed and properly compacted to the satisfaction of the Engineer-in-Charge. The arrangements are to be such that the material may be conveniently handled and placed in the required position without re-handling or segregation in panels of 3m on either side with joints at specified places in between. A slump of 6 cm to 7 cm shall be allowed. Wherever possible .the concrete is to be deposited from bottom-opening skips; it shall not be delivered by chute or dropped from burrows or otherwise through a greater height than 1.2 m, except with the approval of the Engineer-in-Charge who may order the concrete to be dropped on to a bunker and turned over by hand before being placed.

The lining shall normally be placed first on the bed and then on sides. Where site conditions require laying of lining on sides first, it shall be supported on the walls. The concrete shall be dumped and spread on the sides and bottom of the channel in panels of not more than 3 m on either side with joints at specified places in between. Before laying the concrete, precast or cast-in-situ, concrete bed sleepers shall be placed under the joints to serve as templates to reduce seepage through the joints and accurate dressing of the sub-grade. For placing of concrete on slopes, the use of weighted vibrated steel faced slip-form screed in the advancing direction of the concrete pour, shall be supported directly on the sub-grade and operated longitudinally along it. This method of placing shall generally be adopted for moderately large canals. For larger canals and for better economy, longitudinally operated slip forms supported on rails placed on berms of the canal shall be adopted.

iii. The surface on which concrete is to be deposited must be made and maintained free from standing water during concreting operations unless otherwise approved. Running water crossing or entering such areas must be brought under control to. the satisfaction of the Engineer-in-Charge before concreting proceeds.

iv. All construction joints are to be shuttered square to the work. Keyways are to be formed in all horizontal and vertical construction joints except where ordered to be omitted by the Engineer-in-Charge.

v. All concreting shall be carried out in sections previously ordered or approved by the Engineer and shall proceed continuously in each section until completed and no interval shall be allowed to elapse while the work is in hand.

c) Placing Machine Made In-situ Lining.

For placing Machine Made In-situ Lining, the Contractor shall use a construction train for laying the concrete canal lining which shall consist of mechanical trimmer: slip form paver and platforms for lining construction, for cutting and filling contraction joints and for applying curing compound. All lining machinery shall have been built by a reputable manufacturer and evidence of satisfactory operation of similar equipment under similar conditions shall be provided.

While trimmers and slip form pavers are used. a qualified and experienced foreman provided by the manufacture: shall remain in attendance. The Engineer-in-Charge will not permit construction of lining to commence unless he is satisfied that there is a sufficiency of back up plant (e.g. concrete dump trucks) for the lining to progress without significant interruption.

It shall also be ensured that all the operators and mechanics are trained and experienced in such equipment's. Sample lengths of canal lining shall be constructed in advance so that the Engineer-in-Charge may consider and approve the method of working which the Contractor proposes to employ and the quality of lining to be achieved.

d) Finishing

Unless otherwise specified or as directed by the Engineer-in-Charge, the surface of concrete shall be finished smooth and free from projections, honey combing and other objectionable defects. All unsightly 'ridges or lips shall be removed and undesirable local bulging shall be remedied by tooling and rubbing. Repairs to concrete surfaces and additions, where required, shall be made by cutting regular openings into the concrete to the required lines. The fresh concrete shall be trowelled to the surface of the opening.

90.4.6 PRECAUTIONS

(i) No Partially Set Material to be Used

All concrete and mortar must be placed and compacted within 30 minutes of its being mixed unless otherwise approved; no partially set material shall be used in the work.

(ii) Unsuitable Weather

No concreting shall be allowed in the open during storms or rains. All concreting materials and plant are to be adequately protected against the effect of storms and rains.

All Concrete lining irrespective of whether pre cast or cast-in-situ, shall be laid in the dry. The Contractor shall provide sufficient pumping equipment to ensure that any dewatering that is required is effectively carried out.

90.4.7 CURING AND PROTECTION

(i) The concrete shall be covered with hessian cloth and kept watered and continuously damp for a minimum of seven days after placing or for such time as the Engineer-in-Charge may direct. Other methods of preventing the water of hydration in the concrete from evaporating may be used with the approval of the Engineer-in-Charge. After a period of 24 to 36 hours, the lining shall be cured for at least 28 days. On bed this shall be done by constructing 15 cm deep earthen bunds across the bed so that a small depth of water shall stand on the bed. The curing of side slopes shall be done by constructing masonry drains on the berms with weep holes or perforated pipes installed on the berms or by sprinklers. Curing compound SIKA or equivalent may be used if specified.

(ii) Concrete shall be protected wherever practicable from the direct rays of the sun during the curing period.

(iii) Precast concrete slabs used for canal lining shall be cast to the dimensions as shown in the Drawings. They shall be laid square, in straight lines and in a workmanlike manner, and shall be pointed or grouted with 1:2 cement - sand mortar. Laying of the slabs shall commence from the bed. working up

the slopes. Wavy, crooked or irregularly laid slabs will not be accepted and the Contractor shall at his own expense remove and rectify the same to the satisfaction of the Engineer-in-Charge. The Contractor shall exercise all care and diligence in the handling of the concrete slabs. Broken and irregularly shaped slabs shall be rejected and removed forthwith from the site by the Contractor.

90.4.8 JOINTS

(i) Contraction joints, where specified shall be formed as deliberate planes of discontinuity in the concrete structure as opposed to construction joints where continuity has to be maintained. A Construction joint shall consist of saw cut 7 mm in width and (1/6th the thickness of Concrete in depth. Alternatively to form such as to joint the face of concrete slab or block first formed shall be painted with two coats of approved rubber bitumen paint before the adjoining slab or block is concreted.

(ii) Expansion joints as detailed in the Contract drawing shall be formed in the same way as construction joints. Generally, these shall be 13 mm wide; 102 mm to 152 mm deep. Either an approved compressible sheet or filler shall be supplied and placed in the joint to provide freedom for two adjacent concrete slabs / blocks to expand or the joint shall be filled with bitumen, sand & saw dust in the ratio of 1:2:2 and shall extend to full depth of lining. In certain specified situations a highly compressible joint filler of foam rubber or other approved material shall be used. The exposed edges of the joint shall be sealed with an approved synthetic rubber or similar resilient sealing compound.

90.4.9 UNDER-DRAINAGE/ PRESSURE RELIEF VALVES

In stretches of concrete lined canals where a buildup of hydrostatic pressure is expected behind the concrete lining, thereby endangering their stability, the Contractor shall supply and fix pressure relief valves on the bed of the canals together with the appropriate graded filter material as shown in the Drawings. The Contractor shall be responsible for obtaining particulars of locations of pressure relief valves from the Engineer-in-Charge prior to the laying of the concrete lining. The provision of relief values shall be associated with construction of the proper grading and laying of the filter material as specified to ensure proper and effective performance of the relief valves. Any relief valve rendered ineffective as a result of the Contractor's negligence and improper grading and laying of the filter material shall be removed and made good at the Contractor's own expense.

90.5 MEASUREMENT AND PAYMENT

90.5.1 COMPOSITE RATE

The measurement and payment for the items of the work of Lining of Canals hereof shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

The measurement and payment of items of earthworks, all types of concrete and steel shall be made as per the relevant items appearing under chapter of civil works. However the cost of sub grade preparation and other items shall be paid under relevant items here below.

Pay Item No.	Description	Unit of Measurement
90.5 a	Forming, dressing and preparing sub-grade to provide smooth and finished surface for lining in bed and on side slopes on already compacted embankment of canals.	
	i. In bed	SM
	ii. On slopes	SM
90.5 b	Providing and laying 2" (50mm) thick stabilizing layer of cement sand mortar (1:30) on slopes including curing..	SM
90.5 c	Providing and laying 1/2" (13mm) thick cement plaster 1:10 for canals including trowel finishing and curing	
	i. In bed	SM
	ii. On slopes	SM
90.5 d	Providing and laying CS plaster 1:6 in bed and on slopes of canals including trowel finishing and curing.	
	i. In bed (1” thick)	SM
	ii. In bed (1.25” thick)	SM
	iii. In bed (1.5” thick)	SM
	iv. In bed (1.75” thick)	SM
	v. On slopes (1” thick)	SM
	vi. On slopes (1.25” thick)	SM
	vii. On slopes (1.5” thick)	SM
	viii. On slopes (1.75” thick)	SM
90.5 e	Providing and laying 3/8" (10mm) thick CS plaster 1:3 in bed and on slopes of canals including trowel finishing and curing.	
	i. In bed	SM
	ii. On slopes	SM
90.5 f	Providing and spraying asphalt/bitumen membrane 1.65kg/sm. Having a thickness of not less than (1/16") 1.6mm on mortar base and/or on lining including heating and cost of hire charges of plant.	SM
90.5 g	Providing and spraying asphalt/bitumen membrane 3.30kg/sm. Having a thickness of not less than (1/8") 3.2mm on mortar base and/or on lining including heating and cost of hire charges of plant..	SM
90.5 h	Providing and laying first class burnt brick tiles 12" x 6" x 2" (305mm x152mm x 51mmin lining between profile walls in cement sand mortar over and including the cost of 3/8" (9.5mm) bedding and vertical joints and including scaffolding, formwork, its removal and curing.	

	i.	In bed (1:3)	CM
	ii.	In bed (1:6)	CM
	iii.	On slope (1:3)	CM
	iv.	On slope (1:6)	CM
90.5 i	Providing and laying first class burnt brick 9"x4.5"x3"(225mmx113mmx75mm) in bed of canal in cement sand mortar 1:3 including scaffolding, formwork, its removal and curing		
	i.	In bed (1:3)	CM
	ii.	In bed (1:6)	CM
	iii.	On slope (1:3)	CM
	iv.	On slope (1:6)	CM
90.5j	Providing and laying in situ cement concrete using approved local aggregate ¾" to 3/8" thick on slopes of canal (any thickness) including scaffolding, formwork, its removal and curing, complete in all respect.		
	i.	In bed (1:2:4)	CM
	ii.	In bed (1:3:6)	CM
	iii.	In bed (1:4:8)	CM
	iv.	In bed (1:6:12)	CM
	v.	On slope (1:2:4)	CM
	vi.	On slope (1:3:6)	CM
	vii.	On slope (1:4:8)	CM
	viii.	On slope (1:6:12)	CM
90.5k	Providing and laying in situ cement concrete using limestone aggregate ¾" to 3/8" thick in bed of canal (any thickness) including scaffolding, formwork, its removal and curing, complete in all respect.		
	i.	In bed (1:2:4)	CM
	ii.	In bed (1:2.5:5)	CM
	iii.	In bed (1:3:6)	CM
	iv.	On slope (1:2:4)	CM
	v.	On slope (1:2.5:5)	CM
	vi.	On slope (1:3:6)	CM

SECTION 91 PROTECTION AND DIVERSION WORKS

91.1 SCOPE OF WORK

a) The protection and diversion works shall consist of works that may be required to divert the river stream or currents and/or to adopt such measures as may be necessary to strengthen and protect an existing work or an embankment. Such river training and diversion works shall though consist primarily of constructing embankments and dykes, excavating cunnetts and placement of protective pitching, mattresses, rolls, nevertheless may include certain anticipated works to be executed performed or administered by the contractor to the extent of which is unforeseen or is not capable of portrayal in the drawings at the time of issue of the order for execution. Specifications of all material used for this item shall be as described in this item.

b) The scope shall, however, include furnishing all labour, materials, plant, equipment, instruments, accessories and services necessary to complete the work in accordance with herein stated specifications, requirements and stipulations or as directed by the Engineer-in-Charge.

91.2 GENERAL

a) Whenever construction of cunnetts, earthen excavations, construction of earthen embankments or rising earthen dykes are required to be constructed, specifications and requirements detailed in Section 3, Earthwork shall be adhered to, unless such specifications/requirements have been specially modified by the Engineer-in-Charge.

b) The stone for dumping and pitching shall consist of natural rock, quarried from approved locations. The stone for pitching shall be well graded within the limits as specified.

c) Rock spalls shall be not more than 25% larger than 4 inches & not more than 5% smaller than 2 inches.

d) Base course under pitching stone shall be not more than 25% larger than 3 inches& not more than 10% shall be smaller than 2 inches.

e) Cement/Aggregates and water for concrete and mortar shall conform to the applicable provisions of Section 5 - Plain & Reinforced Concrete.

f) The specific gravity of stone materials should not be less than 2.6. The water absorption shall not exceed 6%.

g) The loss under Los Angles Abrasion Test (ASTM Designation C-131) shall not exceed ten percent (10%), by weight at 100 revolutions or 40% by weight at 400 revolutions.

91.3 DIVERSION WORKS

91.3.1 GENERAL

The diversion works are needed to change the course of existing channel for some specific purpose or protection of existing structure.

All the materials required such as brushwood, pilchi/sarkanda, wooden trestles, ropes, mats/tarpaulins, gunny bags, stones and earth for construction of bunds for diversion shall be collected at site before undertaking closing operation for diversion

of flow. Also sufficient labour and dozing equipment shall be arranged and made available for the work.

91.3.2 SPURS AND GROYNE

Spur is an obstruction built across a river projecting from the banks, for training the flow and for the formation of berms. The spurs break up the current and stop erosion by causing silting between the spurs and protect the embankment from damage by flow.

a) In case of emergency, they shall be constructed of 50 to 80 mm diameter stakes or kilas driven in the river bed, 60 to 120 cm apart center to center in a single row for short depths and in two rows of stakes intertwined for deep canals.
b) The height shall be up to half the height of the bank for temporary spurs and up to full height of the bank for permanent spurs; known as Groyne.
c) For best results, these structures shall be placed two to three times their length apart.
d) Brushwood and twigs shall be filled in between the stakes in alternate layers with stones or sand bags. They are quite successful in the case of small streams and where the soil of the bed is firm but in soft soils will cause scouring.
e) For slow moving overflow floods in that country, stone pitching, combined with spur bunds would be suitable. The spurs or Groyne shall be built either projecting at right angles with the banks or sloping downstream.

91.3.2.1 Groynes

Spurs of permanent nature and obstructions going right across into a channel are generally called Groyne. The word spur is generally restricted to a short protrusion. Earthen embankments are also made covered with stones, projecting into the river in order to head up water.

a) Groyne shall be generally 3 to 3.5 m wide at the top with side slopes of 3:1 on the upstream side and 2:1 on the downstream side and section so designed as to cover a hydraulic gradient of 1 in 5 to 1 in 7 depending on the soil.
b) Groyne shall preferably be constructed for the protection of canal masonry structures especially where the bed is sandy.

91.3.2.2 Trunger Spur

Trunger spur is a cage or meshed casing made of about 5 mm steel wire or coir rope 12 to 25 mm dia, which in the case of ordinary size spurs, is made about 7.5 m wide and about one metre higher than the depth of water, is used and the spur so constructed is called trunger. The length of the spur depends upon the width of the river and the scour to be controlled. The filling in the trunger casing may be of anything like small trees, brushwood, dry grass weighed with stone, or it may consist wholly or stones, but in that case the trunger shall be made of wires and not of coir rope. These are also called Gabion mattresses or cages.

91.3.2.3 Stone Spur

This type of spur consists of solid stones tilled in the trunger throughout. Stones of size six (6) inches to nine (9) inches shall be laid in the form of a trapezoidal bank protruding into the river.

91.3.2.4 Brushwood Boulder Spur

This consists of alternate layers of stone and brushwood. The brushwood shall be intertwined on the sides, so that the bottom and the top of each layer of stone forms a continuous lining and the layer.

91.3.2.5 Brushwood Spur

Wooden poles (bullies) of 100 mm to 230 mm dia. and of length of about 2.5 m more than the depth of water are driven 1m to 1.2 m in the bed of the river to form an enclosure protruding from the bank. The space in between is filled with freshly cut shrubs. The wooden poles are held together by means of coir or synthetic ropes 25-mm to 40 mm thick.

91.3.2.6 Tree Spurs

This spur is made of trees alone. Trees 6 m to 12m in height and trunk varying between 45 cm to 120 cm girth may be cut and four or five of them tied to stout iron or wooden pole driven about 12 m to 15 m away from the edge of sour, and are hang upside down along the bank of the river. More trees are then tied in a similar manner to these trees by means of coir ropes or steel wire.

91.3.2.7 Long Spur

Logs of wood are laid alternatively in longitudinal and cross direction in layers, one above the other and secured by means of ropes passed round them and fixed to the wooden poles on the sides, wooden poles are driven into the ground.

91.3.2.8 Tree Groyne

Tree Groyne is a steel wire rope 12 mm to 30 mm dia. depending on the length of the river is stretched across the river and anchored at its ends. At intermediate points it is supported on tripods formed of wooden poles. The anchors may be of iron rails embedded in concrete or rough logs laid in a pits of 2.5 to 3 m deep with earth filled over the decking. Usually holes are drilled through the trunks of the trees, and the tying wire in passing through the trunks fixes the trees to the wire rope. The trees begin to collect rubbish floating in the water and form permeable barrier which then collects sill and becomes impermeable.

91.3.3 OPERATIONS INVOLVED

a) The site for final closing of a channel for diversion shall be one, where depths are not too great and bed is comparatively firm. Also, earth for construction of the bunds is available close at hand. The site finally selected shall be demarcated by dag belling the alignment of the closure bund on dry ground on either side of the channel.

b) The diversion for closing or redirection of a running channel shall be started by dozing the piled earth from both ends simultaneously at the approved point of closing when the flow is at its lowest stage and completed quickly.

c) In the active part of the channel (where water may be flowing) the bunds shall be constructed between specially formed pilchi rolls to prevent wastage of earth by the flowing water.

d) Whenever, directed by the Engineer-in-Charge (as in case when discharge in the channel is about 56.70 cumecs (2,000 cusecs) or more, stones in wire crates, instead of trestles, shall be placed/tipped at some specified distance/alignment on the upstream of proposed earthen bund such that their placing is advanced simultaneously from both the ends and the earthen bunds are continued behind them. The wire and stone for crates shall conform to provisions for wire for gabions, as described hereunder.

e) The earth bunds shall be advanced simultaneously from each side till they meet and close the flow.

f) The operations shall remain under continuous vigilance for safety of operations and their successful completion. Any remedial action which may become necessary shall be promptly taken.

91.4 STONE PITCHING/ RIPRAP AND REINFORCED CONCRETE SLOPEPROTECTION

91.4.1 DESCRIPTION

This work shall consist of furnishing and placing a protective covering of erosion resistant material as stone pitching/riprap or reinforced concrete slope protection on the locations shown on the plans for slopes or pier foundation protection. The work shall be done in accordance with the specifications and conformity with the lines, grades, thickness and typical cross-sections shown on the plans. The terms stone pitching and riprap are synonymous for these specifications.

The areas to receive slope protection of any kind shall be dressed smooth to the slopes or shapes called for on the plans and shall be free from stumps, organic matter, or waste materials. The base course under pitching stone/riprap shall be provided as shown on Drawings. Toe trench and/or base material is to be constructed; as specified and directed by the Engineer-in-Charge.

All materials, regardless of type or kind, shall be placed as per lines and levels called for on the Drawings.

91.4.2 STONE PITCHING/RIPRAP PROTECTION

91.4.2.1 Material Requirements

Stones, base material, rock spalls for pitching/riprap shall conform to the provisions of Sub-Section 91.2(c), (d) & (e). Stones for pitching/riprap unless otherwise required shall be one of the following classes as shown on the Drawings or determined by the Engineer-in-Charge.

Class A: Stones ranging in weight from a minimum of 15 kg to a maximum of 25 kg with at least 50% by weight of the stones weighing more than 20 kg.

Class B: Stones ranging in weight from a minimum of 30 kg to a maximum of 70 kg with at least 50% by weight of the stones weighing more than 50 kg.

Class C: Stones ranging in weight from a minimum of 60 kg to a maximum of 100 kg with at least 50% by weight of the stones weighing more than 50 kg.

91.4.2.2 Construction Requirements

a) Excavation

The bed for the stone pitching/riprap shall be excavated to the required depths and compacted, trimmed and shaped to the entire satisfaction of the Engineer-in-Charge or as shown on the plans.

b) Placing

i. Toe Trench

The stone shall be set in a toe trench as shown on the Drawings. The toe trench shall be filled with stone of the same class as the one specified for the pitching/riprap, unless otherwise specified. All toe trenches and excavations shall be approved by the Engineer-in-Charge with firm sub-grade or base prior to placement of stones. Stones shall be placed so as to provide minimum of voids. Larger stones shall be placed in the toe trench and on the outside surface of the slope.

ii. Slopes

Stones placed below water line shall be distributed so that the minimum thickness of the pitching is not less than the specified.

Stones above the water line shall be placed by hand. They shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with ends in contact.

The pitching shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be chinked with rock spalls firmly rammed into place.

Unless otherwise provided, stone pitching/riprap shall have the following minimum thickness, measured perpendicular to the slope:

Class A:	20 cm (8 inches)
Class B:	45 cm (18 inches)
Class C:	60 cm (24 inches)

The surface of riprap placed above the water line shall not vary from the theoretical surface by more than 8 cm (3 inches) at any point.

iii. Dry Stone Pitching/Riprap

The dry stone pitching/riprap unless otherwise directed shall be started from ground level and shall be placed in layers manually or other methods approved by the Engineer-in-Charge, all to secure a stable mass. Surface irregularities of the slope shall not vary more than 8 cm (3 inches) along the intended slope. All interstices, hollows and inequalities between stones shall be filled with sand, small pieces and wedged up tight with spawl driven in with slight hammering to the satisfaction of the Engineer-in-Charge.

iv. Grouted Stone Pitching/Riprap

Stone for this purpose shall, as far as practicable, be selected of the size and shape so as to secure fairly large, flat-surfaced stone which will lay up with a true and even surface and a minimum of voids. The stones shall be placed first and roughly arranged in close contact, the larger stones being placed near the base of the slope. The spaces between the larger stones shall be filled with stones of suitable

size, leaving the surface smooth, reasonably tight, and conforming to the contour required. In general, the stone shall be laid with a degree of care that will ensure for plane surfaces a maximum variation from a true plane of not more than 3%. Warped and curved surfaces shall have the same general degree of accuracy as specified above for plane surface.

As each of the larger stones is placed, it shall be surrounded by fresh mortar and adjacent stones shall be shoved into contact. After the larger stones are in place, all of the spaces or openings between them shall be filled with grout consisting of one part of Portland Cement and three parts of the fine aggregates, with sufficient water to produce a plastic mix and the smaller stones then placed by shoving them into position forcing excess mortar to the surface, and ensuring that each stone is carefully and firmly bedded laterally. Mortar shall not be placed in temperature lower than five degree C. During hot, dry weather the work shall be protected from the sun and kept moist for a minimum of 3 days after placement. Stones shall be kept wet during placing of the mortar.

After the work has been completed as above described, all excess mortar forced up shall be spread uniformly to completely fill all surface voids. All surface joins shall then be roughly pointed up either with flush joints or with shallow, smooth raked joints.

Weep holes shall be provided through the riprap cover as shown on the plans or as directed by the Engineer-in-Charge.

91.4.3 REINFORCED CONCRETE SLOPE PROTECTION

91.4.3.1 Materials

Materials for reinforced concrete slope protection shall conform to provisions of Sub-Section 5 of these Specification and as shown on the Drawings.

91.4.3.2 Construction Requirements

The slopes with suitable material shall be prepared with appropriate compaction to form a sub-grade approved by the Engineer-in-Charge and formwork shall be completed accordingly.

After furnishing and fixing the steel reinforcement, reinforced concrete slope protection shall be constructed after light spray of water at the locations shown on the plans or where directed by the Engineer-in-Charge. Placing and finishing of concrete shall conform to the requirements specified in Section 5 – Plain &Reinforced Concrete.

91.5 GABIONS

91.5.1 SCOPE

This work shall consist of wire-mesh gabions, furnished and placed in accordance with these specifications, and the specifications for the other work items involved, and at the locations and in conformity with the lines and grades shown on the Drawings. The work in general, covers gabions used for river and stream stabilization work, such as bank revetments, jetties, groins deflector, scour protection and retaining structures.

91.5.2 MATERIAL REQUIREMENTS

91.5.2.1 General

Gabions shall be enclosed by galvanized steel wire mesh, which shall be supplied folded flat to facilitate transport and handling.

Gabions shall be furnished in accordance with the various lengths, widths and heights required, by the Drawings, or as directed by the Engineer in-charge. If not otherwise required, all gabions shall be 40 inches (one meter) in width. The lengths shall be multiples of 2,3 or 4 times the width of the gabion and heights shall be three tenth (0.3), one half (0.5) or one (1) meteri.e14 inches, 20 inches or 40 inches.

91.5.2.2 **Wire**

All wire shall be a good commercial quality of steel and size as per Drawings coated with a prime western speller or equal (AASHTO M 120) applied at a rate of not less than 0.8 ounces per square foot (0.25 kg/Sq.M) of uncoated wire.

Uniformity of coating shall withstand ten (10) one-minute dips by the Preece Test in accordance with AASHTO T-66. “Uniformity of Coating by the Preece Test (Cooper Sulphate Dip) on Zinc Coated (Galvanized) Iron or Steel Articles”. Wire mesh shall withstand 220 hours of exposure before failure by rusting of any part when subjected to a salt spray test in accordance with ASTM B 117.

The tensile strength of the wire shall be in the range of four thousand (4,000) to six thousand (6000) kg / sq. cm. and shall have an elasticity to permit elongation of the mesh equivalent to a minimum of ten (10) % without reducing the gauge or tensile strength of the wire.

The minimum size of the wire used in fabrication of the gabion baskets shall be as follows:

Description	Diameter(mm)	US Steel Wire Gauge
Body Wire	2.3	11
Selvedge or Perimeter Wire	2.8	9
Tying and Connecting Wire	1.95	13

91.5.2.3 **Fabrication**

Gabions shall be in the form of rectangular baskets of the required dimensions and shall be manufactured from wire as specified above. Gabions shall be made of steel wire triple twisted forming a uniform hexagonal mesh pattern with openings eight (8) cm or by twelve (12) cm. The edges shall be formed into securely connected selvedges adequate to prevent raveling. Individual basket ties and connections shall be made by using a quantity of wire not less than 8 percent of the weight of each basket.

When the gabion length exceeds its width, it shall have securely tied diaphragms connected at all edges to form individual cells of equal length and width. Diaphragms shall be of the same material and manufacture as specified above for the gabions.

Four cross-connecting wires shall be provided in each cell having a height of one half the width or less, and eight (8) cross-connecting wires shall be provided in each cell having a height greater than one half the width.

All the characteristics and values given in the above specifications are subject to the tolerance of plus or minus five (5) percent.

91.5.2.4 Rock Fill

Fill for gabions shall consist of hard, durable rock pieces that will not deteriorate when submerged in water or exposed to severe weather conditions. Rock pieces shall be generally uniformly graded in sizes ranging from ten (10) cm to twenty (20) cm. Filled gabions shall have a minimum density of one thousand three hundred sixty (1,360) kg per cubic meter. Void spaces shall be evenly distributed and shall not exceed a maximum of thirty (30) percent.

The rock shall meet the requirements of AASHTO M 63 except that the Sodium Sulphate Soundness Loss shall not exceed nine (9) % after five (5) cycles.

91.5.3 CONSTRUCTION REQUIREMENTS

Installation shall be performed in a skillful manner as approved by the Engineer in-charge. Beds for gabions shall be suitable level. Gabions forming elements of structures shall be securely connected along the complete length of top contract edges by means of the above specified tying and connecting wire.

Before the rock fill is placed the gabions shall be stretched in such manner as will permit proper shape, alignment and compaction of fill.

Rock fill for exposed faces of gabions walls shall be carefully selected for uniformity or size, and the pieces shall be hand placed to provide a neat appearance as approved by the Engineer in-charge.

The vertical joints of gabion baskets shall be staggered as in running bond brickwork.

91.6 MEASUREMENT AND PAYMENT

91.6.1 Measurement

The quantities shall be measured for payment as below:

i. Earthworks

Earthworks shall be measured as per Section 3 of these Specifications.

ii. Stone Pitching

Stone Pitching shall be measured in Square Meters (SM)

iii. Reinforced Concrete

Reinforced Concrete shall be measured as per Section 5 of these Specifications in CM

iv. Wire Mesh

The galvanized steel wire mesh furnished placed and accepted shall be the theoretical number of kilograms (KG) calculated from the weight per square meter of mesh certified by the manufacturer and approved by the Engineer. The area of mesh to be measured shall be the net area of the Gabion in position.

v. Rock Fill

The rock fill shall be the number of loose cubic meters of rock placed in the gabion with an allowance of maximum thirty (30) % voids and accepted and measured by the width, depth and length of the gabion constructed as above in Cubic Meters (CM).

91.6.2 **Payment**

The quantities determined as provided above shall be paid for at the contract unit price, which shall be full compensation for all necessary works, furnishing and placing of materials and all other costs related to completion of the work.

Pay Item No.	Description	Unit of Measurement
91.6 a	Supplying and filling cotton bags 50kg capacity with sand or earth, sewing and stacking	
	i. in dry	NO
	ii. in position under water	NO
91.6 b	Supplying and filling cotton bags 200kg to 250kg capacity with sand or earth, sewing and stacking	
	i. in dry	NO
	ii. in position under water	NO
91.6 c	Carriage of cotton bags 50kg capacity filled with sand or earth	
	i. Up to 30m	NO
	ii. From 30m to 122m	NO
	iii. For each subsequent 30	NO
91.6 d	Carriage, loading and unloading of cotton bags by jeep (4x4), 200kg to 250kg capacity filled with sand or earth.	
	i. Up to 30m	NO
	ii. From 30m to 1 km	NO
	iii. For each subsequent 1 km	NO
91.6 e	Carriage within 152m.	
	i. Boulders 229mm and above	CM
	ii. Carriage Oversize shingle 76mm to 229mm	CM
	iii. Carriage mix graded shingle	CM
91.6 f	Providing and filling brick bats in crates.	CM
91.6 g	Providing and filling brick crates and hand packing.	CM
91.6 h	Providing and filling stone (semi dressed) in wire crates and sewing.	CM
91.6 i	Providing and laying shingle on top of bund including carriage of material within 92m.	CM
91.6 j	Providing and Dumping shingle spawls and boulders including carriage of material within 92m.	CM
91.6 k	Provide & weave GI wire netting for wire crates	
	i. 6"x6" mesh (15 SWGwire)	SM
	ii. 6"x6" mesh (10SWGwire)	SM
	iii. 6"x6" mesh (8SWGwire)	SM
	iv. 4"x4" mesh (15 SWGwire)	SM
	v. 4"x4" mesh (10SWGwire)	SM
	vi. 4"x4" mesh (8SWGwire)	SM
91.6 l	Providing and Laying stone pitching/filling, dry hand packed in pitching & aprons	CM
91.6 m	Providing and Laying stone pitching with hammer dressed stones on surface, laid in courses	CM

91.6 n	Providing and Laying stone pitching for top layer only	
	i. On slope	CM
	ii. On level	CM
91.6 o	Providing and Laying stone or spawl filling	
	i. On slope	CM
	ii. On level	CM
91.7 p	Providing and Laying grouted stone pitching, in 1:8 c/s mortar	
	i. Top layer on slope	CM
	ii. Top layer on level	CM
91.7 q	Providing and laying grouted stone pitching with un coursed rubble (15-20cm thick) for any purpose in cement sand mortar.	
	i. CS 1:3	SM
	ii. CS 1:6	SM
91.7 r	Remove stone & re-pitching hand packed, on slopes or level, making good damaged portion.	CM
91.7 s	Providing and grouting jharies between blocks with local coarse aggregate 3/4" to 3/8" size.	CM
91.7 t	Breaking stone into spawls and stacking.	CM
91.7 u	Providing and fixing floating spurs, with material from canal plantation within 1 km,	
	i. Up to 2ft FS depth	NO
	ii. 2ft to 3ft FS depth	NO
	iii. 3ft to 4ft FS depth	NO
	iv. More than 4ft FS depth	NO

SECTION 92 OUTLETS

92.1 SCOPE OF WORK

The Scope covers all works required in connection with the construction, repairs, adjustments, dismantling, earthwork, etc. of an outlet as per approved Drawings and Specifications and may include such other works in connection therewith as may be specified or as directed by the Engineer-in-Charge. Specifications items, shall be same as mentioned under Part-1of this Specifications, unless otherwise mentioned herein.

The scope shall also include furnishing all labour, materials, plants, equipment, instruments, accessories and services necessary to complete the works such as excavation, concreting, brickwork etc. in a workman-like manner. The scope shall also include the outlet according to its sanctioned size as per approved Drawings and Alteration Form of the outlet.

92.2 CONSTRUCTION OF OUTLETS (OTHER THAN PIPE)

92.2.1 MATERIALS

i. Cement

Portland cement shall conform to ASTM C-150 Type-1 or B.S.S-12 and shall meet the requirements and stipulations, specified for Portland cement in Section 5 – Plain & Reinforced Concrete.

ii. Sand

Sand shall conform to Specifications, requirements and stipulations specified for Sand in Section 5 – Plain & Reinforced Concrete.

iii. Aggregate

Course Aggregate shall conform to the specifications already given in Section 5 – Plain & Reinforced Concrete.

iv. Bricks

First class bricks sand moulded shall be used, which shall conform to the specifications for Brickwork under Section 11.

v. Water

Water shall conform to the Specifications for Water, Section 5 – Plain & Reinforced Concrete.

92.3 EXCAVATION

Excavation of the bank for the construction of an outlet shall be in accordance with Section 3 – Earthwork and made as per dimensions suitable to the size of the outlet structure with proper side slope and the depth given in the approved Drawing and earth thus obtained shall be thrown 2 cft. (6 meters) away from theedge of the cutting. Bottom of the excavated portion of bank shall be leveled and well compacted before laying of foundation concrete. If the length, width, depth, grade, levels and side slopes are not indicated on the Drawing, they shall be carried out to the profile agreed by the Engineer-in-Charge in writing. After the completion of work the excavated portions on both sides of the outlet shall be refilled, rammed and / or puddled as per specifications or as directed by the Engineer-in-Charge.

92.4 PLACING CONCRETE

The production and placing of concrete as specified shall be done according to approved mix and dimensions given on the drawing as per specifications in Section 5 – Plain & Reinforced Concrete. As the concrete is being placed, it should be compacted thoroughly and uniformly by means of hand tools or finishing machines to secure a dense structure and smooth surface. Immediately before placing concrete all surfaces upon or against which it is to be placed shall be free from standing water, mud, debris or loose material. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that moisture is not drawn from the freshly placed concrete.

Slabs to be laid on the water course culverts, liable to be damaged by dropping from a height, shall be lowered down to the ground by means of a rope or another approved appliance or as directed by the Engineer-in-Charge. If any slab is damaged or broken on account of the negligence of the Contractor, he shall have to replace it at his own cost.

92.5 BRICKWORK

Brickwork for an outlet shall be executed according to the specifications given in Section 11 – Brickwork in addition to fixing cast-iron or brick block of APM Outlet or open flume outlet including dressing of bricks, which shall be treated as a separate item of work for payment purpose.

92.6 DISMANTLING AND ADJUSTING OF EXISTING OUTLETS

92.6.1 SCOPE

Dismantling of different types of existing outlets for including Kennedy Gauge outlet, Orifice, Adjustable Proportional Module, Open Flume, Tail Cluster Bifurcation, Tail Cluster Trifurcating, Tail Cluster Quadrification for the under-mentioned purposes as per approved Alteration Form or as directed by the Engineer-in-Charge in writing shall be done in accordance with Section 4 – Dismantling (Demolition) and would involve.

i. Dismantling Outlet old type such as KGO Orifice and replacing by APM or of types commensurate with the designed discharge size and change in site.

ii. Adjusting size, changing of site or type of the outlets of various types mentioned above.

iii. Improving the working conditions of the non-modular outlets by changing their type and if need be their site also.

iv. Dismantling side wall for taking out bricks block of APM and fixing Iron block in place of brick block and rebuilding dismantled walls.

v. Dismantling side walls of an open Flume outlet for adjusting its width (B), fixing roof block and rebuilding the side walls.

vi. Adjusting size(Y) of an APM outlet and rebuilding its side walls.

vii. Removing the old iron block of an APM outlet and re-fixing the iron block after adjusting its 'B' and 'Y' and rebuilding the side walls.

92.7 PIPE OUTLETS

92.7.1 SCOPE

The scope covers all works required in connection with the fixing of pipe outlets including earthwork excavation, concreting, fixing Cast Iron, Steel or RCC hume Pipes, brick work in face and walls, earthwork refilling and puddling etc. all items of work i.e. excavation, laying of pipes, concreting, brick work. The refilling, ramming and puddling of earthwork shall be carried out as per specifications given in the Section 3 - Earthwork of specifications and as directed by the Engineer-in-Charge.

92.8 CONSTRUCTING OR ADJUSTING OUTLETS IN RUNNING WATER

92.8.1 SCOPE

When work for a new or existing outlet is to be executed in running water, an earthen ring bund in a semi-circle form shall be constructed in the channel to provide a working space for the safe execution of work. Water side of this bund shall be protected by killa bushing so as to check side erosion by the running water and thus eliminate the possibility of any damage to the bund. After satisfactory completion of work this bund shall be removed to the satisfaction of the Engineer-in-Charge. The modus operandi for dismantling and adjusting the existing outlet is given in Specification No. 92.6 above.

92.9 MISCELLANEOUS

92.9.1 SCOPE

In case of non-availability of water during construction of New Channels or in long closures, special arrangements for supply of water for construction and curing etc. shall be made by the Contractor for which separate allowance shall be paid to the Contractor for each Outlet at the rate tendered by the Contractor corresponding to the applicable CSR item.

92.10 MEASUREMENT AND PAYMENT

92.10.1 COMPOSITE RATE

The measurement and payment for the items of the work of Outlets shall be made corresponding to the applicable items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

All items of works mentioned in Part-1 or Part-2 will be used under this Part, based on the drawings. Rates will be applicable as per Part-1 or Part-2 of these documents, unless otherwise mentioned herein.

Pay item No.	Description	Unit of Measurement
92.10 a	Earth work for outlets excavation refilling ramming and puddling	
	i. Channels discharge up to 1.40 cumecs	NO
	ii. Channels discharge up to 1.45 to 2.80 cumecs	NO
	iii. Channels discharge up to 2.85 to 5.60 cumecs	NO
	iv. Channels discharge up to 5.60 to 10.00 cumecs	NO
	v. Channels discharge more than 10.00cumecs	NO

92.10 b	Dismantling outlets	
	i. Old type such as K.G.O orifices etc.	NO
	ii. A.P.M or O.F height up to 610mm	NO
	iii. A.P.M or O.F height up to 610mm to 914mm	NO
	iv. A.P.M or O.F height more than 914mm	NO
	v. Tail cluster bifurcation	NO
	vi. Tail cluster trifurcation	NO
	vii. Tail cluster quadrification	NO
92.10 c	Making temporary A.P.Mbricks block and fixing at site	NO
92.10 d	Dismantling wall taking out temporary A.P.M bricks block and fixing iron block and rebuilding dismantled walls	NO
92.10 e	Dismantling walls and fitting iron block of O.F outlet	NO
92.10 f	Constructing, watching and removing bund for outlet built in running water	
	i. Up to 914mm depth	NO
	ii. More than 914mm depth	NO
92.10 g	Adjusting “B” of tail cluster by dismantling and rebuilding throat walls	NO
92.10 h	Adjusting “Y” of an A.P.M outlet including dismantling and rebuilding	NO
92.10 i	Fixing A.P.M and O.F outlets blocks including dressing of brick	
	i. For channel depth of 1.5m	NO
	ii. For channel depth of 1.2m to1.5m	NO
	iii. For channel depth of 0.9m to1.2m	NO
	iv. For channel depth of 0.6m to 0.9m	NO
	v. For channel depth of less than 0.6m	NO
92.10 j	Repairing damaged reducing collar of hume pipe outlets, as per drawings and as directed by the Engineer.	NO
92.10k	Laying iron pipes of outlets, as per drawings and as directed by the Engineer.	LM
92.10 l	Water allowance for construction of outlets or culverts when channel water is not flowing, as per drawings and as directed by the Engineer.	NO
92.10m	Hoisting and placing R.C slab or stone in position on outlets or W.C culverts, as per drawings and as directed by the Engineer.	
92.10 n	Providing and fixing pipe outlets including back filling of earth and pudding, portion under bank, as per drawings and as directed by the Engineer.	

	i.	portion under bank	LM
	ii.	Portion under road beyond bank	LM
92.10 o	Removing pipe outlets refilling earth and pudding, as per drawings and as directed by the Engineer.		
	i.	Portion under water	LM
	ii.	Portion under road beyond bank	LM
92.10 p	Changing pipe outlets (removing one pipe and replacing it at the same site with another pipe) complete with earth and pudding, as per drawings and as directed by the Engineer.		
	i.	Portion under bank.	LM
	ii.	Portion under road beyond bank	LM
92.10 q	Providing and laying Pre-cast parabolic segments without steel, moulded with cement concrete 1:1-1/2:3, including carriage, lowering in water channels to correct alignment and grade, jointing, finishing where necessary, etc. complete in all respect.		
	i.	PCPS 9”X12”	LM
	ii.	PCPS 9”X14”	LM
	iii.	PCPS 12”X18”	LM
	iv.	PCPS 24”X14”	LM
	v.	PCPS 24”X18”	LM
	vi.	PCPS 27”X19”	LM
	vii.	PCPS 21”X30”	LM
	viii.	PCPS 30”X48”	LM
	ix.	PCPS 36”X24”	LM
92.10 r	Providing and laying Pre-cast parabolic segments with steel, moulded with cement concrete 1:1-1/2:3, including carriage, lowering in water channels to correct alignment and grade, jointing, finishing where necessary, etc. complete in all respect.		
	i.	PCPS 9”X12”	LM
	ii.	PCPS 9”X14”	LM
	iii.	PCPS 12”X18”	LM
	iv.	PCPS 24”X14”	LM
	v.	PCPS 24”X18”	LM
	vi.	PCPS 27”X19”	LM
	vii.	PCPS 21”X30”	LM
	viii.	PCPS 30”X48”	LM
	ix.	PCPS 36”X24”	LM
92.10 s	Providing and laying following items for distribution system of water course/water channels, including carriage, lowering in water channels to correct alignment and grade, jointing, finishing where necessary, etc. complete in all respect.		
	i.	2 way 9” outlet	NO
	ii.	3 way 9” outlet	NO
	iii.	2 way 12” outlet	NO

iv.	3 way 12” outlet	NO
v.	Nuccaone way 24”	NO
vi.	RCC pipe 9”	LM
vii.	RCC pipe 12”	LM
viii.	Drop structure 9”x14”	NO
ix.	Bend 9”x14”	NO

SECTION 93 SURFACE DRAINAGE

93.1 SCOPE OF WORK

The work covered by this Section consists of furnishing all plant, labour equipment, appliances and materials and performing all operations in connection with the construction of Surface Drainage works in accordance with the Drawings and relevant Part of Specifications.

Specifications of items used shall be same as mentioned under Part-1or Part-2 this Specifications, unless otherwise mentioned herein.

93.2 RELATED WORKS/SPECIFICATIONS

i. Earthwork – Section 3 – Earthwork

ii. Concrete – Section 5 – Plain & Reinforced Concrete

iii. Block Masonry – Section 9 – Cement Concrete Block Masonry

iv. Rubble Masonry – Section 12 – Stone Masonry

v. RCC Pipes and Construction – Section 25 - Sewerage

All works shall be carried out according to the applicable provisions of the Sections referred above.

93.3 CONSTRUCTION REQUIREMENTS

93.3.1 PUNJAB STANDARD TYPE DRAINS

Punjab Standard Type Drains Types IV to VIII shall be constructed and shall be made of cement concrete 1:2:4 with 1:4:8 bedding or as specified concrete mix. The exposed surfaces of all inverts and drains including side concrete walls and bullnoze shall be applied a thin skin of about 6 mm thick 1:1 cement sand mortar immediately after the concrete has been placed and floating the same to clean smooth finish. The concrete walls for the side walls shall be moulded separately and shall be laid in 1:2 cement sand mortar on the concrete backing, previously prepared, not less than 14 days after being made. All joints being carefully struck perfectly clean and flush with the faces of the slabs. Where specified the walls shall be constructed of brick masonry, concrete block masonry or rubble masonry as shown on Drawings according to the applicable Sections referred in Sub-Section 93.2 above.

The preparation of the trench, aligning and grading shall be carried out in the same manner as required for sewers.

No extra payment shall be admissible for curves, bends, falls, junctions, inlets, outlets and all other special work in connection with the drains and the cost of all such special work shall be included in the rates as given in the schedule.

93.3.2 CROSSING OVER DRAINS

RCC slab 15 cm as specified shall be provided over the drains where shown on drawings or directed by the Engineer-in-Charge.

93.3.3 APPROACHES TO THE CROSSINGS

The approaches in the street to the crossing shall be laid in herring bone pattern either flat or on edge as directed in first class bricks. The base shall be of cement concrete as specified and the bricks shall be laid on a 6 mm layer of plaster. Any special cutting or curved work, boundary corners, curves, slopes and changes of slopes, cambers, cutting shaping and wastage of bricks to fit irregular area and all other special work is also included. The joints shall be struck flush and smooth. All profiles and strips shall be provided by the contractor at his own costs. Unless cement pointing is required by the Engineer-in-Charge, the external surface of the joints shall be struck flush as the work proceeds and left perfectly flushed and smooth.

93.3.4 CONNECTION WITH SEWERS

The surface drains shall be connected with sewers through gully gratings or as shown on drawings.

93.3.5 HOUSE OUTLET CONNECTIONS

The house outlet is connected through a khurra by means of connection drain to the main drain. The size of the khurra shall be according to the size of the outlet. The standard sizes of khurras are 30 cm x 30 cm, 30 cm x 23 cm and 23 cm x 15 cm. Khurras shall be made in the space between the house wall and the reimbursement or side wall of main drain and if there shall be no space available then khurra shall be constructed on the reimbursement. The house connection drain shall join the main drain at 45 degree to provide smooth flow.

93.3.6 TESTING OF DRAINS

After completion the drain shall be tested for flow by filling upto the full section.

93.3.7 REIMBURSEMENT

The reimbursement is bricks laid in cement mortar 1:5 on both sides of the roads sloping towards the drain (3 mm in 229 mm slope) on a 6 mm layer or mortar over specified thickness of base concrete. The work shall include any strips, sides and edging of narrow width area to be paved with dry bricks on edge or flat. The work shall also include all extra works involved in laying narrow strips I6 mm, 114 mm or 229 mm in width along sides of the drains and for all curves, bends, slopes and changes of slopes and other work involving added labor and material for irregular areas, cutting, fixing and wastage of bricks required for such works.

All joints between the bricks and along outer end and inner side of the reimbursement shall be completely filled with specified mortar.

93.3.8 TEGA

The house walls shall be protected by 76 mm or 114 mm thick Tega (i.e. brick on end) laid in cement mortar projecting to a maximum height of not more than 150 mm above the drain and the work shall include all excavation, cutting and wastage of bricks. The external surface of the joints must be flushed as the work proceeds.

93.3.9 FOUNDATION FOR REIMBURSEMENT AND TEGA

Cement concrete of 75 mm thickness shall be provided under reimbursement and Tega.

93.3.10 RCC PIPES

RCC pipes shall be laid as specified and shown on Drawings. The work shall be performed complying with the provisions of Sub-Section 25.3 - RC Pipes under Sewerage.

93.4 MEASUREMENT AND PAYMENT

93.4.1 COMPOSITE RATE

The measurement and payment for the items of the work of Surface Drainage hereof shall be made corresponding to the applicable Civil Works item as provided in the Contract Agreement and shall constitute full compensation, for procurements, transportations, performance in all respect and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

Special items, related to other items of specifications and not General Specification items, will become part of Special Provisions, to be written by the Designer.

SECTION 94 DRIP AND SPRINKLER IRRIGATION SYSTEM

94.1 DRIP IRRIGATION SYSTEM

94.1.1 BACKGROUND

Drip irrigation is the most efficient method of irrigating. While sprinkler systems are around 75-85% efficient, drip systems typically are 90% or higher. What that means is much less wastage of water. For this reason, drip is the preferred method of irrigation in the desert regions of the region. Drip irrigation has other benefits also which makes it useful almost anywhere. It is easy to install, easy to design, can be very inexpensive, and can reduce over moisture problems associated with high levels of moisture on some plants.

Drip irrigation (sometimes called trickle irrigation) works by applying water slowly, directly to the soil. The high efficiency of drip irrigation results from two primary factors. The first is that the water soaks into the soil, before it can evaporate or run off. The second is that the water is only applied where it is needed, (at the plant's roots) rather than sprayed everywhere. Further, drip systems are simple and pretty forgiving of errors in design and installation, there are some guidelines that if followed, will make for a much better drip system.

94.1.2 PARTS OF A DRIP SYSTEM

a. Valve

b. Back Flow Preventer

c. Pressure Regulator

d. Filter

e. Tubing Adopter

f. Drip Tubing

g. Emitters

h. End Cap or Flush Valve

i. Air Vents

94.1.3 PRESCRIPTIVE DRIP DESIGN GUIDELINES

94.1.3.1 Emitter Type and Flow

Use pressure compensating emitters if you have an elevation difference of over 1.5 meters in the area to be irrigated. For more level areas turbulent flow emitters will work great and are often less expensive. For gravity flow systems use short-path emitters, they typically work better than the others at very low water pressures.

For most soil types 2.0 l/hr (0.52 gph) emitters work well and are more economical. For sandy soil 4.0 l/hr (1.0 gph) emitters will suit.

How Many Emitters are needed?

1 or 2 emitters per plant, depending on the size of the plant. Trees and large shrubs may need more. Obviously, using two allows for a backup, if one clogs up (which happens now and then, even on the best designed and maintained drip systems.)

But just as important, more emitters also wet more soil area. This results in more roots, and a healthier, happier plant. Exception: if the plants are very close together you may need to use less than 2 per plant in order to maintain the minimum spacing between emitters. Minimum spacing for emitters: In most situations install emitters at least 450mm (18″) apart. Good default spacing for quick and dirty design is to space the emitters 600mm (24″) apart. For supplemental watering of low-water-use plants, use one emitter per plant. Supplemental watering is used for establishment of drought tolerant plants that are not likely to need irrigation, once they have developed a good root system, or might be used to apply a little extra water now and then to make them a bit more lush. Use of low-water plants with supplemental drip irrigation is considered very "green" and is the current trend in landscape design.

Rule of thumb-

Install emitters 600mm (24″) apart under 80% of the leaf canopy of the plant. That's where the roots are, and the roots need water. If the soil is very permeable install emitters 300mm to 450mm (12-18 inches) apart.

94.1.3.2 Backflow Preventer

Drip emitters rest directly on the soil so it is especially important to have a backflow preventer to prevent water contamination by soil-borne disease. There are several types that will work depending on situation and local codes.

What valve type and size to use

Use a 20mm (3/4″) valve for most systems. Any type of valve may be used.

How many emitters per valve

Use the Table 94.1 below to determine how many emitters to install on each valve circuit.

Table 94.1: Number of Emitters

Emitter volume used	Any water supply that comes out of a building, such as a hose bib. Any system with a pump*.	20mm (3/4″) water supply. Use a 20mm (3/4″) valve.	25mm (1″) water supply. OK to use a 20mm (3/4″) valve.
2.0 l/hr (0.52 gph)	300	300	700
4.0 l/hr (1.0 gph)	180	180	420

*Pumps can be tricky. This is a conservative figure in order to make it work with the majority of pump fed systems. You may be able to use a larger number of emitters by calculating the actual output of the pump.

94.1.3.3 Mainlines & Laterals

Use 25mm (1 inch) PVC, PEX or polyethylene irrigation pipe for mainlines ("mains") and laterals. The total length of the mainline and the lateral together should not be more than 120 meters (400 feet). So for 100 meters of mainline and 20 meters of lateral, for a total of 120 meters of both can be adopted. But it is not recommended to have 80 meters of mainline and 60 meters of lateral because the total of both would be more than 120 meters. It may be noted by the Designer that mainline is

the pipe before the control valve, lateral is pipe after the control valve. Many drip systems won't need mainlines or laterals. Or they may need just a mainline, or just a lateral.

94.1.3.4 Maximum drip tube length

The length of drip tube (or drip hose) may not exceed 60 meters (200′) from the point the water enters the tube to the end of the tube. Thus the Designer could have 120 meters (400′) of tube if the water entered the tube in the middle (that would be 60 meters from the point the water enters the tube to the end of the tube in each direction, which would be OK). Designer can extend one tube-off of another, as long as the total length of the tubes that are connected is not more than 60 meters (200′).

94.1.3.5 Buried Emitters

Never bury emitters underground unless they are made to be buried. If it is buried near roots, then the roots will grow into it and clog the emitter. If it is needed to bury the emitters, do a search for "subsurface drip irrigation" to find specialty drip products designed to be buried. Follow the manufacturer's recommendations for those products, as these must be designed and installed to very exact standards to avoid problems.

94.1.3.6 Buried Tube

Don't bury the drip tube. If drip tube is buried, it may be chewed up by gophers, moles or other rodents. A water bowl with an emitter over it to keep it full sometimes will distract wildlife from the tubes. If it is required to hide the tube, dig a shallow trench for it, so that it is just below the level of the surrounding soil. Don't put dirt over the tube. Throw some mulch or bark over the top to hide the tube, or plant a low spreading plant that will grow over it and hide it.

94.1.3.7 Feeder, Spaghetti, and Distribution Tubing

Avoid using feeder, spaghetti, or distribution tubing if possible.

94.1.3.8 Hard-Piped Drip Systems

A type of drip system used in commercial and high quality landscapes called "hard-piped" uses buried PVC pipe rather than poly drip tubing. The PVC pipe is installed underground and a pipe goes to each plant location, so it takes a lot of pipe. At each plant the emitters are installed above ground on short poly tubes called "risers". Hard pipe systems can be pretty expensive. The design of a hard-piped drip system is essentially the same as shown here, except to use PVC or larger size poly irrigation pipe in place of the inexpensive drip tubing.

94.1.3.9 Fittings- Use the correct size!

This is really important! There are many different sizes of drip tubing sold, and the fittings have to be made for the exact size tube. If they aren't, they will either be very hard to install, or the tube will blow off the fitting. Sometimes it takes a week or so for the tube to come loose, but if the fitting is even 1mm too large, the tubing will come off eventually. Never heat the drip tube or use oil on it to make it easier to insert into or onto the fittings.

94.1.3.10 Check Valves, Slopes and Hillsides

Install check valves if the drip system is on a hillside of slope to prevent the water in the tubes from draining out through the lowest emitter each time the system stops running.

94.1.3.11 Air Vents

Install an air vent at the highest point on each drip valve circuit. If there are multiple high points, air vents are installed at each one. Air vents should always be used for drip systems on sloped areas. Air vents are often not installed on small homeowner drip systems without any slopes. If air vents are not used be sure the emitters at the highest points are not installed, where dirt could be sucked into them.

94.1.3.12 Flush Valves and End Caps

Install a flush valve or end cap at the end of each drip tube. Automatic flush valves are available.

94.2 SPRINKLER IRRIGATION SYSTEM

94.2.1 The Rotor Irrigation System

The Rotor system is in demand currently, since it's water-efficient and makes it easy for the soil to absorb the water without a lot of wastage. Some believe that it is more practical than spray heads. They emit water at a slower pace and work for both small as well as large areas. The radius and the application patterns are adjustable, which makes it easier for uniform distribution of the water.

94.2.2 Before Investing in a Sprinkler Irrigation System

Prior to investing in a sprinkler system, there are certain things to check. There are three main things that are needed to take care of before investing in it. Designer must ensure that the type of soil to irrigate is ideal for irrigation. The next step is ensuring that enough water sources are available near the landscape, to supplement the irrigation system. These are some of the things that you need to consider before purchasing an irrigation system.

94.2.2.1 The Factors to Consider

Investing in a sprinkler irrigation system without prior planning or thought process, can prove to be problematic lateron. There are certain parameters to consider before choosing a sprinkler system, as under:

94.2.2.2 The shape of the field

Before picking the right sprinkler type and system, it is needed to consider the shape of the field. If it's an odd shape, choose the rotor system. If even distribution is desired, then opt for either the drip method or overhead sprinkler method, based on the overall requirement.

94.2.2.3 The size of the field

The next factor to consider is the size. Based on the size, Designer has to pick the right sprinkler, and space it strategically at a distance to ensure even distribution of the water. While some crops or plants need slow and calculated distribution of water, others need a steady flow of water to sustain.

94.2.2.4 The time and labour required

Most irrigation systems require adequate maintenance and management. Based on the size of field and the amount of time and labour required, pick the right sprinkler irrigation system.

94.2.2.5 The location of the field

The topography of location is extremely crucial. Whether it is a flat plain or a hilly area, each location requires a specific type of sprinkler head and system for effective irrigation.

94.2.2.6 Sprinkler System Capacity

The capacity of a sprinkler system is proportional to the flow rate required for irrigation of an area. The capacity is dependent on the crop requirements, the texture of the soil, water-holding capacity of the soil, the root depth and permitted pumping rate as approved by the authorities.

One of the major benefits of investing in a sprinkler system is the low erosion rate. This is why the application rate of the system needs to match the intake rate of the soil. If the system's application is higher than the intake rate, there are chances of water runoff. This will eventually lead to overwatering or under watering of your field.

The system timer: Checking the timer of the irrigation system is essential to optimize the irrigation schedule for a specific landscape.

The sprinkler heads: Any damage to the sprinkler head can cause problems for the system. Check for any wear and tear on a periodic basis.

94.3 MEASUREMENT AND PAYMENT

Pay Item No.	Description	Unit of Measurement
94.3 a	Supply an installation of drip irrigation system including drip line, dripper, control valve, flow disk filter and 2HP submersible pump with motor and MCU including all fitting, testing and commissioning, complete in all respect. (Excavation/ Backfilling and Carriage from District Headquarter to project site will be paid extra)	SM
94.3 b	Supply an installation of sprinkler irrigation system including rain bird pop up turf standard rotor with nozzle, flow control valve, U-PVC pipe, flow disk filter and 2HP submersible pump with motor and MCU including all fitting, testing and commissioning, complete in all respect. (Excavation/ Backfilling and Carriage from District Headquarter to project site will be paid extra)	SM

SECTION 95 PRE-CAST / PRE-FABRICATED IRRIGATION CHANNELS, OUTLETS AND BARRIERS

INTRODUCTION AND SCOPE

Pre cast irrigation channels, Outlets and Barriers will be of various sizes/various shapes made of pre cast concrete of specified strength.

The quality of concrete and maximum size aggregate shall be as per the drawings of the project, whereas the strength and pre casting procedure shall be as per section-5 (Plain and Reinforced Concrete).

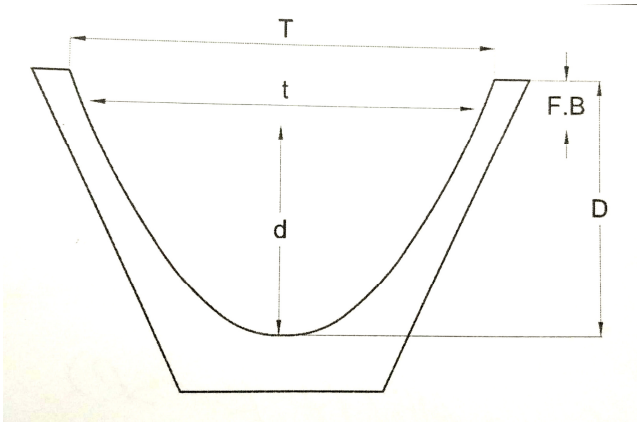
Any operation other than supplying and fixing of pre cast channel shall be as per the drawing, whereas the specifications will be followed under the relevant item of these Specifications.

PRECAST CONCRETE LINING

Lining of Watercourses is generally done by using precast concrete segments available in different sizes depending upon the design flow. Available precast concrete segments are tabulated below along with a typical cross section of the precast concrete segment;

Table 95-1: Available Precast Concrete segments for lining of watercourses

Sr No.	Segment Size	Top Width (T)	Total depth (D)	Free Board (FB)	Max. Flow Depth (d)	Flow Area (A)	Eq. Coefficient (a)
	(mm x mm)	(mm)	(mm)	(mm)	(mm)	(sq. m)	
1	360 x 225	360	225	70	155	0.054	0.006944
2	457 x 305	457	305	70	235	0.093	0.005842
3	600 x 360	600	360	70	290	0.144	0.004000
4	540 x 460	640	450	70	390	0.196	0.004492
5	675 x 480	675	450	70	410	0.216	0.004214
6	780 x 530	760	530	70	460	0.269	0.003670
6a	800 x 600	600	600	70	530	0.320	0.003750



RECOMMENDED MAJOR CONSTRUCTION EQUIPMENT

SECTION NO.	DESCRIPTION	CONSTRUCTION MACHINERY
Part-1	**Civil and Allied Works**	
Section 3	Earthwork	1. Excavator (with appropriate attachment) 2. Pump (2 horse-power)
Section 4	Dismantling (Demolition)	1. Jack Hammer 2. Compressor 125CFM
Section 5	Plain and Reinforced Concrete	**Category-I (small concrete works)** 1. Concrete Mixer (1 bag) 2. Concrete Vibrator (1/2" size) **Category-II (single or two story building)** 1. Concrete Mixer (1 cu-m) 2. Poker Concrete Vibrator (1/2" size) 3. Concrete Crane (for buckets) Or Concrete Hoist **Category-III (Ground + 3)** 1. Concrete Mixer (1 cu-m) 2. Poker Concrete Vibrator (1/2" or 2") 3. Surface Vibrator 4. Concrete Pump (10 cu-m / hr) 5. Crane Bucket arrangement 6. Water Tanker (4000 liter) with Tractor **Category-IV (Multi-story building)** 1. Concrete Batching Plant 2. Poker Concrete Vibrator (1/2" or 2") 3. Surface Vibrator 4. Concrete Pump (10 cu-m / hr) 5. Crane Bucket arrangement Or Tower Crane 6. Water Tanker (4000 liter) with Tractor
Section 6	Sheet Piling	1. Pneumatic Hammer
Section 7	Pile Works	1. Boring (Rotary / Percussion) 2. Concrete Batching Plant Or Concrete Mixer (1 cu-m)
Steel 10	Steel Reinforcement	1. Bar Bending Machine
Steel 11	Brick Masonry	1. Water Tanker (4000 liter) 2. Hoist (Lift)
Steel 13	Roofing	1. Small Drill Machine
Steel 14	Flooring	1. Grinding Machine
Section 19	Steel Doors, Windows and Misc. Works	1. Cutter (Steel) 2. Punching Machine 3. Welding Machine
Section 20	Steel Structures	1. Forging machine 2. Cutter (Steel) 3. Punching Machine

		4. Welding Machine
Section 21	External Paving, Parking Areas	1. Roller (8-10 tons)
Section 22	Horticulture	1. Farm Tractor
Part-2	**Public Health Engineering Works**	
Section 42	Water Supply, Gas, Fire Protection, Fountain Piping and Specialities	1. Excavator or Backhoe (for trenches)
Section 43	Sanitary, Storm Drainage, Sewerage Piping and Specialities	1. Excavator or Backhoe (for trenches) 2. Plate Compactor (300 kg)
Section 45	Tube-Well	1. Drilling Rig Percussion 2. Small Crane
Part-3	**Electrical Works**	
Section 57	Cutting Floor, Walls & Ceiling	1. Cutting Machine (1/2 horse-power)
Section 58	Testing & Inspection	1. Testing and Commissioning Equipment
Section 68	Light Fittings & Fixtures	1. Cabin type Crane 2. Testing and Commissioning Equipment
Section 75	Power Transformer	1. Crane 2. Protection Equipments 3. Testing and Commissioning Equipment
Section 76	External Lighting	1. Cabin type Crane 2. Testing and Commissioning Equipment
Section 80	Generators	1. Crane 2. Protection Equipments 3. Testing and Commissioning Equipment
Part-4	**Irrigation and Drainage Works**	
Section 90	Lining of Canals	1. Concrete Batching Plant 2. Concrete Lining Machine 3. Plate Compactor Or Vibratory suided Roller
Section 92	Outlets	1. Concrete Mixer (1 cu-m) or 2. Concrete Mixer (1 bag) 3. Plate Compactor
Section 93	Surface Drainage	1. Excavator 2. Plate Compactor 3. Surface Vibrator

LIST OF APPROVED MANUFACTURERS / SUPPLIERS/SOURCES – CIVIL WORKS

This list of recommended manufactures/Suppliers of different materials/equipments with brand names have been provided in order to establish a standard level of performance. The Contractor is supposed to provide and fix the materials / equipments of acceptable quality from the list or equivalent as approved by the Engineer. Material from approved list shall stand rejected, if it fails in any of the specified tests or quality standards.

Sr. No.	Description	Manufacturer/Supplier/Source
1	Cement (OPC, SR)	Lucky, Pioneer, Maple Leaf, State Cement, Fouji, Askari, Facto, Charat, DG Khan
2	Cement (White)	Anwarzeb, Kohat, Maple Leaf, Zealpak
3	Construction Chemicals & Sealants	Sika, Fosroc, BASF, Ultra, Fastchem, Vertex, MAPEI, KALON, Mitchell
4	Anchoring / Fixing Systems	Strong hold, Strong force, Hilti, Fischer
5	Sand (for RCC)	From approved source (AJK) as per Mix Design and for high risk structure/construction Lawrencepur.
6	Sand (other works)	From approved source (AJK) as per nature of work.
7	Aggregate	From approved source (AJK) looking to the nature of work as per recommendations of M/s NESPAK under study of Construction material sources in and around AJ&K.
8	Steel Reinforcement	AFCO, Ittefaq, Fazal, Razzak, Pak Steel, Model Steel, FF Steel, Nizami Brothers, Moiz Steel, Poineer, Tayyaba Steel
9	Bitumen (Cold)	National Refinery, Attock Petroleum, PARCO
10	Bricks/Blocks	Local (Brand / source to be approved by the Engineer)
11	Ceramic Tiles	Shabbir, Master, Time Ceramic or Equivalent imported
12	Vinyl Tiles	Decora, Marflex, A.T.S. Synthetic
13	Textured Decorative Wall Coating	Rockwall, Wall Tec, Rock Shield, Sand Tec, Graffito, Jotun
14	Aluminium Doors / Windows	ALCOP, Pakistan Cables, Chawla, Prime, Ittehad Aluminium
15	Aluminium Composite Panel	ALCOP, Chawla, Pakistan Safety Glass (Alcobond), AKB (EuroBond – Exterior. & DuBond – Interior)

16	Paint	ICI, Burger, Master, Kansai (Japan), Nippon, Jotun, Diamond, Buxly, Pakistan Phthalates Limited (Kalon Chemicals Company)
17	Powder Coating	Jotun or approved equivalent
18	Concrete Pavers	Tuff Tiles, Izhar, Envicrete, National Pavers, Banu Mukhtar
19	Insulation	Diamond (Jumbolon), Pakistan Insulations, Safe line, Insugreen,
20	Membranes for Roof and Basement walls	Polytec (Henkel Polybit), Hygrip, Roof Grip, A.T.S. Synthetic, Petro Seal, Bitumat (Saudi Arabia), Pakistan Phthalates Limited (Kalon Chemicals Company)
21	uPVC Doors / Windows	Framez, Uniwin, Nasar Steel, U-Tech, Green Door, V-Make, Chawla
22	Steel Doors and windows	SECCO or any other approved equivalent
23	Termite Proofing	Agenda (Termidor), Biflex, Fiprokil, Mirage, Termicure, Ability
24	Terrazzo Tiles	Ajaibat-e-Sung Lahore or as approved by Engineer
25	Pre-Engineered Steel Buildings	Zamil, Mammut, Mabani, Kirby, Banu Mukhtar, Izhar, SACHAL
26	Pre-cast water courses and water channels	Sher Ali concrete Industry shaerghar Malakand KPK, ALI RCC Sheikupura, Asif Ranja construction Gujranwala, Khaiber RCC Sherghar Jalala-KPK.
27	Gypsum False Ceiling	United Gypsum, Arish
28	Glass	Ghani, Al-Fattah, Pakistan Safety Glass
29	Door hardware	Sitara Hardware, Jb.Saeed, IM Hardware (Yale) or approved equivalent

Conditions of Enlistment

1. The subject list is provisional, which may be changed and refreshed when deemed necessary.
2. Addition or Subtraction of any company, manufacturer, supplier and vender depends on its performance.
3. The client is responsible to ensure quality, by batch wise testing, from well reputed material testing laboratory.

LIST OF APPROVED MANUFACTURERS / SUPPLIERS/SOURCES - PUBLIC HEALTH WORKS

This list of recommended manufactures / Suppliers of different materials / equipments with brand names has been provided in order to establish a standard level of performance. The Contractor is supposed to provide and fix the materials / equipments of acceptable quality from the list or equivalent as approved by the Engineer. Material from approved list shall stand rejected, if it fails in any of the specified tests or quality standards.

PUBLIC HEALTH WORKS		
1	Sanitary Ware	Master, ICL, Porta, Marachi
2	Bath / Kit. Fittings	Master, Faisal, Sonex, Porta
3	PPR-C Pipes & Fitting	Dadex, Beta, Master, Plasco, Turk Plast, Popular Pipe, Accufit, Minhas, Dura Built, IIL, Builtec, Euro Gulf, YAH Plastic Industry, Pelikan Pipe Industry (Civic)
4	uPVC Pipes & Fittings	Fast Flow, Dadex, Beta, Turk Plast, Jamal, Plasco, Popular Pipe, Master, Accufit, Dura Built, Builtec, Euro Gulf, YAH Plastic Industry, Newtech, Pelikan Pipe Industry (Civic), Prime Star Industries
5	RCC Pipe	Shalimar, Pakistan Pipes, National Pipe Industry
6	G. I. Pipes	International Industries Ltd. (IIL), Bashir Pipe, Master Pipe, Jamal, Victory
7	C. I. Pipes	Teepu, Alpine, NPC
8	Sluice Valves	KITZ (Star Corporation), Teepu, Rehman Group, Sirajia Trading co.
9	G.I. Fittings	KITZ (Star Corporation), Health Engineering (HE)
10	C. I. Fittings & Valves	Teepu, Alpine, Sirajia Trading co.
11	C. I. Manhole Cover	CME, Teepu, Alpine, Turk Plast
12	MS Seamless Pipe	Huffaz Industries, Jamal, KITZ, Sirajia Trading co., Master Pipes, Victory
13	Gas Geyser	Cannon, General, Nesgas
14	Water Pump (Imported)	KSB, DAB (Italy), Lowara, Grundfos, HMA (Vansan, Rovatti), SAER (Italy), XYLEM (USA), WILO (Germany)
15	Water Pump (Local)	PECO, Flowpak, Nobel, Golden Dynamics (Nowa)
16	Fire Pump	DAB (Italy), A-C Fire Pump, Firechief
17	PVC Water Stop	Fosroc, Sika, Decora, Marflex
18	HDPE pipe and Fittings	Dadex, Jamal, Plasco, Turk Plast, Beta, Popular Pipe, Accufit, IIL,DURA BUILT, Builtec, Fast Flow,

		YAH Plastic Industry, Newtech, Pelikan Pipe Industry (Pelikan), Prime Star Industries
19	Water Tank	Super Tuff, Dura, Accufit, Prime Master,
20	Electric water heater	Cannon, General, Nesgas
21	Kitchen Sink	Atlas or approved equivalent

Conditions of Enlistment

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LIST OF APPROVED MANUFACTURERS/ SUPPLIERS/ SOURCES – ELECTRICAL WORKS

This list of recommended manufactures/Suppliers of different materials / equipments with brand names has been provided in order to establish a standard level of performance. The contractor is supposed to provide and fix the materials / equipments of acceptable quality from the list or equivalent as approved by the Engineer. Material from approved list shall stand rejected, if it fails in any of the specified tests or quality standards.

Sr. No.	Description	Manufacturer / Brand / Supplier
1.	Light Fixtures	Philips, Galaxie (LED), Sunlight, Ledvance Osram (LED), Crest (LED)
2.	Distribution Boards and Main and Sub main Panel Boards	Siemens, Electrech, Acrotech, Schneider, South Asian
3.	Cables and Wires	Pakistan Cables, Newage Cables, Fast Cables, Coopergat, GM Cables
4.	PVC Conduit & Accessories	Beta, Popular, Plasco, Dadex
5.	Steel Conduit & Accessories	Hilal Industries, IIL, Jamal, Pioneer
6.	Switches, Sockets etc.	Bosch, Clipsal, Legrand, ABB, Hero (Premium)
7.	Back Boxes, Pull Boxes, etc.	Bosch, Clipsal, Legrand, ABB, Jamal, Hero (Premium)
8.	Telephone Cables Dish Antenna Cables	Siemens (Germany), Pakistan Cables Limited, Newage Cables
9.	Telephone Junction Boxes	S.A. Electric, N.R. Industries, MISTO Industries, TIP
10.	Fire Alarm System and PAS, CCTV	Sunlight, C-XOR, Mega Plus, Samsung, Bosch
11.	Fans	Pak, Millat, Climax, National, Royal, GFC, Lahore Fan
12.	MCCBs, MCBs & ELCBs, etc.	Siemens (Germany), ABB (Italy), Legrand (France), Schneider (Germany), Crest, South Asia Electric
13.	ACBs	ABB (Italy), Siemens (Germany), Legrand (France), Schneider (Germany)
14.	Generator Sets	Caterpillar, Siemens, FG Wilson, VPL (Onis Visa), PEL, Hyundai, Crest
15.	Transformers	Siemens (Validus Engg.), Climax, PEL, Hammad
16.	Earthing/Lightening Protection System	C-XOR (Spain), Mega Plus, Crest
17.	KNX System	ABB, Schneider

18.	HVAC	Samsung (Korea), Daikin (Malaysia), GREE (Australia), Mitsubishi, Panasonic
19.	Fire Fighting	Matron, Haseen Habib, SFFECO GLOBAL(UAE), LIFECO(UAE)
20.	Poles Steel	Jamal, Bashir
21.	Poles (Concrete)	Izhar or Equivalent

Conditions of Enlistment

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LIST OF APPROVED MANUFACTURERS / SUPPLIERS/SOURCES – IRRIGATION WORKS

This list of recommended manufactures/Suppliers of different materials/equipments with brand names has been provided in order to establish a standard level of performance. The Contractor is supposed to provide and fix the materials / equipments of acceptable quality from the list or equivalent as approved by the Engineer. Material from approved list shall stand rejected, if it fails in any of the specified tests or quality standards.

Sr. No.	Description	Manufacturer/Supplier/Source
1	Cement (OPC, SR)	Lucky, Pioneer, Maple Leaf, State Cement, Fouji, Askari, Facto, Charat, DG Khan
2	Sand (for RCC)	From approved source (AJK) as per Mix Design and for high risk structure/construction Lawrencepur.
3	Sand (other works)	From approved source (AJK) as per nature of work.
4	Aggregate	From approved source (AJK) looking to the nature of work as per recommendations of M/s NESPAK under study of Construction material sources in and around AJ&K.
5	Bitumen	National Refinery, Attock Petroleum, PARCO
6	Bricks	Local (Brand / source to be approved by the Engineer)
7	Pre-cast water courses and water channels	Sher Ali concrete Industry shaerghar Malakand KPK, ALI RCC Sheikupura, Asif Ranja construction Gujranwala, Khaiber RCC Sherghar Jalala-KPK.
8	Drip and Sprinkler Irrigation System	Rainmakers, Natural Resources Management Technology

Conditions of Enlistment

1. The subject list is provisional, which may be changed and refreshed when deemed necessary.
2. Addition or Subtraction of any company, manufacturer, supplier and vender depends on its performance.
3. The client is responsible to ensure quality, by batch wise testing, from well reputed material testing laboratory.

REFERENCES

The following references were taken into account for the compilation of General Specifications for Highways developed for Planning and Development Department, Government of Azad Jammu and Kashmir.

i. **General Specifications National Highway Authority, Government of Pakistan.**

ii. **AASHTO / ASTM Specifications (USA)**

iii. **British Standard Specifications (BS)**

iv. **Eurocode**

v. **SHRP Publications (USA)**

vi. **ACI Manual of Concrete Practice**

vii. **AISC Manual of Steel Construction**

viii. **The Asphalt Institute Manual Series**

ix. **Equipment Catalogues of different manufacturers**

x. **Various other international publications**

PATRONAGE (Client)

Client's Senior Executives, whose patronage contributed towards successful accomplishment of the assignment.

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