INVITATION FOR BIDS

Tender Notice

The Institute of Business Administration (IBA), Karachi has arranged funds form its own resources and partly from Govt. of Sindh towards the cost of **Construction of Faculty Apartment** and is intended that the funds will be utilized to make eligible payments under the contract for the aforesaid construction work. Sealed bids are invited from Prequalified firms having valid registration with Pakistan Engineering Council in category C-3 or above CE-09, CE-10, EE-11 and registered with relevant tax authorities (whichever is applicable) for the following tender.

Tender Title (Ref. No.)	Procedure	Bid Security	Project Estimated Cost	Completion Time
Construction of 32 Nos Faculty Apartment at IBA Staff Town, Karachi. (Project/05/21-22)	Single Stage Two Envelope	1%	380	18 months
Tender Fee & Dates				
Fee: Rs.10,000/- The pre-bid meeting will be held on -------Oct, 2022, at 11am with Manager Contracts (Project) Main Campus, IBA Karachi Issuance start date: ---------- 2022 at 9.00 AM Issuance end date & time: ---------- 2022 at 12.00 Noon Submission date & time: ---------- 2022 to ---------- 2022 at 12.00 Noon Opening date & time: ---------- 2022 at 12.30 Noon .				

Tender Document may be collected after submission of paid fee challan from the Office of **Head of Procurement, Fauji Foundation Building, IBA Main Campus, University Enclave, Karachi** on any working day (Monday to Friday). Alternatively, the tender document can be downloaded from the website. The Tender fee challan is to be generated from the IBA website https://www.iba.edu.pk/tenders/ which may be deposited in any branch of Meezan Bank Ltd. Sealed bids should be dropped in Tender Box placed at the Security Office, Gate # 4, IBA Main Campus University Enclave Karachi and will be opened on same date & venue in the presence of the bidders representatives who may wish to attend. In case of holiday the tender shall be opened / received on the next working day at same place and time. Bid Security in the form of Pay Order or Demand Draft has to be submitted in favor of "**IBA Karachi**" along with the Financial Proposal.

Kindly mention "Tender Number" at top left corner of the envelope.

N.B. IBA Karachi reserves the right to reject any bid or cancel the bidding process subject to relevant provision of SPP Rules 2010.

ADDRESS
Procurment Department
IBA, Main Campus, Univeristy Enclave, Karachi 75270
111-422-422 Fax (92-21) 99261508
Contact Person Senior Manager Contracts on 38104700 ext: 2517
Email nmalik@iba.edu.pk Website https://www.iba.edu.pk/tenders/

Evaluation/Qualification Criteria.

Evaluation Criteria is based on Technical Evaluation & Financial Evaluation. The Technical Evaluation is based on marks/score. The final selection will be on the basis of marks obtained by the bidder on combined Technical & Financial Evaluation as per detail given in Evaluation Criteria.

1. Criteria based on Marks/Score.

Mandatory Provisions/Eligibility: Firms/Contractors must possess

(i) Valid registration certificate of PEC in the category C-3 or above with specialization code CE-09, CE-10 & EE-11 for 2022 .

(ii) valid registration certificate from income tax authority (NTN); SRB

(iii) Affidavit for not blacklisted & litigation, if there is litigation then kindly provide a brief regarding the case/cases *(Attach all certificates and affidavit of not blacklisting).*

(***For a JV, Certificates& affidavit for each JV partner is mandatory***)

A bid fail in Mandatory Provisions /Eligibility will be declared as non-Responsive without any further proceeding.

Technical Evaluation Criteria

Aggregate Qualifying Score is for Technical Evaluation is 60%, but it is mandatory to obtain at least 30% in each of the following sections.

(A) Company Profile.

i.	Period since Firm/Contractor is in construction business	**10 Marks**
	Up to 5 years	02 Marks
	Up to 10 years	05 Marks
	Above 10 years	10 Marks

(Attach PEC license & firm Registration Certificate)

ii.	Office facilities	0**5 Marks**
	In Karachi	03 Marks
	In any other City of Sindh Province	01 Marks
	In any other City of Pakistan	01 Marks

(For Proof of Office establishment kindly provide evidence in the form of PTCL/ KE Bill or tenancy agreement in the Name of Firm)

(B) General Experience Record **35 Marks**

i. Projects of similar nature and complexity 20 Marks

Completed during the last 05 years.

Academic Building/ Residential G + 3 RCC Structure Min . built up having Covered area 30,000 Sft for individual project completed and approx. cost of Project Rs. 250M or above for each individual Project.

(4 Marks for each project)

(Attach Completion certificates of the Project along with Work Order and valid Reference from Owner)

ii. Projects of similar nature and complexity in hand. 15 Marks

Academic/ Residential Building G + 3 RCC Structure Min . Building Covered area 4,0000 Sft and approx. Estimated Cost of Construction 300 Million for each individual Project.

(3 Marks for each project having cost 300 Million or above).

(*Attach copies of work orders & Latest Status of the Project along with valid reference from Client*)

(C) Personnel Capabilities required for this project **30 Marks**

Sr. No.	Description/Position with qualification & experience	Number Required	Marks assigned	Remarks
1.	BSc (Civil Engg.) /BE(Civil) Engineers having valid registration with Pakistan Engineering Council (PEC) with experience of 15 years or above.	1 Nos.	10	05 Marks for experience of 5 to 14 years. 10 Marks for 15 or above. (***Kindly provide the Current Income Tax/EOBI Contribution Certificate of the Employee***)
2.	BSc / BE (Mechanical / Electrical) Engineers registered with Pakistan Engineering Council (PEC) with experience of 5 years or above or DAE with 10 Years Experience	1 Nos.	10	05 Marks for experience of 5 to 9 years. 10 Marks for 10years or above (***Kindly provide the Current Income Tax deduction Certificate of the Employee***
2.	Diploma in Civil Engineering, with experience of 10years or above.	01	10	05 Marks for 05 years to 9Years experience, 10 Nos for 10yrs or above .

(D) Equipment Capability **10 Marks**

S#	Description	Unit	Min. Qty	Marks
01	Mixer Machine (1 bag capacity)	Nos.	01	03
02	Shuttering (Wooden / steel) with supports	Sq. ft	10,000	03
03	Total station & Level Machine	No	01	02
04	Electrically operated Bar cutting machine	Nos.	01	02

The Bidder has to verify the above mentioned equipment are owned by the firm.

(a) High value equipment should be an option to own, lease or hire.

(b) Total equipment available with the applicant is to be listed along with its current mobilization on on-going projects.

(Details are to be provided in the attached form)

(E) Financial Soundness /Status **10 Marks**

For Financial Status assessment, the Applicants may be required to submit Audited Financial Statements for the last three years or any other document which verifies their Financial Status. Where necessary, the Procuring Agency will make enquiries with the firm's/contractor's bankers.

Working Capital in hand for this project/work (Attach proof of Bank Statement/Credit Facilities)

i. Less than 15% of Estimated Cost of this Work (Upto 57Million) 02 Marks

ii. 16 - 25% of Estimated Cost of this Work (Upto 95Million) 04 Marks

iii. 26 - 40% of Estimated Cost of this Work (Upto 152Million) 08 Marks

iv. More than 40% of Estimated Cost of this Work (More than 152Million) 10 Marks

(F) Any other information:

Any other document/information desired by procuring agency which shall not discriminate among contractors/firms.

Contractors/firms who fail to qualify in any of the above sections shall be disqualified from the tendering process.

Bids which fails to get 60 % aggregate marks in Technical Evaluation and 30 % in individual sections of the Technical Section will be declared as non responsive.

Scope of Contract:

1.1 Back Ground :

Institute of Business Administration Karachi is one of the oldest leading & Most prestigious Business School of the Country. Presently it is operating Two Campus with around four thousand students enrolled, One at Garden Road Campus known as City Campus spread over about 3.5 Acres with high rise academic buildings and the other one at Karachi University enclave Known as Main Campus. It is spread over about 23 Acres.

Institute of Business Administration intends to undertake Construction of Faculty Apartment at IBA Staff Town Karachi University Enclave Karachi and has decided to carry out the bidding process for selection of the Bidders to whom the Project(s) may be awarded.

1.2 Scope of Work :

The Proposed Project is Phase-I of 32 NOS FACULTY APARTMENTS and Comprises of the Following Components :

a) Block I ,II, III & IV Ground Plus Three Stories 8 Apartments. Covered area Total Each apartment is about 1850 Sqft Covered Area .There are Total 32 Nos of Apartments . Thus total covered area 59200 sft
b) Roads & Paths
c) External Sewerage & Water Supply Net Work
d) External Drainage
e) External Development
f) Horticulture

The Scope of Work includes the following works :

a) Building (Civil Works)
b) Plumbing, water supply, HVAC & Fire suppression Works
c) Electrical Works
d) Security and Net Working
e) Horticulture
f) Roads, Path & Parking

INSTRUCTION TO BIDDERS

INSTRUCTIONS TO BIDDERS

A. GENERAL

IB.1 Scope of Bid

1.1 The Procuring Agency as defined in the Bidding Data hereinafter called "the Procuring Agency" wishes to receive bids for the construction and completion of works as described in these Bidding Documents and summarized in the Bidding Data hereinafter referred to as the "Works".

1.2 The successful bidder will be expected to complete the Works within the time specified in Appendix-A to Bid.

IB.2 Source of Funds

2.1 The Procuring Agency has enough funds to cater for the cost of project.

IB.3 Eligible Bidders

3.1 This Invitation for Bids is open to all interested bidders who are eligible under provisions of Sindh Public Procurement Rules as mentioned below and the criteria given in the Notice Inviting Tender (NIT)/ Bidding Document.

Firms and individuals, national or international, may be allowed to bid for any project where international competitive bidding is feasible. Any conditions for participation shall be limited to those that are essential to ensure the bidder's capability to fulfill the contract in question.

(a) Bidders may be excluded if;

(i) As a matter of law or official regulations, commercial relations are prohibited with the bidder's country by the federal government in case of ICB, or

(ii) a firm is blacklisted/ debarred by the procuring agency and the matter has been reported to the Authority, subject to Rule 30 of Sindh Public Procurement Rules 2010.

(b) Government-owned enterprises or institutions may participate only if they can establish that they are;

(i) legally and financially autonomous, and

(ii) operate under commercial law.

Provided that where government-owned universities or research centers in the country are of a unique and exceptional nature, and their participation is critical to project implementation, they may be allowed to participate; and

Bidders shall include all those contractors who are registered or incorporated in Pakistan, irrespective of the nationality of their owners and professional staff, or

(c) Bidders are:-

(i) Registered with Pakistan Engineering Council in particular category and discipline,

(ii) registered with relevant tax authorities

IB.4 One Bid per Bidder

4.1 Each bidder shall submit only one bid either by himself, or as a partner in a joint venture. A bidder who submits or participates in more than one bid (other than alternatives pursuant to Clause IB.16) will be disqualified.

IB.5 Cost of Bidding

5.1 The bidders shall bear all costs associated with the preparation and submission of their respective bids and the procuring agency will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

IB.6 Site Visit

6.1 The bidders are advised to visit and examine the Site of Works and its surroundings and obtain for themselves on their own responsibility all information that may be necessary for preparing the bid and entering into a contract for construction of the Works. All cost in this respect shall be at the bidder's own expense.

6.2 The bidders and any of their personnel or agents will be granted permission by the Procuring Agency to enter upon his premises and lands for the purpose of such inspection, but only upon the express condition that the bidders, their personnel and agents, will release and indemnify the Procuring Agency, his personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of such inspection.

B. BIDDING DOCUMENTS

IB.7 Contents of Bidding Documents (SPP Rule-21)

7.1 The Bidding Documents, in addition to invitation for bids, are those stated below and should be read in conjunction with any Addenda issued in accordance with Clause IB.9.

1. Instructions to Bidders.
2. Bidding Data.
3. General Conditions of Contract, Part-I (GCC).
4. Particular Conditions of Contract, Part-II (PCC).
5. Specifications – Special Provisions.
6. Specifications - Technical Provisions.
7. Form of Bid & Appendices to Bid.
8. Bill of Quantities (Appendix-D to Bid).
9. Form of Bid Security.
10. Form of Contract Agreement.
11. Forms of Performance Security and Mobilization Advance Guarantee/Bond.
12. Drawings.
13. Addendum if any

7.2 The bidders are expected to examine carefully the contents of all the above documents. Failure to comply with the requirements of bid submission will be at the Bidder's own risk. Pursuant to Clause IB.26, bids which are not substantially responsive to the requirements of the Bidding Documents will be rejected.

IB.8 Clarification of Bidding Documents (SPP Rule-23(1))

8.1 Any interested bidder requiring any clarification(s) in respect of the bidding documents may notify the procuring agency in writing at the procuring agency's address indicated in the Invitation for Bids/NIT. Procuring agency will respond to any request for clarification provided they are received at least five calendar days prior to the date of opening of bid.

Provided that any clarification in response to query by any bidder; shall be communicated to all parties who have obtained bidding documents.

IB.9 Amendment / Modification of Bidding Documents

9.1 At any time prior to the deadline for submission of bids, the Procuring Agency may, for any reason, whether at his own initiative or in response to a clarification requested by a interested bidder, modify the Bidding Documents by issuing addendum.

9.2 Any addendum thus issued shall be part of the Bidding Documents pursuant to Sub-Clause 7.1 hereof and shall be communicated in writing to all purchasers of the Bidding Documents. Interested bidders shall acknowledge receipt of each addendum in writing to the Procuring Agency.

9.3 To afford bidders reasonable time in which to take an addendum into account in preparing their bids, the procuring agency may extend the deadline for submission of bids in accordance with Clause IB.20

C. PREPARATION OF BIDS

IB.10 Language of Bid

10.1 The bid and all correspondence and documents related to the bid exchanged by a bidder and the Procuring Agency shall be in the bid language stipulated in the Bidding Data and Particular Conditions of Contract. Supporting documents and printed literature furnished by the bidders may be in any other language provided the same are accompanied by an accurate translation of the relevant parts in the bid language, in which case, for purposes of evaluation of the bid, the translation in bid language shall prevail.

IB.11 Documents Accompanying the Bid

11.1 Each bidder shall:

(a) Submit a written power of attorney authorizing the signatory of the bid to act for and on behalf of the bidder;

(b) Update the information indicated and listed in the Bidding Data. and previously submitted with the application for tendering and continue to meet the minimum criteria. set out in the tender documents which as a minimum, would include the following;

(i) Evidence of access to financial resources along with average annual construction turnover.

(ii) Financial predictions for the current year and the two following years including the effect of known commitments;

(iii) Work commitments since pre-qualification;

(iv) Current litigation information; and

(v) Availability of critical equipment.

and

(c) furnish a technical proposal taking into account the various Appendices to Bid specially the following:

Appendix-E to Bid	Proposed Construction Schedule
Appendix-F to Bid	Method of Performing the Work
Appendix-G to Bid	List of Major Equipment
Appendix-K to Bid	Organization Chart for Supervisory Staff
	and other pertinent information such as mobilization programme etc;

11.2 **DELETED**

11.3 Bidders shall also submit proposals of work methods and schedule, in sufficient detail to demonstrate the adequacy of the Bidders' proposals to meet the technical specifications and the completion time referred to in Sub-Clause 1.2 hereof.

IB.12 Bid Prices

12.1 Unless stated otherwise in the bidding documents, the contract shall be for the whole of the works as described in IB 1.1 hereof, based on the unit rates or prices submitted by the bidder or percentage quoted above or below on the rates of Composite Schedule of Rates (CSR), as the case may be.

12.2 The bidders shall fill in rates and prices for all items of the works described in the Bill of Quantities. Items against which no rate or price is entered by a bidder will not be paid for by the procuring agency when executed and shall be deemed to be covered by rates and prices for other items in the Bill of Quantities. In case of Composite Schedule of Rates, if the bidder fails to mention the percentage above or below, it shall be deemed to be at par with the rates of Composite Schedule of Rates.

12.3 The bid price submitted by the contractor shall include all rates and prices including the taxes. All duties, taxes and other levies payable by the contractor under the contract, or for any other cause during the currency of the execution of the work or otherwise specified in the contract as on the date seven days prior to the deadline for submission of bids.

Additional / reduced duties, taxes and levies due to subsequent additions or changes in legislation shall be reimbursed / deducted as per Sub-Clause 70.2 of the General Conditions of Contract Part-I.

12.4 **DELETED**

IB.13 Currencies of Bid and Payment

13.1 The unit rates and the prices shall be quoted by the bidder entirely in Pak rupees. A bidder expecting to incur expenditures in other currencies for inputs to the Works supplied from outside the Procuring Agency's country (referred to as the "Foreign Currency Requirements") shall indicate the same in Appendix-B to Bid. The proportion of the Bid Price (excluding Provisional Sums) needed by him for the payment of such Foreign Currency Requirements either (i) entirely in the currency of the Bidder's home country or, (ii) at the bidder's option, entirely in Pak rupees provided always that a bidder expecting to incur expenditures in a currency or currencies other than those stated in (i) and (ii) above for a portion of the foreign currency requirements, and wishing to be paid accordingly, shall indicate the respective portions in his bid.

13.2 **DELETED**

IB.14 Bid Validity

14.1 Bids shall remain valid for the period stipulated in the Bidding Data after the Date of Bid Opening specified in Clause IB.23.

14.2 In exceptional circumstances, prior to expiry of the original bid validity period, the procuring agency may request that the bidders extend the period of validity for a specified additional period which shall in no case be more than the original bid validity period. The request and the responses thereto shall be made in writing. A bidder may refuse the request without forfeiting his Bid Security. A bidder agreeing to the request will not be required or permitted to modify his bid, but will be required to extend the validity of his Bid Security for the period of the extension, and in compliance with Clause IB.15 in all respects.

IB.15 Bid Security

15.1 Each bidder shall furnish, as part of his bid, a Bid Security in the amount stipulated in the Bidding Data in Pak Rupees or an equivalent amount in a freely convertible currency.

15.2 The bid security shall be at the option of the bidder, in the form of deposit at call, Pay order or a bank guarantee issued by a Scheduled Bank in Pakistan or from a foreign bank duly counter guaranteed by a Scheduled Bank in Pakistan in favor of the procuring agency, which should commensurate with the bid validity period. The bank guarantee for bid security shall be acceptable in the manner as provided at Annexure BS-1.

15.3 Any bid not accompanied by an acceptable Bid Security shall be rejected by the Procuring Agency as

non-responsive.

15.4 Bid security shall be released to the unsuccessful bidders once the contract has been signed with the successful bidder or the validity period has expired.

15.5 The bid security of the successful bidder shall be returned when the bidder has furnished the required Performance Security and signed the Contract Agreement.

15.6 The Bid Security may be forfeited:

(a) if the bidder withdraws his bid except as provided in Sub-Clause 22.1;

(b) if the bidder does not accept the correction of his Bid Price pursuant to Sub-Clause 27.2 hereof; or

(c) In the case of successful bidder, if he fails within the specified time limit to:

(i) furnish the required Performance Security; or

(ii) sign the Contract Agreement.

IB.16 Alternate Proposals by Bidder

16.1 Each bidder shall submit only one bid either by himself, or as a member of a joint venture, until and unless they have been requested or permitted for alternative bid, then he has to purchase separate bidding documents and alternate bid shall be treated as separate bid.

16.2 Alternate proposals are allowed only for procurement of works where technical complexity is involved and more than one designs or technical solutions are being offered. Two stage two envelope bidding procedure will be appropriate when alternate proposal is required.

16.3 Alternate bid(s) shall contain (a) relevant design calculations; (b) technical specifications; (c) proposed construction methodology; and (d) any other relevant details / conditions, provided that the total sum entered on the Form of Bid shall be that which represents complete compliance with the bidding documents.

IB.17 Pre-Bid Meeting

17.1 Procuring agency may, on his own motion or at the request of any prospective bidder(s), hold a pre-bid meeting to clarify issues and to answer any questions on matters related to the Bidding Documents. The date, time and venue of pre-bid meeting, if convened, shall be communicated to all bidders. All bidders or their authorized representatives shall be invited to attend such a pre-bid meeting at their own expense.

17.2 The bidders are requested to submit questions, if any, in writing so as to reach the Procuring Agency

not later than seven (7) days before the proposed pre-bid meeting.

17.3 Minutes of the pre-bid meeting, including the text of the questions raised and the replies given, will be transmitted without delay to all bidders. Any modification of the Bidding Documents listed in Sub-Clause 7.1 hereof which may become necessary as a result of the pre-bid meeting shall be made by the Procuring Agency exclusively through the issue of an Addendum pursuant to Clause IB.9 and not through the minutes of the pre-bid meeting.

17.4 Absence at the pre-bid meeting will not be a cause for disqualification of a bidder.

IB.18 Format and Signing of Bid

18.1 Bidders are particularly directed that the amount entered on the Form of Bid shall be for performing the Contract strictly in accordance with the Bidding Documents.

18.2 All appendices to Bid are to be properly completed and signed.

18.3 Alteration is not to be made in the Form of Bid nor in the Appendices thereto except in filling up the blanks as directed. If any such alterations be made or if these instructions be not fully complied with, the bid may be rejected.

18.4 Each bidder shall prepare by filling out the forms without alterations and shall provide an original copy along with photocopies as per the requirement of the procuring agency specified in the bidding data. The original as well as copies of the document shall be clearly marked as “ORIGINAL” and „COPY”, as the case may be. If there is any discrepancy between original and copy (ies) then the original shall prevail.

18.5 The original and all copies of the bid shall be typed or written in indelible ink (in the case of copies, Photostats are also acceptable) and shall be signed by a person or persons duly authorized to sign on behalf of the bidder pursuant to Sub- Clause 11.1(a) hereof. All pages of the bid shall be initialed and stamped by the person or persons signing the bid.

18.6 The bid shall contain no alterations, omissions or additions, except to comply with instructions issued by the Procuring Agency, or as are necessary to correct errors made by the bidder, in which case such corrections shall be initialed by the person or persons signing the bid.

18.7 Bidders shall indicate in the space provided in the Form of Bid their full and proper addresses at which notices may be legally served on them and to which all correspondence in connection with their bids and the Contract is to be sent.

18.8 Bidders should retain a copy of the Bidding Documents as their file copy.

D. SUBMISSION OF BIDS

IB.19 Sealing and Marking of Bids

19.1 Each bidder shall submit his bid as under:

(a) ONE ORIGINAL and ONE COPY of the Bid shall be separately sealed and put in separate envelopes and marked as such.

(b) The envelopes containing the ORIGINAL and COPIES shall be put in one sealed envelope and addressed as given in Sub- Clause 19.2 hereof.

19.2 The inner and outer envelopes shall:

(a) be addressed to the procuring agency at the address provided in the Bidding Data;

(b) bear the name and identification number of the contract as defined in the Bidding Data; and

(c) provide a warning not to open before the time and date for bid opening, as specified in the Bidding Data.

19.3 In addition to the identification required in Sub- Clause 19.2 hereof, the inner envelope shall indicate the name and address of the bidder to enable the bid to be returned unopened in case it is declared "late" pursuant to Clause IB.21

19.4 If the outer envelope is not sealed and marked as above, the procuring agency will assume no responsibility for the misplacement or premature opening of the Bid.

IB.20 Deadline for Submission of Bids

20.1

(a) Bids must be received by the procuring agency at the address specified no later than the time and date stipulated in the Bidding Data.

(b) Bids with charges payable will not be accepted, nor will arrangements be undertaken to collect the bids from any delivery point other than that specified above. Bidders shall bear all expenses incurred in the preparation and delivery of bids. No claims will be entertained for refund of such expenses.

(c) Where delivery of a bid is by mail and the bidder wishes to receive an acknowledgment of receipt of such bid, he shall make a request for such acknowledgment in a separate letter attached to but not included in the sealed bid package.

(d) Upon request, acknowledgment of receipt of bids will be provided to those making delivery in person or by messenger.

20.2 The Procuring Agency may, at his discretion, extend the deadline for submission of bids by issuing an amendment in accordance with Clause IB.9, in which case all rights and obligations of the

procuring agency and the bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.

IB.21 Late Bids

21.1

(a) Any bid received by the Procuring Agency after the deadline for submission of bids prescribed in Clause IB.20 will be returned unopened to such bidder.

(b) Delays in the mail, delays of person in transit, or delivery of a bid to the wrong office shall not be accepted as an excuse for failure to deliver a bid at the proper place and time. It shall be the bidder's responsibility to to submit the bis in time.

IB.22 Modification, Substitution and Withdrawal of Bids

22.1 Any bidder may modify**,** substitute or withdraw his bid after bid submission provided that the modification, substitution or written notice of withdrawal is received by the procuring agency prior to the deadline for submission of bids.

22.2 The modification, substitution, or notice for withdrawal of any bid shall be prepared, sealed, marked and delivered in accordance with the provisions of Clause IB.19 with the outer and inner envelopes additionally marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" as appropriate.

22.3 No bid may be modified by a bidder after the deadline for submission of bids except in accordance with Sub-Clauses 22.1 and 27.2.

22.4 Withdrawal of a bid during the interval between the deadline for submission of bids and the expiration of the period of bid validity specified in the Form of Bid may result in forfeiture of the Bid Security in pursuance to Clause IB.15.

E. BID OPENING AND EVALUATION

IB.23 Bid Opening

23.1 Procuring agency will open the bids, including withdrawals, substitution and modifications made pursuant to Clause IB.22, in the presence of bidders' representatives who choose to attend, at the time, date and location stipulated in the Bidding Data. The bidders' representatives who are in attendance shall sign an attendance sheet.

23.2 Envelopes marked "MODIFICATION", "SUBSTITUTION" or "WITHDRAWAL" shall be opened and read out first. Bids for which an acceptable notice of withdrawal has been submitted pursuant to Clause IB.22 shall not be opened.

23.3 No bid may be modified by a bidder after the deadline for submission of bids except in accordance with to sub - clauses IB 22.1 and IB 27.2.

23.4 Withdrawal of a bid during the interval between the deadlines for submission of bids and the expiration of the period of bid validity specified in the Form of Bid may result in forfeiture of the bid security in pursuance to clause IB 15.

IB.24 Process to be Confidential (SPP Rule-53)

24.1 Information relating to the examination, clarification, evaluation and comparison of bid and recommendations for the award of a contract shall not be disclosed to bidders or any other person not officially concerned with such process before the announcement of bid evaluation report in accordance with the requirements of Rule 45, which states that Procuring agencies shall announce the results of bid evaluation in the form of a report giving reasons for acceptance or rejection of bids. The report shall be hoisted on website of authority and that of procuring agency if it website exists and intimated to all bidders at least seven (7) days prior to the award of contract The announcement to all bidders will include table(s) comprising read out prices, discounted prices, price adjustments made, final evaluated prices and recommendations against all the bids evaluated. Any effort by a bidder to influence the procuring agency's processing of bids or award decisions may result in the rejection of such bidder's bid. Whereas, any bidder feeling aggrieved, may lodge a written complaint as per Rule 31; however mere fact of lodging a complaint shall not warrant suspension of the procurement process.

IB.25 Clarification of Bids (SPP Rule-43)

25.1 To assist in the examination, evaluation and comparison of bids, the Procuring Agency may, at his discretion, ask any bidder for clarification of his bid, including breakdowns of unit rates. The request for clarification and the response shall be in writing but no change in the price or substance of the bid shall be sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by the procuring agency in the evaluation of the bids in accordance with Clause IB.28.

IB.26 Examination of Bids and Determination of Responsiveness

26.1 Prior to the detailed evaluation of bids, the procuring agency will determine whether the bidder fulfills all codal requirements of eligibility criteria given in the tender notice such as registration with tax authorities, registration with PEC (where applicable), turnover statement, experience statement, and any other condition mentioned in the NIT and bidding document. If the bidder does not fulfill

any of these conditions, it shall not be evaluated further.

26.2 Once found to be fulfilling the eligibility criteria, as mentioned in sub- clause 26.1, the bids of eligible bidders will be evaluated for technical responsiveness as per specification and criteria given in the bidding documents. Technical and financial evaluations may be carried out in accordance with single stage-single one envelope, single stage-two envelopes, two stage or two stage-two envelopes bidding procedures, depending on the selection procedure adopted by the procuring agency.

26.3 A bid will be considered technically responsive if it (i) has been properly signed; (ii) is accompanied by the required bid security; and (iii) conforms to all the terms, conditions and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (i) which affect in any substantial way the scope, quality or performance of the works; (ii) which limits in any substantial way, inconsistent with the bidding documents, the procuring agency's rights or the bidder's obligations under the contract; or (iii) adoption/rectification whereof would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

26.4 If a bid has major deviations to the commercial requirements and technical specifications will be considered technically non responsive. As a general rule, major deviations are those that if accepted, would not fulfill the purposes for which the bid is requested, or would prevent a fair comparison or affect the ranking of the bids that are compliant with the bidding documents.

(A). Major (material) Deviations include:-

(i) has been not properly signed;

(ii) is not accompanied by the bid security of required amount and manner;

(iii) stipulating price adjustment when fixed price bids were called for;

(iv) failing to respond to specifications;

(v) failing to comply with Mile-stones/Critical dates provided in Bidding Documents;

(vi) sub-contracting contrary to the Conditions of Contract specified in Bidding Documents;

(vii) refusing to bear important responsibilities and liabilities allocated in the Bidding Documents, such as performance guarantees and insurance coverage;

(viii) taking exception to critical provisions such as applicable law, taxes and duties and dispute resolution procedures;

(ix) a material deviation or reservation is one :

(a) which affect in any substantial way the scope, quality or performance of the works;

(b) Adoption/rectification whereof would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

(B) Minor Deviations

Bids that offer deviations acceptable to the Procuring Agency and which can be assigned a monetary value may be considered substantially responsive at least as to the issue of fairness. This value would however be added as an adjustment for evaluation purposes only during the detailed evaluation process.

26.5. If a bid is not substantially responsive, it will be rejected by the procuring agency, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

IB.27 Correction of Errors before Financial Evaluation.

27.1 Bids determined to be substantially responsive will be checked by the procuring agency for any arithmetic errors. Errors will be corrected by the Procuring Agency as follows:

a) where there is a discrepancy between the amounts in figures and in words, the amount in words will govern; and

b) where there is a discrepancy between the unit rate and the line-item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern, unless in the opinion of the Procuring Agency there is an obviously gross misplacement of the decimal point in the unit rate, in which case the line item total as quoted will govern and the unit rate will be corrected.

27.2 The amount stated in the Form of Bid will be adjusted by the procuring agency in accordance with the above procedure for the correction of errors and with the concurrence of the bidder, shall be considered as binding upon the bidder. If the bidder does not accept the corrected Bid Price, his Bid will be rejected, and the Bid Security shall be forfeited in accordance with Sub- Clause 15.6(b) hereof.

IB.28 Financial Evaluation and Comparison of Bids

28.1 The procuring agency will evaluate and compare only the Bids determined to be substantially responsive in accordance with Clause IB.26.

28.2 In evaluating the Bids, the procuring agency will determine for each Bid the evaluated Bid Price by adjusting the Bid Price as follows:

a. making any correction for errors pursuant to Clause IB.27;

b. excluding Provisional Sums and the provision, (if any), for contingencies in the Summary Bill of

Quantities, but including competitively priced Day work; and

c. making an appropriate adjustment for any other acceptable variation or deviation.

28.3 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in Bid evaluation.

28.4 If the Bid of the successful bidder is seriously unbalanced in relation to the Procuring Agency's estimate of the cost of work to be performed under the Contract, the procuring agency may require the bidder to produce detailed price analyses for any or all items of the Bill of Quantities to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analyses, the procuring agency may require that the amount of the Performance Security set forth in Clause IB.32 be increased at the expense of the successful bidder to a level sufficient to protect the Procuring Agency against financial loss in the event of default of the successful bidder under the Contract.

28.5 Bidders may be excluded if involved in **"Corrupt and Fraudulent Practices"** means either one or any combination of the practices given below SPP Rule2 (q);

(i) "**Coercive Practice**" means any impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence the actions of a party to achieve a wrongful gain or to cause a wrongful loss to another party;

(ii) "**Collusive Practice**" means any arrangement between two or more parties to the procurement process or contract execution, designed to achieve with or without the knowledge of the procuring agency to establish prices at artificial, noncompetitive levels for any wrongful gain;

(iii) **"Corrupt Practice"** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence the acts of another party for wrongful gain;

(iv) "**Fraudulent Practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation;

(v) **"Obstructive Practice"** means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in a procurement process, or affect the execution of a contract or deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements before investigators in order to materially impede an investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or acts intended to materially impede the

exercise of inspection and audit rights provided for under the Rules

28.6 Evaluation Report (SPP Rule 45)

After the completion of evaluation process, as described in clauses IB 27 and IB 28, the procuring agency shall announce the results of bid evaluation in the form of report (available on the website of the authority) giving reasons for acceptance and rejection of bid. The report shall be hoisted on website of the authority and that of procuring agencies if its website exists and intimated to all bidders at least seven (7) days prior to the award of contract.

F. AWARD OF CONTRACT

IB.29 Award (SPP Rule-49)

29.1 Subject to Clauses IB.30 and IB.34, the procuring agency will award the Contract to the bidder whose bid has been determined to be substantially responsive to the Bidding Documents and who has offered the lowest evaluated Bid Price**,** provided that such bidder has been determined to be eligible in accordance with the provisions of Clause IB.3 and qualify pursuant to Sub-Clause IB 29.2.

29.2 The procuring agency, at any stage of the bid evaluation, having credible reasons for or *prima facie* evidence of any defect in supplier's or contractor's capacities, may require the suppliers or contractors to provide information concerning their professional, technical, financial, legal or managerial competence whether already pre-qualified or not for the said project.

Provided that such qualification shall only be laid down after recording reasons therefor in writing. They shall form part of the records of that bid evaluation report.

IB.30 Procuring Agency's Right to accept any Bid or Annul/Cancellation the Bidding Process (SPP Rule-25)

Notwithstanding clause IB 29 and provision of the rule: (1) A procuring agency reserves may cancel the bidding process at any time prior to the acceptance of a bid or proposal; (2) The procuring agency shall incur no liability towards bidders solely by virtue of its invoking sub –rule (1); (3) Intimation of the cancellation of bidding process shall be given promptly to all bidders and bid security shall be returned along with such intimation; (4) The procuring agency shall, upon request by any of the bidders, communicate to such bidder, grounds for cancellation of the bidding process, but is not required to justify such grounds.

IB.31 Notification/ Publication of the Award of Contract (SPP Rule 25)

31.1 Prior to expiration of the period of bid validity prescribed by the Procuring Agency, the procuring agency will notify the successful bidder in writing ("Letter of Acceptance") that his Bid has been

accepted. This letter shall name the sum which the Procuring Agency will pay the Contractor in consideration of the execution and completion of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Conditions of Contract called the "Contract Price").

31.2 No Negotiation with the bidder having evaluated as lowest responsive or any other bidder shall be permitted, however, Procuring Agency may have clarification meetings to get clarify any item in the bid evaluation report.

31.3 The notification of award and its acceptance by the bidder will constitute the formation of the Contract, binding the procuring agency and the bidder till signing of the formal Contract Agreement.

31.4 Upon furnishing by the successful bidder of a Performance Security, the procuring agency will promptly notify the other bidders that their Bids have been unsuccessful and return their bid securities accordingly.

31.5 Within seven days of the award of contract, procuring agency shall publish on the website of the Authority and on its own website, if such a website exists, the results of the bidding process, identify the bid through procurement identifying numbers, and the following information:

(1) Evaluation Report;

(2) Form of Contract and letter of Award;

(3) Bill of Quantities or Schedule of Requirement.

31.6 Debriefing (SPP Rule 51).

(a) A bidder may ask the procuring agency for reasons for non-acceptance of his bid and may request for a debriefing meeting and procuring agency shall give him the reasons for such non acceptance, either in writing or by holding a debriefing meeting with such a bidder.

(b) The requesting bidder shall bear all the costs of attending such a debriefing.

IB.32 Performance Security (SPP Rule 39)

32.1 The successful bidder shall furnish to the Procuring Agency a Performance Security in the form and the amount stipulated in the Bidding Data and the Conditions of Contract within a period of 28 days after the receipt of Letter of Acceptance.

32.2 Failure of the successful bidder to comply with the requirements of Sub-Clause IB.32.1 or Clauses IB.33 or IB.35 shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security.

32.3 Validity of performance security shall extend at least ninety says beyond the date of completion of contract, or as mentioned in the bidding data to cover defects liability period or maintenance period subject to final acceptance by the procuring agency.

IB.33 Signing of Contract Agreement

33.1 Within 14 days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the Procuring Agency will send the successful bidder the Contract Agreement in the form provided in the Bidding Documents, incorporating all agreements between the parties.

33.2 The formal Agreement between the Procuring Agency and the successful bidder shall be executed within 14 days of the receipt of the Contract Agreement by the successful bidder from the Procuring Agency.

33.3 A procurement contract shall come into force when the procuring agency requires signs contract, the date on which the signatures of both the procuring agency and the successful bidder are affixed to the written contract. Such affixing of signatures shall take place within the time prescribed in the bidding documents.

Provided that the procuring agency may reduce the maximum time limit for signing of contract, as and when required, and shall be mentioned in the bidding documents.

33.4 **Stamp Duty.**

The formal Agreement between the Procuring Agency and the successful bidder shall be duly stamped at rate of as mentioned in bidding data of bid price (updated from time to time) stated in Letter of Acceptance

IB.34 General Performance of the Bidders

The Procuring Agency reserves the right to obtain information regarding performance of the bidders on their previously awarded contracts/works. The Procuring Agency may in case of consistent poor performance of any Bidder as reported by the Procuring Agency of the previously awarded contracts, interalia, reject his bid and/or refer the case to the Pakistan Engineering Council (PEC). Upon such reference, PEC in accordance with its rules, procedures and relevant laws of the land take such action as may be deemed appropriate under the circumstances of the case including black listing of such Bidder and debarring him from participation in future bidding for similar works.

IB.35 Integrity Pact (SPP Rule 89)

The Bidder shall sign and stamp the Integrity Pact provided at Appendix-L to Bid in the Bidding Documents for all Federal Government procurement contracts exceeding Rupees ten million. Failure to provide such Integrity Pact shall make the bidder non-responsive.

IB.36 Instructions not Part of Contract

Bids shall be prepared and submitted in accordance with these Instructions which are provided to

assist bidders in preparing their bids, and do not constitute part of the Bid or the Contract Documents.

IB.37 Arbitration (SPP Rule 34)

Any dispute that is not amicably resolved shall be finally settled, unless otherwise specified in the Contract, under the Arbitration Act 1940 updated from time to time and would be held anywhere in the Province of Sindh at the discretion of procuring agency.

BIDDING DATA

BIDDING DATA

1.1	**Name and address of the Employer:**	**Institute of Business Administration (IBA),** **Main Campus University Road** **Karachi 75270**
1.1	**Name of the Project:**	**Construction of 32 Nos Faculty Apartment Towers** **IBA Staff Town,** **Karachi**
2.1	**Name of the Borrower/Source of Financing /Funding Agency:**	IBA
2.1	**Amount and type of financing:**	IBA resource
.		
3.1	**Time limit for clarification:**	15 days
10.1	**Bid language:**	English

11.1 (a) Qualification information to be updated:

1. Name of the Firm, Address and valid contact numbers.
2. Date of incorporation of firm.
3. Valid Pakistan Engineering Council Certificate in category C-3 or above with code CE-09, CE-10, EE-11
4. Valid NTN Number:
5. Valid S.S.T Number alongwith last three years SRB return.
6. Bank statement at least three years.
7. Last three years financial audited balance sheets.
8. Similar works executed within 5 Years along with documentary Evidence at least three works.
9. Works in hand along with documentary Evidence
10. Total Experience should not be less than 10 Years with supporting documents.
11. List of Technical Staff along with their Signed CV's
12. An affidavit duly singed and stamped that company is not black listed / litigation by any Government, Semi Government, Autonomous or by private organization

11.1(b) Furnish Technical Proposal:

The bidder to submit a technical proposal in sufficient detail to demonstrate the adequacy of the bid in meeting requirements for timely completion of the Works.

14.1	**Period of Bid Validity:**	90 days from the date of opening of the bids.

15.1 **Amount of Bid Security:**

Minimum 1% of the total bid price, in the form of a Pay Order/Demand Draft payable to the Institute of Business Administration, Karachi or in the form of ***Bank Guarantee*** issued by a Scheduled Bank of Pakistan.

17.1 **Venue, time, and date of the pre-Bid meeting:**

Aman CD Building
G/Floor Meeting Room,
University Road, Karachi

Date; ====== , 2021 Time: === am

18.4	**Number of copies of the Bid to be completed and returned:**	one original and one copy
19.2(a)	**Employer's address for the purpose of Bid submission**	Head of Procurement Fauji Building First Floor Main Campus University Road, Karachi
19.2(b)	**Name and Number of the Contract:**	IBA 32 Nos Faculty Apartments, **IBA/MC/DP/09/2022**
20.1(a)	**Deadline for submission of bids:**	Date as announced in 'Invitation for Bid'.
23.1	**Venue, time, and date of Bid opening:**	Meeting Room, AMAN CD Building Ground Floor, Main Campus, University Road, Karachi. Date as announced in 'Invitation for Bid'.

32.1 **Standard form and amount of Performance Security acceptable to the Employer:**

Performance Bond in the form of a ***Bank guarantee*** from a Scheduled Bank for an amount equal to 5% of the bid Price.

32.4 **Stamp Duty:**

This contract agreement is required to be written on Stamp Paper of appropriate value, as per applicable law. To the best of our knowledge, the present "appropriate value" is 0.35% of the value of the contract.

The Stamp Paper will be purchased by the successful bidder at his own cost and provided to Procuring Agency for preparation of the contract agreement.

FORM OF BID
AND
APPENDICES TO BID

FORM OF BID

Bid Reference No. _____

(Name of Contract/Works)

To:

_____
_____
_____

Gentleman,

1. Having examined the Bidding Documents including Instructions to Bidders, Bidding Data, and Conditions of Contract. Specifications, Drawings and Bill of Quantities and Addenda Nos. _____for the execution of the above-named Works, we, the undersigned, offer to execute and complete such Works and remedy any defects therein in conformity with the Conditions of Contract. Specifications, Drawings, Bill of Quantities and Addenda for the sum of Rs. _____ (Rupees _____) or such other sum as may be ascertained in accordance with the said conditions.
2. We understand that all the Appendices attached hereto form part of this Bid.
3. As security for due performance of the undertakings and obligations of this Bid, we submit herewith a Bid Security in the amount of Rupees _____
(Rs. _____) drawn in your favor or made payable to you and valid for a period of _____days beginning from the date Bids are opened.
4. We undertake, if our Bid is accepted, to commence the Works and to complete the whole of the Works comprised in the Contract within the time stated in Appendix-A to Bid.
5. We agree to abide by this Bid for the period of _____ days from the date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
6. Unless and until a formal Agreement is prepared and executed, this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.
7. We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other bidder for the Works.
8. We understand that you are not bound to accept the lowest or any Bid you may receive.

Dated this _____day of_____20_____

Signature: _____

in the capacity of _____duly authorized to sign Bids for and on behalf of

_____
(Name of Bidder in Block Capitals)
(Seal)

Address:_____
_____
_____

Witness:

Signature: _____
Name: _____

Address. _____
_____
Occupation_____

Appendix-A to Bid
SPECIAL STIPULATIONS

		Clause	Conditions of Contract
1.	IBA Engineer's Authority to issue Variations in an **emergency**	2.1	2% of the Contract Price stated in the Letter of Acceptance.
2.	Amount of Performance Security	10.1	5% of Contract Price stated in the Letter of Acceptance.
3.	Time for Furnishing Programme	14.1	Within 15 days from the date of receipt of Letter of Acceptance.
4.	Minimum amount of Third-Party Insurance	23.2	Rs. 500,000 per occurrence with number of occurrences unlimited.
5.	Time for Commencement	41.1	Within 14 days from the date of receipt of Engineer's Notice to Commence which shall be issued within fourteen (14) days after signing of Contract Agreement.
6.	Time for Completion	43.1, 48.2	18 Months period from the date of receipt of Engineer's Notice to Commence.
7.	Amount of Liquidated Damages	47.1	Liquidated damages for **each** day of delay in completion of the whole of the works shall be a sum equal to 10% of the total cost of the works (or the accepted bid price, whichever is higher) divided by one-fourth of the number of days specified as completion time.
8.	Defects Liability Period	49.1	12 Months from the effective date of Taking Over Certificate.

9.	Valuation of Variations	52.1	Contractor's mark-up on all CSR Based additional items will be same as premium quoted by the Contractor On Non Schedule items 25% inclusive of all taxes tax, overhead and profit. Mark-up on all additional sub-contractors' and supplier's items will be 15% inclusive all taxes.
10.	Percentage of Retention Money	60.2	10 % of the amount of Interim Payment Certificate.
11.	Limit of Retention Money	60.2	5 % of Contract Price stated in the Letter of Acceptance.
12.	Minimum amount of Interim Payment Certificates (Running Bills)	60.2	1% of contract amount
13.	Time of Payment from delivery of Engineer's Interim Payment Certificate to the Procuring Agency.	60.10	30 days (After joint verification of the bill and submission to finance office).
14.	Financial assistance to the Contractor	60.11 60.12	Secured advance on materials as per Clause 60.11 and Mobilization Advance as per Clause 60.12 of the Conditions of Contract.
15	Difference in Basic Price	--	The difference (if any) in basic price of material, for those items of BOQ, where basic market price of any material is already indicated, will be added to or deducted from contractor's bill for the material so approved by the Engineer which might be of different value.

Appendix-B to Bid

FOREIGN CURRENCY REQUIREMENTS

1. The Bidder may indicate here in below his requirements of foreign currency (if any), with reference to various inputs to the Works.
2. Foreign Currency Requirement as percentage of the Bid Price excluding Provisional Sums _____%.
3. Table of Exchange Rates

Unit of Currency	Equivalent in Pak. Rupees
Australian Dollar	----------
Euro	----------
Japanese Yen	----------
U.K. Pound	----------
U.S. Dollars	----------
----------	----------
----------	----------

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Appendix-C to Bid

PRICE ADJUSTMENT UNDER CLAUSE 70 OF CONDITIONS OF CONTRACT

The source of indices and the weightages or coefficients for use in the adjustment formula under Clause 70 shall be as follows:

Cost Element	Description	Weightages	Applicable index
1	2	3	4
(i)	Fixed Portion	0.30	
(ii)	Local Labor	0.25	
(iii)	Cement – in bags	0.15	Government of Pakistan (GP) Federal Bureau of Statistics (FBS) Monthly Statistical Bulletin
(iv)	Reinforcing Steel	0.15	" " "
(v)	High Speed Diesel (HSD)	0.05	" " "
(vi)	Bricks /Blocks/PAVERS	0.05	" " "
(vii)	Wood	0.05	" " "
	Total	1.000	

Notes:

1) Indices for "(ii)" to "(vii)" are taken from the Government of Pakistan Federal Bureau of Statistics, Monthly Statistical Bulletin. The base cost indices or prices shall be those applying 28 days prior to the latest day for submission of bids. Current indices or prices shall be those applying 28 days prior to the last day of the billing period.

2) Any fluctuation in the indices or prices of materials other than those given above shall not be subject to adjustment of the Contract Price.

Appendix-D to Bid

BILL OF QUANTITIES

---------- Please refer to Volume-II attached with this bid----------

Appendix-E to Bid

PROPOSED CONSTRUCTION SCHEDULE

Pursuant to Sub-Clause 43.1 of the General Conditions of Contract, the Works shall be completed on or before the date stated in Appendix-A to Bid. The Bidder shall provide as Appendix-E to Bid, the Construction Schedule in the bar chart (CPM, PERT or any other to be specified herein) showing the sequence of work items and the period of time during which he proposes to complete each work item in such a manner that his proposed programme for completion of the whole of the Works and parts of the Works may meet Procuring Agency's completion targets in days noted below and counted from the date of receipt of Engineer's Notice to Commence (Attach sheets as required for the specified form of Construction Schedule):

	Description	**Time for Completion**
a)	Whole Works	18 Months

Note: The Construction Schedule will be submitted by the contractor either as a bar chart or CPM, specifying various activities, their sequence and the number of days required for completion of each activity.

Appendix-F to Bid

METHOD OF PERFORMING THE WORK

[The Bidder is required to submit a narrative outlining the method of performing the Work. The narrative should indicate in detail and include but not be limited to:

1. Organization Chart indicating head office and field office personnel involved in management and supervision, engineering, equipment maintenance and purchasing.

2. Mobilization in Pakistan, the type of facilities including personnel accommodation, office accommodation, provision for maintenance and for storage, communications, security and other services to be used.

3. The method of executing the Works, the procedures for installation of equipment and machinery and transportation of equipment and materials to the site.]

Appendix-G to Bid

LIST OF MAJOR EQUIPMENT – RELATED ITEMS

[The Bidder will provide on Sheet 2 of this Appendix a list of all major equipment and related items, under separate heading for items owned, to be purchased or to be arranged on lease by him to carry out the Works. The information shall include make, type, capacity, and anticipated period of utilization for all equipment which shall be in sufficient detail to demonstrate fully that the equipment will meet all requirements of the Specifications.]

LIST OF MAJOR EQUIPMENT

Owned Purchased or Leased	Description of Unit (Make, Model, Year)	Capacity HP Rating	Condition	Present Location or Source	Date of Delivery at Site	Period of Work on Project
1	2	3	4	5	6	7
a. Owned						
b. To be Purchased						
c. To be arranged on Lease						

Appendix-H to Bid

CONSTRUCTION CAMP AND HOUSING FACILITIES

The Contractor in accordance with Clause 34 of the Conditions of Contract shall provide description of his construction camp's facilities and staff housing requirements.

The Contractor shall be responsible for pumps, electrical power, water and electrical distribution systems, and sewerage system including all fittings, pipes and other items necessary for servicing the Contractor's construction camp.

The Bidder shall list or explain his plans for providing these facilities for the service of the Contract as follows:

1. Site Preparation (clearing, land preparation, etc.).
2. Provision of Services.
    a) Power (expected power load, etc.).
    b) Water (required amount and system proposed).
    c) Sanitation (sewage disposal system, etc.).
3. Construction of Facilities
    a) Contractor's Office. Workshop and Work Areas (areas required and proposed layout, type of construction of buildings, etc.).
    b) Warehouses and Storage Areas (area required, type of construction and layout).
    c) Housing and Staff Facilities (Plans for housing for proposed staff, layout, type of construction, etc.).
4. Construction Equipment Assembly and Preparation (detailed plans for carrying out this activity).
5. Other Items Proposed (Security services, etc.).
6 ***As the Construction Site is Located in IBA Staff Town , bidder must his proposed security plan which will be subject to approval of IBA,s security department.***

Appendix-I to Bid

LIST OF SUBCONTRACTORS

I/We intend to subcontract the following parts of the Work to subcontractors. In my/our opinion, the subcontractors named hereunder are reliable and competent to perform that part of the work for which each is listed.

Enclosed are documentation outlining experience of subcontractors, the curriculum vitae and experience of their key personnel who will be assigned to the Contract, equipment to be supplied by them, size, location and type of contracts carried out in the past.

Part of Works (Give Details)	**Subcontractor (With Complete Address)**
1	**2**

Appendix-J to Bid

ESTIMATED PROGRESS PAYMENTS

Bidder's estimate of the value of work which would be executed by him during each of the periods stated below, based on his Programme of the Works and the Rates in the Bill of Quantities, expressed in thousands of Pakistani Rupees:

Quarter/ Year/ Period	**Amounts (1,000 Rs.)**
1	**2**
Ist Quarter	
2nd Quarter	
3rd Quarter	
4th Quarter	
Bid Price	

Appendix-K to Bid

ORGANIZATION CHART FOR THE SUPERVISORY STAFF AND LABOUR

(Attached separate sheet as necessary)

Appendix-L to Bid
(INTEGRITY PACT)

DECLARATION OF FEES, COMMISSION AND BROKERAGE ETC.

PAYABLE BY THE SUPPLIERS OF GOODS, SERVICES & WORKS IN

CONTRACTS WORTH RS. 10.00 MILLION OR MORE

Contract No._____ Dated _____

Contract Value: _____

Contract Title: _____

…… [name of Supplier] hereby declares that it has not obtained or induced the procurement of any contract, right, interest, privilege or other obligation or benefit from Government of Sindh (GoS) or any administrative subdivision or agency thereof or any other entity owned or controlled by GoS through any corrupt business practice.

Without limiting the generality of the foregoing, [name of Supplier] represents and warrants that it has fully declared the brokerage, commission, fees etc. paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within or outside Pakistan either directly or indirectly through any natural or juridical person, including its affiliate, agent, associate, broker, consultant, director, promoter, shareholder, sponsor or subsidiary, any commission, gratification, bribe, finder's fee or kickback, whether described as consultation fee or otherwise, with the object of obtaining or inducing the procurement of a contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoS, except that which has been expressly declared pursuant hereto.

[name of Supplier] certifies that it has made and will make full disclosure of all agreements and arrangements with all persons in respect of or related to the transaction with GoS and has not taken any action or will not take any action to circumvent the above declaration, representation or warranty.

[name of Supplier] accepts full responsibility and strict liability for making any false declaration, not making full disclosure, misrepresenting facts or taking any action likely to defeat the purpose of this declaration, representation and warranty. It agrees that any contract, right, interest, privilege or other obligation or benefit obtained or procured as aforesaid shall, without prejudice to any other rights and remedies available to GoS under any law, contract or other instrument, be voidable at the option of GoS.

Notwithstanding any rights and remedies exercised by GoS in this regard, [name of Supplier] agrees to indemnify GoS for any loss or damage incurred by it on account of its corrupt business practices and further pay compensation to GoS in an amount equivalent to ten time the sum of any commission, gratification, bribe, finder's fee or kickback given by [name of Supplier] as aforesaid for the purpose of obtaining or inducing the procurement of any contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoS.

Name of Buyer: ……	Name of Seller/Supplier: ……
Signature: ……	Signature: ……
[Seal]	[Seal]

FORMS

BID SECURITY
PERFORMANCE SECURITY
CONTRACT AGREEMENT
MOBILIZATION ADVANCE GUARANTEE/BOND

BID SECURITY
(**Bank Guarantee)**

Security Executed on _____
(Date)

Name of Surety (Bank) with Address: _____
(Scheduled Bank in Pakistan)

Name of Principal (Bidder) with Address _____

_____

Penal Sum of Security Rupees. _____(Rs. _____)

Bid Reference No. _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bid and at the request of the said Principal (Bidder) we, the Surety above named, are held and firmly bound unto _____

(hereinafter called the 'Procuring Agency') in the sum stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Bidder has submitted the accompanying Bid dated _____ for Bid No. _____ for_____(Particulars of Bid) to the said Procuring Agency; and

WHEREAS, the Procuring Agency has required as a condition for considering said Bid that the Bidder furnishes a Bid Security in the above said sum from a Scheduled Bank in Pakistan or from a foreign bank duly counter-guaranteed by a Scheduled Bank in Pakistan, to the Procuring Agency, conditioned as under:

(1) that the Bid Security shall remain in force up to and including the date 28 days after the deadline for validity of bids as stated in the Instructions to Bidders or as it may be extended by the Procuring Agency, notice of which extension(s) to the Surety is hereby waived;

(2) that the Bid Security of unsuccessful Bidders will be returned by the Procuring Agency after expiry of its validity or upon signing of the Contract Agreement; and

(3) that in the event of failure of the successful Bidder to execute the proposed Contract Agreement for such work and furnish the required Performance Security, the entire said sum be paid immediately to the said Procuring Agency pursuant to Clause 15.6 of the Instruction to Bidders for the successful Bidder's failure to perform.

NOW THEREFORE, if the successful Bidder shall, within the period specified therefor, on the prescribed form presented to him for signature enter into a formal Contract with the said Procuring Agency in accordance with his Bid as accepted and furnish within twenty eight (28) days of his being requested to do so, a Performance Security with good and sufficient surety, as may be required, upon the form prescribed by the said Procuring Agency for the faithful performance and proper fulfilment of the said Contract or in the event

of non-withdrawal of the said Bid within the time specified for its validity then this obligation shall be void and of no effect, but otherwise to remain in full force and effect.

PROVIDED THAT the Surety shall forthwith pay the Procuring Agency the said sum upon first written demand of the Procuring Agency (without cavil or argument) and without requiring the Procuring Agency to prove or to show grounds or reasons for such demand, notice of which shall be sent by the Procuring Agency by registered post duly addressed to the Surety at its address given above.

PROVIDED ALSO THAT the Procuring Agency shall be the sole and final judge for deciding whether the Principal (Bidder) has duly performed his obligations to sign the Contract Agreement and to furnish the requisite Performance Security within the time stated above, or has defaulted in fulfilling said requirements and the Surety shall pay without objection the said sum upon demand from the Procuring Agency forthwith and without any reference to the Principal (Bidder) or any other person.

IN WITNESS WHEREOF, the above bounden Surety has executed the instrument under its seal on the date indicated above, the name and seal of the Surety being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

SURETY (Bank)

WITNESS:

1. _____
   _____

Signature _____
Name _____
Title _____

Corporate Secretary (Seal)

Corporate Guarantor (Seal)

2. _____

_____
Name, Title & Address

FORM OF PERFORMANCE SECURITY

(Bank Guarantee)

Guarantee No._____

Executed on _____

Expiry date _____

[Letter by the Guarantor to the Procuring Agency]

Name of Guarantor (Bank) with address:_____

(Scheduled Bank in Pakistan)

Name of Principal (Contractor) with address:_____

_____

Penal Sum of Security (express in words and figures)_____

_____

Letter of Acceptance No. _____Dated _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bidding Documents and above said Letter of Acceptance (hereinafter called the Documents) and at the request of the said Principal we, the Guarantor above named, are held and firmly bound unto the _____ (hereinafter called the Procuring Agency) in the penal sum of the amount stated above for the payment of which sum well and truly to be made to the said Procuring Agency, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has accepted the Procuring Agency's above said Letter of Acceptance for _____ _____ (Name of Contract) for the _____

_____ (Name of Project).

NOW THEREFORE, if the Principal (Contractor) shall well and truly perform and fulfill all the undertakings, covenants, terms and conditions of the said Documents during the original terms of the said Documents and any extensions thereof that may be granted by the Procuring Agency, with or without notice to the Guarantor, which notice is, hereby, waived and shall also well and truly perform and fulfill all the undertakings, covenants terms and conditions of the Contract and of any and all modifications of said Documents that may hereafter be made, notice of which modifications to the Guarantor being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue till all requirements of

Clause 49, Defects Liability, of Conditions of Contract are fulfilled.

Our total liability under this Guarantee is limited to the sum stated above and it is a condition of any liability attaching to us under this Guarantee that the claim for payment in writing shall be received by us within the validity period of this Guarantee, failing which we shall be discharged of our liability, if any, under this Guarantee.

We, _____ (the Guarantor), waiving all objections and defences under the Contract, do hereby irrevocably and independently guarantee to pay to the Procuring Agency without delay upon the Procuring Agency's first written demand without cavil or arguments and without requiring the Procuring Agency to prove or to show grounds or reasons for such demand any sum or sums up to the amount stated above, against the Procuring Agency's written declaration that the Principal has refused or failed to perform the obligations under the Contract which payment will be effected by the Guarantor to Procuring Agency's designated Bank & Account Number.

PROVIDED ALSO THAT the Procuring Agency shall be the sole and final judge for deciding whether the Principal (Contractor) has duly performed his obligations under the Contract or has defaulted in fulfilling said obligations and the Guarantor shall pay without objection any sum or sums up to the amount stated above upon first written demand from the Procuring Agency forthwith and without any reference to the Principal or any other person.

IN WITNESS WHEREOF, the above-bounden Guarantor has executed this Instrument under its seal on the date indicated above, the name and corporate seal of the Guarantor being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

_____
Guarantor (Bank)

Witness:

1. _____ Signature _____

_____ Name _____
Corporate Secretary (Seal)

Title _____

2. _____

_____ _____
Name, Title & Address Corporate Guarantor (Seal)

FORM OF CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the "Agreement") made on the _____ day of_____(month) 20_____ between _____ (hereafter called the "Procuring Agency") of the one part and _____ (hereafter called the "Contractor") of the other part.

WHEREAS the Procuring Agency is desirous that certain Works, viz _____ should be executed by the Contractor and has accepted a Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

NOW this Agreement witnesseth as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.

2. The following documents after incorporating addenda, if any, except those parts relating to Instructions to Bidders shall be deemed to form and be read and construed as part of this Agreement, viz:
   - (a) The Contract Agreement;
   - (b) The Letter of Acceptance;
   - (c) The completed Form of Bid;
   - (d) Special Stipulations (Appendix-A to Bid);
   - (e) The Particular Conditions of Contract – Part II;
   - (f) The General Conditions – Part I;
   - (g) The priced Bill of Quantities (Appendix-D to Bid);
   - (h) The completed Appendices to Bid (B, C, E to L);
   - (i) The Drawings;
   - (j) The Specifications.
   - (k) _____ (any other)

3. In consideration of the payments to be made by the Procuring Agency to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Procuring Agency to execute and

complete the Works and remedy defects therein in conformity and in all respects with the provisions of the Contract.

4. The Procuring Agency hereby covenants to pay the Contractor, in consideration of the execution and completion of the Works as per provisions of the Contract, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS WHEREOF the parties hereto have caused this Agreement to be executed on the day, month and year first before written in accordance with their respective laws.

Signature of the Contactor	Signature of Procuring Agency
_____	_____
(Seal)	(Seal)

Signed, Sealed and Delivered in the presence of:

Witness:	Witness:
_____	_____
(Name, Title and Address)	(Name, Title and Address)

Notes: 1. This contract agreement is required to be written on Stamp Paper of appropriate value, as per applicable law. To the best of our knowledge, the present "appropriate value" is 0.35% of the value of the contract.

2. The Stamp Paper will be purchased by the successful bidder at his own cost and provided to Procuring Agency for preparation of the contract agreement.

MOBILIZATION ADVANCE GUARANTEE/BOND

Guarantee No._____ Date _____

WHEREAS _____(hereinafter called the 'Procuring Agency') has entered into a Contract for _____

(Particulars of Contract)

with _____ (hereinafter called the "Contractor').

AND WHEREAS, the Procuring Agency has agreed to advance to the Contractor, at the Contractor's request, an amount of Rupees _____ (Rs _____) which amount shall be advanced to the Contractor as per provisions of the Contract.

AND WHEREAS, the Procuring Agency has asked the Contractor to furnish Guarantee to secure the mobilization advance for the performance of his obligations under the said Contract.

AND WHEREAS, _____
(Scheduled Bank in Pakistan or Insurance Company acceptable to the Procuring Agency)

(hereinafter called the "Guarantor") at the request of the Contractor and in consideration of the Procuring Agency agreeing to make the above advance to the Contractor, has agreed to furnish the said Guarantee.

NOW, THEREFORE, the Guarantor hereby guarantees that the Contractor shall use the advance for the purpose of above mentioned Contract and if he fails and commits default in fulfilment of any of his obligations for which the advance payment is made, the Guarantor shall be liable to the Procuring Agency for payment not exceeding the aforementioned amount.

Notice in writing of any default, of which the Procuring Agency shall be the sole and final judge, on the part of the Contractor, shall be given by the Procuring Agency to the Guarantor, and on such first written demand, payment shall be made by the Guarantor of all sums then due under this Guarantee without any reference to the Contractor and without any objection.

This Guarantee shall remain in force until the advance is fully adjusted against payments from the Interim Payment Certificates of the Contractor or until _____whichever is earlier.

(Date)

The Guarantor's liability under this Guarantee shall not in any case exceed the sum of Rupees _____(Rs _____).

This Guarantee shall remain valid up to the aforesaid date and shall be null and void after the aforesaid date or earlier if the advance made to the Contractor is fully adjusted against payments from Interim Payment Certificates of the Contractor provided that the Guarantor agrees that the aforesaid period of validity shall be deemed to be extended if on the above mentioned date the advance payment is not fully adjusted.

GUARANTOR

1. Signature _____
2. Name _____
3. Title _____

WITNESS

1. _____
_____
Corporate Secretary (Seal)

2. _____ _____
(Name Title & Address) Corporate Guarantor(Seal)

INDENTURE FOR SECURED ADVANCES.

(For use in cases in which is contract is for finished work and the contractor has entered into an agreement for the execution of a certain specified quantity of work in a given time).

This INDENTURE made the …….. day of ..... 20…… BETWEEN (hereinafter called "the Contractor" which expression shall where the context so admits or implied be deemed to include his heirs, executors, administrators and assigns) of the one part and THE GOVERNOR OF SINDH (hereinafter called "the Government" of the other part).

WHEREAS by an agreement, dated (hereinafter called the said agreement, the contractor has agreed to perform the under-mentioned works (hereinafter referred to as the said work):-

(Here enter (the description of the works).1

AND WHEREAS the contractor has applied to the …….. ……..for an advance to him of Rupees ……

(Rs. .....) on the security of materials absolutely belonging to him and brought by him to the site of the said works the subject of the said agreement for use in the construction of such of the said works as he has undertaken to execute at rates fixed for the finished work (inclusive of the cost of materials and labor and other charge) AND WHEREAS the Government has agreed to advance to the Contractor the sum of Rupees, (Rs. .....) on the security of materials the quantities and other particulars of which are detailed in Part II of Running Account Bill (B). the said works signed by the contractor

Fin R.Form.l7.A

On …….. and on such covenants and conditions as are hereinafter contained and the Government has reserved to itself the option of marking any further advance or advances on the security of other materials brought by the Contractor to the site of the said works.

NOW THIS INDENTURE WTTNESSETH that in pursuance of the said agreement and in consideration of the sum of Rupees……..

(Rs. ……) on or before the execution of these presents paid to the Contractor by the Government (the receipt whereof the Contractor doth hereby acknowledge) and of such further advances (if any) as may be made to him as aforesaid (all of which advances are hereinafter collectively referred to as the said amount) the Contractor doth hereby assign unto the Government the said materials by way of security for the said amount

And doth hereby covenant and agree with the Government and declare ay follow :-

(1) That the said sum of Rupees. …… RS. ……) so advanced by the Government to the Contractor as aforesaid and all or any further sum or sums which may be advanced as

aforesaid shall be employed by the contractor in or towards expending the execution of the said works and for no other purpose whatsoever.

(2) That the materials detailed in the said Running Account Bill (B) which have been offered to and accepted by (he Government as security for the said amount are absolutely by the Contractors own property free from encumbrances of any kind and the Contractor will not make any application for or receive a further advance on the security of materials which are not absolutely his own property and free from encumbrances of any kind and the contractor hereby agrees, at all times, to indemnify and save harmless the Government against all claims whatsoever to any materials in respect of which an advance has been made to him as aforesaid.

(2) That the said materials detailed in the said Running Account Bill (B) and all other materials on the security of which any further advance or advances may hereafter be made as aforesaid (hereinafter called the said materials) shall be used by the Contractor solely in *the* execution of the said works in accordance with the directions of the Divisional Officer (hereinafter called the Divisional Officer) and in the terms of the said agreement.

(4) That the Contractor shall make at his own cost all necessary and adequate arrangement for the proper watch, safe custody and protection against all risks of the said material and that until used in construction as aforesaid the said materials shall remain at jthe site of the said works in the Contractor's custody and at his own risk and on his own responsibility and shall at all times be open to inspection by (he Divisional Officer or any officer authorized by him. In the event of the said materials of any part (hereof being stolen, destroyed or damaged or becoming deteriorated in a greater degree than is due to reasonable use and wear thereof Contractor will forthwith replace the same with other materials of like qualify or repair and make good the same as required by the Divisional Officer and the materials so brought to replace the said materials so repaired and made good shall also be considered as security for the said amount.

(5) 'Hurt the said materials shall not on any account be removed from the site of the said works except with the written permission of the Divisional Officer or an officer authorized by him in that behalf

(6) That the said amount shall be payable in full when or before the Contractor receives payment, from the Government of the price payable to him for the said works under the terms and provisions of the said agreement PROVIDED THAT if any intermediate payments are made to the contractor on account of work done then on the occasion of each such payment the Government will be at liberty to make a recovery from the Contractors Bill for such payment by deducting there from in the value of the said materials (hen actually used in the construction and in respect of which recovery has not been made previously the value for this

purpose being determined in respect of each description of material at (he rates at which the amount of the advances made under these presents were calculated.

(6) at if the Contractor shall at any time make any default in the performance or observation in any respect of any of the terms and provisions of the said agreement or of these presents the total amount of the advance or advances that may still be owing to the Government shall immediately on the happening of such default be repayable by the Contractor to the Government together with interest thereon at twelve percent per annum from the date or respective dates of such advance or advances to the date or repayment and with all costs, charges, damages and expenses incurred by the Government in or for the recovery thereof or the enforcement of this security or otherwise by reason of (he default of the Contractor and any moneys so becoming due and payable shall constitute a debt due from the Contractor to the Government and the Contractor hereby covenants and agrees with the Government to repay and the same respectively to it accordingly.

That the Contractor hereby charges all the said materials with the repayment to the Government of the said sum of Rupees .... (Rs. .....) and any further sum or sums which may be advanced as aforesaid and all costs charges damages and expenses payable under these present PROVIDED ALWAYS and it is hereby agreed and declared that not, withstanding anything in the said agreement and without prejudice to the powers contained therein if and whether the covenant for payment and repayment hereinbefore contained shall become enforceable and the money owing shall not be paid to accordingly.

Once there with the Government may at any time thereafter adopt all or any of following courses as it may deem best ;-

(a) Seize and utilize the said materials or any part thereof in the completion of the said works on behalf of the Contractor in accordance with the provisions in that behalf contained in the said agreement debiting the Contractor with the actual cost of effecting such completion the amount due in respect of advances under these presents and crediting the Contractor with the value of work done as he had carried it out in accordance with the said agreement and at the rates thereby provided. If the balance is against the Contractor he is to pay the same to the Government on demand.

(b) Remove and sell by public auction the seized materials or any part thereof and out of the moneys arising from the sale retain all the sums aforesaid repayable to the Government under these presents and pay over the surplus (if any) to the Contractor.

(c) Deduct all or any part of the moneys owing out of the security deposit or any sum due to the Contractor under the said agreement.

(9) That except as is expressly provided by the presents interest on the said advance shall not be payable.

(10) That in the event of any conflict between the provisions of these presents and the said agreement the provisions of these presents shall prevail and in the event of any dispute or difference arising over the construction or effect of these presents the settlement of which has not been hereinbefore expressly provided for the same shall be referred to the Superintending Engineer/Executive District Officer/Officer one grade higher to officer signed the agreement Circle whose……. decision shall be final and the provisions of the Arbitration Act 1940 for the time being in force so far as they are applicable shall apply to any such reference.

enforcement of this security or otherwise by reason of (he default of the Contractor and any moneys so becoming due and payable shall constitute a debt due from the Contractor to the Government and the Contractor hereby covenants and agrees with the Government to repay and the same respectively to it accordingly.

Singed, sealed and delivered by*	Singed, sealed and delivered by*
In the presence of	In the presence of
SEAL	SEAL
1st witness	2nd witness

CONDITIONS OF CONTRACT

The conditions of contract comprise two parts and are based on Pakistan Engineering Council's "Standard Form of Bidding Documents":

(a) Part I - General Conditions of Contract
(b) Part II - Particular Conditions of Contract

PART I: GENERAL CONDITIONS OF CONTRACT

The General Condition of Contract as a part of Civil Engineering Contracts is a document prepared by the International Federation of Consulting Engineers (Federation International des Ingenieurs-Conseil, or FIDIC) whose address is as follows:

FIDIC Secretariat
P.O. Box 86
1000 Lausanne 12
Switzerland
e-mail: fidic.pub@fidic.org – FIDIC.org/bookshop

The aforesaid document is also known as The FIDIC Conditions of Contract. It is a copyright material and therefore cannot be made available here as a part of Tender Documents. Interested bidders are advised to obtain a copy of the document from the address given above.

In the following Part II: Particular Conditions of Contract, any reference to General Conditions of Contract or the FIDIC Condition of Contract **assumes that the bidder submitting this bid has read and is fully conversant with it.**

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PART II - PARTICULAR CONDITIONS OF CONTRACT

1.1 Definitions

(a) (i) The "Procuring Agency" is synonymous with "Procuring Agency is the **Institute of Business Administration, Main Campus, University Road, Karachi.**

(a) (iv) The Engineer is "The Project & Development Department Institute of Business Administration Karachi and the Project shall be Managed by Project Department of IBA Karachi or any other competent person appointed by the Procuring Agency, and notified to the Contractor, to act in replacement of the Engineer. Provided always that except in cases of professional misconduct, the outgoing Engineers is to formulate his certifications/recommendations in relation to all outstanding matters, disputes and claims relating to the execution of the Works during his tenure.

The following paragraphs are added:

(a)(vi) "Bidder or Tenderer" means any person or persons, company, corporation, firm or joint venture submitting a Bid or Tender.

(a)(vii) "Project Manager" means a person or firm appointed by the Procuring Agency to manage the construction project on his behalf and provide detailed supervision during the construction phase of the project.

(b)(v) The following is added at the end of the paragraph:

The word "Tender" is synonymous with "Bid" and the word "Tender Documents" with "Bidding Documents".

The following paragraph is added:

(b)(ix) "Programme" means the programme to be submitted by the Contractor in accordance with Sub-Clause 14.1 and any approved revisions thereto.

(e)(i) The text is deleted and substituted with the following:

"Contract Price" means the sum stated in the Letter of Acceptance as payable to the Contractor for the execution and completion of the Works subject to such additions thereto or deductions therefrom as may be made and remedying of any defects therein in accordance with the provisions of the Contract.

(g)(iv) Add the words "and e-mail, CD or DVD"

2.1 Engineer's Duties and Authority

With reference to Sub-Clause 2.1(b), the following provisions shall also apply;

The Engineer shall obtain the specific approval of the Procuring Agency before carrying out his duties in accordance with the following Clauses:

(i) Consenting to the sub-letting of any part of the Works under Sub-Clause 4.1 “Subcontracting”.

(ii) Certifying additional cost determined under Sub-Clause 12.2 “Not Foreseeable Physical Obstructions or Conditions”.

(iii) Any action under Clause 10 “Performance Security” and Clauses 21,23,24 & 25 “Insurance” of sorts.

(iv) Any action under Clause 40 “Suspension”.

(v) Any action under Clause 44 “Extension of Time for Completion”.

(vi) Any action under Clause 47 “Liquidated Damages for Delay” or Payment of Bonus for Early Completion of Works (PCC Sub-Clause 47.3).

(vii) Issuance of “Taking Over Certificate” under Clause 48.

(viii) Issuing a Variation Order under Clause 51,except:

a) in an emergency* situation, as stated here below, or

b) if such variation would increase the Contract Price by less than the amount stated in the Appendix-A to Bid.

(ix) Fixing rates or prices under Clause 52.

(x) Extra payment as a result of Contractor’s claims under Clause 53.

(xi) Release of Retention Money to the Contractor under Sub-Clause 60.3 “Payment of Retention Money”.

(xii) Issuance of “Final Payment Certificate” under Sub-Clause 60.8.

(xiii) Issuance of “Defect Liability Certificate” under Sub-Clause 62.1.

(xiv) Any change in the ratios of Contract currency proportions and payments thereof under Clause 72 “Currency and Rate of Exchange”.

(Note: Procuring Agency may further vary according to need of the project)

* (If in the opinion of the Engineer an emergency occurs affecting the safety of life or of the Works or of adjoining property, the Engineer may, without relieving the Contractor of any of his duties and responsibilities under the Contract, instruct the Contractor to execute all such work or to do all such things as may, in the opinion of the Engineer, be necessary to abate or reduce the risk. The Contractor shall forthwith comply with any such instruction of the Engineer. The Engineer shall

determine an addition to the Contract Price, in respect of such instruction, in accordance with Clause 52 and shall notify the Contractor accordingly, with a copy to the Procuring Agency.)

2.2 Engineer's Representative

The following paragraph is added:

The Procuring Agency or the Project Manager appointed by him shall ensure that the Engineer's Representative is a professional engineer as defined in the Pakistan Engineering Council Act 1975 (V of 1976)

The following Sub-Clauses 2.7 and 2.8 are added:

2.7 Engineer Not Liable

Approval, reviews and inspection by the Engineer or Project Manager of any part of the Works does not relieve the Contractor from his sole responsibility and liability for the supply of materials, plant and equipment for construction of the Works and their parts in accordance with the Contract and neither the Engineer's authority to act nor any decision made by him in good faith as provided for under the Contract whether to exercise or not to exercise such authority shall give rise to any duty or responsibility of the Engineer to the Contractor, any Subcontractor, any of their representatives or employees or any other person performing any portion of the Works.

2.8 Replacement of the Engineer

"If the Procuring Agency intends to replace the Engineer, the Procuring Agency shall, not less than 14 days before the intended date of replacement, give notice to the Contractor, of the name, address and relevant experience of the intended replacement Engineer. The Procuring Agency shall not replace the Engineer with a person against whom the Contractor raises reasonable objection by notice to the Procuring Agency, with supporting particulars."

5.1 Language(s) and Law

(a) The Contract Documents shall be drawn up in the English language.
(b) The Contract shall be subject to the Laws of Islamic Republic of Pakistan.

5.2 Priority of Contract Documents

The documents listed at (1) to (6) of the Sub-Clause are deleted and substituted with the following:

(1) The Contract Agreement (if completed);

(2) The Letter of Acceptance;

(3) The completed Form of Bid;

(4) Special Stipulations (Appendix-A to Bid);

(5) The Particular Conditions of Contract – Part II;

(6) The General Conditions – Part I;

(7) The priced Bill of Quantities (Appendix-D to Bid);

(8) The completed Appendices to Bid (B, C, E to L);

(9) The Drawings; and

(10) The Specifications

In case of discrepancies between drawings, those of larger scale shall govern unless they are superseded by a drawing of later date regardless of scale. All Drawings and Specifications shall be interpreted in conformity with the Contract and these Conditions. Addendum, if any, shall be deemed to have been incorporated at the appropriate places in the documents forming the Contract.

The following Sub-Clauses 6.6 and 6.7 are added:

6.6 Shop Drawings

The Contractor shall submit to the Procuring Agency, Engineer and Project Manager for review 3 copies of all shop and erection drawings along with CD applicable to this Contract as per provision of relevant Sub-Clause of the Contract.

Review and approval by the Engineer and/or the Project Manager shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory and that the Engineer's review or approval shall not relieve the Contractor of any of his responsibilities under the Contract.

IBA shall make no additional payment in this regard

6.7 As-Built Drawings

At the completion of the Works under the Contract, the Contractor shall furnish to the Engineer 3

copies and one reproducible of all drawings amended to conform with the Works as built. The contractor will also provide to the Procuring Agency a softcopy (CD, etc.) of the drawings. The price of such Drawings and CD shall be deemed to be included in the Contract Price. ***IBA shall make no additional payment in this regard.***

8.3 Project Requirements

The Contractor shall make the following arrangements for the Client's deputed Project Staff at Site :

a) Site Office : Two Furnished rooms with attached bath and properly insulated roof min. size 12'-0"x18'-0" & 12'-0"x14'-0" minimum clear height 10-0" with CC floor & distemper paint on walls with proper lighting & ventilation and 1.0 Ton AC in each room. The maintenance of the office shall be the responsibility of the contractor.

b) No additional payment for the Project office shall be made separately by IBA

8.4 MATERIAL TESTING AT SITE

The Contractor shall make full arrangement of equipment for field density test, Cube/ Cylinder casting arrangement, slump test etc. The cubes/ Cylinders shall be tested in designated lab as directed by the Engineer in the presence of Engineer's representatives. No additional payment shall be made and the cost shall be deemed to be included in the rates of the BOQ items.

10.1 Performance Security

The text is deleted and substituted with the following:

The Contractor shall provide Performance Security to the Procuring Agency in the prescribed form. The said Security shall be furnished or caused to be furnished by the Contractor within 28 days after the receipt of the Letter of Acceptance. The Performance Security shall be of an amount equal to 5% of the Contract Price stated in the Letter of Acceptance. Such Security shall be in the form of bank guarantee from any Scheduled Bank in Pakistan.

The cost of complying with requirements of this Sub-Clause shall be borne by the Contractor. Validity of the Performance shall be till completion of the maintenance period of the contract.

The following Sub-Clause10.4 is added:

10.4 Performance Security Binding on Variations and Changes

The Performance Security shall be binding irrespective of changes in the quantities or variations in the Works or extensions in Time for Completion of the Works which are granted or agreed upon under the provisions of the Contract.

14.1 Programme to be submitted

The programme shall be submitted along with soft copy within 15 days from the date of receipt of Letter of Acceptance, which shall be in the form of:

i) a Bar Chart identifying the critical activities, or

ii) a CPM identifying the critical path/activities

iii) a primavera VI programme

14.3 Cash Flow Estimate to be submitted

The detailed Cash Flow Estimate shall be submitted within 21 days from the date of receipt of Letter of Acceptance

The following Sub-Clause 14.5 is added:

14.5 Detailed Programme and Monthly Progress Report

a) For purposes of Sub-Clause 14.1, the Contractor shall submit to the Engineer and the Project Manager detailed programme for the following:

(1) ***Execution of Works;***

(2) Labour Employment;

(3) Local Material Procurement;

(4) Material Imports, if any; and

(5) Other details as required by the Engineer or the Project Manager.

(b) During the period of the Contract, the Contractor shall submit to the Engineer or the Project Manager not later than the 8th day of the following month, two copies each of Monthly Progress Reports covering:

(1) A Construction Schedule indicating the monthly progress in percentage;

(2) Description of all work carried out since the last report;

(3) Description of the work planned for the next 56 days sufficiently detailed to enable the Engineer and/or the Project Manager to determine his programme of inspection and testing;

(4) Monthly summary of daily job record;

(5) Photographs to illustrate progress; and

(6) Information about problems and difficulties encountered, if any, and proposals to overcome the same.

(c) During the period of the Contract, the Contractor shall keep a daily record of the work progress, which shall be made available to the Engineer and/or the Project Manager as and when requested.

The daily record shall include particulars of weather conditions, number of men working, deliveries of materials, quantity, location and assignment of Contractor's equipment. Fortnightly meetings will be held on site to review progress and coordination issues. Representatives of Architect, Consultants, Project Manager, Client, Contractor and Sub-contractor (if any) are to attend the meetings on regular basis.

The following Sub-Clauses 15.2 and 15.3 are added:

15.2 Language Ability of Contractor's Representative

The Contractor's authorized representative shall be fluent in the English language. Alternately an interpreter with ability of English language shall be provided by the Contractor on full time basis.

15.3 Contractor's Representative

The Contractor's authorised representative and his other professional engineers working at Site shall register themselves with the Pakistan Engineering Council.

The Contractor's authorised representative at Site shall be authorised to exercise adequate administrative and financial powers on behalf of the Contractor so as to achieve completion of the Works as per the Contract.

The following Sub-Clauses 16.3 and 16.4 are added:

15.4 Contractor's Staff

The Contractor Shall ensure the minimum exclusive Staff is available at Site :

a) Project Manager : BE (Civil) Minimum experience 15 Years registered PEC

b) Site Engineer : BE (Civil)10 Years / DAE with 15 Years Site Experience

c) Site Supervisor DAE (Civil) 5 Year Site Experience

d) Site Supervisor DAE (Elect./ Mech) 5 Years Site Experience

e) Quantity Surveyor BE (Civil) 5 Years Post Qualification Experience or DAE 10 Years Experience

16.3 Language Ability of Superintending Staff of Contractor

A reasonable proportion of the Contractor's superintending staff shall have a working knowledge of the English language. If the Contractor's superintending staff is not fluent in English language, the Contractor shall make competent interpreters available during all working hours in a number deemed

sufficient by the Engineer.

16.4 Employment of Local Personnel

The Contractor is encouraged, to the extent practicable and reasonable, to employ staff and labour from sources within Pakistan.

The following Sub-Clauses 19.3 and 19.4 are added:

19.3 Safety Precautions

In order to provide for the safety, health and welfare of' persons, and for prevention of damage of any kind, all operations for the purposes of or in connection with the Contract shall be carried out in compliance with the Safety Requirements of the Government of Pakistan with such modifications thereto as the Engineer may authorise or direct and the Contractor shall appoint a full time safety inspector and shall take such further measures and comply with such further requirements as the Engineer may determine to be reasonably necessary for such purpose.

The Contractor shall make, maintain and submit reports to the Engineer concerning safety, health and welfare of persons and damage to property, as the Engineer may from time to time prescribe.

19.4 Lighting Work at Night

In the event of work being carried out at night, the Contractor shall at his own cost, provide and maintain such good and sufficient light as will enable the work to proceed satisfactorily and without danger. The approaches to the Site and the Works where the night-work is being carried out shall be sufficiently lighted. All arrangement adopted for such lighting shall be to the satisfaction of the Engineer's Representative. However, no work will be carried out at night without prior approval of the Procuring Agency.

20.4 Procuring Agency's Risks

The Procuring Agency's risks are:

Delete the text and substitute with the following:

(a) insofar as they directly affect the execution of the Works in Pakistan:

(i) war and hostilities (whether war be declared or not), invasion, act of foreign enemies,

(ii) rebellion, revolution, insurrection, or military or usurped power, or civil war,

(iii) ionizing radiations, or contamination by radioactivity from any nuclear fuel, or from any nuclear waste from the combustion of nuclear fuel, radioactive toxic explosive or other hazardous properties of any explosive nuclear assembly or nuclear component thereof,

(iv) pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds,

(v) riot, commotion or disorder, unless solely restricted to the employees of the Contractor or of his Subcontractors and arising from the conduct of the Works;

(b) loss or damage due to the use or occupation by the Procuring Agency of any Section or part of the Permanent Works, except as may be provided for in the Contract;

(c) loss or damage to the extent that it is due to the design of the Works, other than any part of the design provided by the Contractor or for which the Contractor is responsible; and

(d) any operation of the forces of nature (insofar as it occurs on the Site) which an experienced contractor:

(i) could not have reasonably foreseen, or

(ii) could reasonably have foreseen, but against which he could not reasonably have taken at least one of the following measures:

(a) prevent loss or damage to physical property from occurring by taking appropriate measures, or

(b) insure against.

21.1 Insurance of Works and Contractor's Equipment

In Clause 21.1(b), read 25%, instead of 15%.

21.4 Exclusions

The text is deleted and substituted with the following:

There shall be no obligation for the insurances in Sub-Clause 21.1 to include loss or damage caused by the risks listed under Sub-Clause 20.4 paras (a) (i) to (iv).

The following Sub-Clause 25.5 is added:

25.5 Insurance Company

The Contractor shall be obliged to place all insurances relating to the Contract (including, but not limited to, the insurances referred to in Clauses 21, 23 and 24) with either National Insurance Company of Pakistan or any other insurance company operating in Pakistan and acceptable to the

Procuring Agency.

Costs of such insurances shall be borne by the Contractor.

The following Sub-Clause 31.3 is added:

31.3 Co-operation with other Contractors

During the execution of the Works, the Contractor shall co-operate fully with other contractors working for the Procuring Agency at and in the vicinity of the Site and also shall provide adequate precautionary facilities not to make himself a nuisance to local residents, other contractors and students and faculty of the Procuring Agency.

The following Sub-Clauses 34.2 to 34.12 are added:

34.2 Rates of Wages and Conditions of Labour

The Contractor shall pay rates of' wages and observe conditions of labour not less favourable than those established for the trade or industry where the work is carried out. In the absence of any rates of wages or conditions of labour so established, the Contractor shall pay rates of wages and observe conditions of labour which are not less favourable than the general level of wages and conditions observed by other Procuring Agency whose general circumstances in the trade or in industry in which the Contractor is engaged are similar.

34.3 Employment of Persons in the Service of Others

The Contractor shall not recruit his staff and labour from amongst the persons in the services of the Procuring Agency or the Engineer or the Project Manager; except with the prior written consent of the Procuring Agency, the Engineer or the Project Manager, as the case may be.

34.4 Housing for Labour

Save insofar as the Contract otherwise provides, the Contractor shall provide, if not provided for otherwise elsewhere in these documents, and maintain such housing accommodation and amenities as he may consider necessary for all his supervisory staff and labour, employed for the purposes of or in connection with the Contract including all fencing, electricity supply, sanitation, cookhouses, fire prevention, water supply and other requirements in connection with such housing

accommodation or amenities. On completion of the Contract, these facilities shall be handed over to the Procuring Agency or if the Procuring Agency so desires, the temporary camps or housing provided by the Contractor shall be removed and the Site reinstated to its original condition, all to the approval of the Engineer.

34.5 Health and Safety

Due precautions shall be taken by the Contractor, and at his own cost, to ensure the safety of his staff and labour at all times throughout the period of the Contract. The Contractor shall further ensure that suitable arrangements are made for the prevention of epidemics and for all necessary welfare and hygiene requirements.

34.6 Epidemics

In the event of any outbreak of illness of an epidemic nature, the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Government, or the local medical or sanitary authorities, for purpose of dealing with and overcoming the same.

34.7 Supply of Water & Power

The Contractor shall, arrange water and power required for execution and working labour and staff at site from his own resources and IBA shall make no additional payment in this regard.

34.8 Alcoholic Liquor or Drugs

The Contractor shall not, otherwise than in accordance with the Statutes, Ordinances and Government Regulations or Orders for the time being in force, import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or suffer any such importation, sale, gift, barter or disposal by his Subcontractors, agents, staff or labour.

34.9 Arms and Ammunition

The Contractor shall not give, or otherwise dispose of to any person or persons, any arms or ammunition of any kind or permit or suffer the same as aforesaid.

34.10 Festivals and Religious Customs

The Contractor shall in all dealings with his staff and labour have due regard to all recognised festivals, days of rest and religious and other customs.

34.11 Disorderly Conduct

The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst staff and labour and for the preservation of peace and protection of persons and property in the neighbourhood of the Works against the same.

34.12 Compliance by Subcontractor

The Contractor shall be responsible for compliance by his Subcontractors of the provisions of this Clause.

The following Sub-Clauses 35.2 and 35.3 are added:

35.2 Records of Safety and Health

The Contractor shall maintain such records and make such reports concerning safety, health and welfare of persons and damage to property as the Engineer may from time to time prescribe.

35.3 Reporting of Accidents

The Contractor shall report to the Engineer details of any accident as soon as possible after its occurrence. In the case of any fatality or serious accident, the Contractor shall, in addition, notify the Engineer immediately by the quickest available means.

The following Sub-Clause 36.6 is added:

36.6 Use of Pakistani Materials and Services

The Contractor shall , so far as may be consistent with the Contract, make the maximum use of materials, supplies, plant and equipment indigenous to or produced or fabricated in Pakistan and services, available in Pakistan provided such materials, supplies, plant, equipment and services shall be of required standard.

41.1 Commencement of Works

The text is deleted and substituted with the following:

The Contractor shall commence the Works on Site within the period named in Appendix-A to Bid from the date of receipt by him from the Engineer of a written Notice to Commence. Thereafter, the Contractor shall proceed with the Works with due expedition and without delay.

48.2 Taking Over of Sections or Parts

For the purposes of para (a) of this Sub-Clause, separate Times for Completion shall be provided in the Appendix-A to Bid “Special Stipulations”.

51.2 Instructions for Variations

At the end of the first sentence, after the word “Engineer", the words “or the Project Manager, in writing” are added.

52.1 Valuation of Variations

In the tenth line, after the words "Engineer shall" the following is added:

within a period not exceeding one-eighth of the completion time subject to a minimum of 56 days from the date of disagreement whichever is later.

53.4 Failure to Comply

This Sub-Clause is deleted in its entirety.

54.3 Customs Clearance

This Sub-Clause is deleted in its entirety.

54.5 Conditions of Hire of Contractor's Equipment

The following paragraph is added:

The Contractor shall, upon request by the Engineer at any time in relation to any item of hired Contractor's Equipment, forthwith notify the Engineer in writing the name and address of the Owner of the equipment and shall certify that the agreement for the hire thereof contains a provision in accordance with the requirements set forth above.

57.1 Method of Measurement

The following paragraph is added at the end:

Measurements for the purpose of billing shall be recorded on a Measurement Book (MB). No other documents shall be considered valid for payment.

The following Sub-Clauses 59.4 & 59.5 are added:

59.4 Payments to Nominated Subcontractors

The Contractor shall pay to the nominated Subcontractor the amounts which the Engineer certifies to be due in accordance with the subcontract. These amounts plus other charges shall be included in the Contract Price in accordance with Clause 58 [Provisional Sums], except as stated in Sub-Clause 59.5 [Certification of Payments].

59.5 Certification of Payments & Nominated Subcontractors

Before issuing a Payment Certificate which includes an amount payable to a nominated Subcontractor, the Engineer may request the Contractor to supply reasonable evidence that the nominated Subcontractor has received all amounts due in accordance with previous Payment Certificates, less applicable deductions for retention or otherwise. Unless the Contractor:

a) submits reasonable evidence to the Engineer, or

b) i) satisfies the Engineer in writing that the Contractor is reasonably entitled to withhold

or refuse to pay these amounts, and

ii) submits to the Engineer reasonable evidence that the nominated Subcontractor has been notified of the Contractor's entitlement,

then the Procuring Agency may (at his sole discretion) pay direct to the nominated Subcontractor, part or all of such amounts previously certified (less applicable deductions) as are due to the nominated Subcontractor and for which the Contractor has failed to submit the evidence described in sub-paragraphs (a) or (b) above. The Contractor shall then repay, to the Procuring Agency, the amount which the nominated Subcontractor was directly paid by the Procuring Agency.

60.1 Monthly Statements

In the first line after the word "shall", the following is added:

"on the basis of the joint measurement of work done under Clause 56.1,"

In Para (c) the words "the Appendix to Tender" are deleted and substituted with the words " Sub-Cause 60.11 (a)(6) hereof".

(in case Clause 60.11 is applicable)

60.10 Time for Payment

The text is deleted and substituted with the following:

The amount due to the Contractor under any Interim Payment Certificate issued by the Engineer pursuant to this Clause, or to any other terms of the Contract, shall , subject to Clause 47, be paid by the Procuring Agency to the Contractor within 30 working days after such Interim Payment Certificate has been jointly verified by Procuring Agency and Contractor, or, in the case of the Final Certificate referred to in Sub Clause 60.8, within 60 days after such Final Payment Certificate has been jointly verified by Procuring Agency and Contractor; Provided that the Interim Payment shall be caused in 30 days and Final Payment in 45 days in case of foreign funded project.

The following Sub-Clause 60.11and 60.12 are added:

60.11 Secured Advance on Materials

(a) The Contractor shall be entitled to receive from the Procuring Agency Secured Advance against an Indemnity Bond acceptable to the Procuring Agency of such sum as the Engineer may consider proper in respect of non-perishable materials brought at the Site but not yet incorporated in the Permanent Works provided that:

(i) The materials are in accordance with the Specifications for the Permanent Works;

(ii) Such materials have been delivered to the Site and are properly stored and protected against loss or damage or deterioration to the satisfaction and verification of the Engineer but at the

risk and cost of the Contractor;

(iii) The Contractor's records of the requirements, orders, receipts and use of materials are kept in a form approved by the Engineer, and such records shall be available for inspection by the Engineer;

(iv) The Contractor shall submit with his monthly statement the estimated value of the materials on Site together with such documents as may be required by the Engineer for the purpose of valuation of materials and providing evidence of ownership and payment therefore;

(v) Ownership of such materials shall be deemed to vest in the Procuring Agency and these materials shall not be removed from the Site or otherwise disposed of without written permission of the Procuring Agency;

(vi) The sum payable for such materials on Site shall not exceed 75 % of the (i) landed cost of imported materials, or (ii) ex-factory / ex-warehouse price of locally manufactured or produced materials, or market price of stands other materials;

(c) Recovery of Secured Advance:

(i) Secured Advance paid to the Contractor under the above provisions shall be effected from the monthly payments on actual consumption basis, but not later than period specified in the rules not more than three months (even if unutilized); other conditions.

60.12 Financial Assistance to Contractor (Mobilization Advance)

Mobilization Advance up to 10 % of the Contract Price stated in the Letter of Acceptance shall be paid by the Procuring Agency to the Contractor by way of Mobilization Advance on following conditions:

(i) on submission by the Contractor of a Mobilization Advance Guarantee for the full amount of the Advance in the specified form from a Scheduled Bank in Pakistan to the Procuring Agency;

(ii) This Advance shall be recovered in 5 equal installments from the five (05) R.A bills and in case the number of bills is less than five (05) then 1/5th of the advance inclusive of the interest thereon shall be recovered from each bill and the balance together with interest be recovered from the final bill. It may be insured that there is sufficient amount in the final bill to enable recovery of the Mobilization Advance.

63.1 Default of Contractor

The following para is added at the end of the Sub-Clause:

Provided further that in addition to the action taken by the Procuring Agency against the Contractor under this Clause, the Procuring Agency may also refer the case of default of the Contractor to Pakistan Engineering Council for punitive action under the Construction and Operation of Engineering

Works Bye-Laws 1987, as amended from time to time.

65.2 Special Risks

The text is deleted and substituted with the following:

The Special Risks are the risks defined under Sub-Clause 20.4 sub paragraphs (a) (i) to (a) (v).

67. 3 Arbitration

In the sixth to eight lines, the words “shall be finally settled ..... appointed under such Rules” are deleted and substituted with the following:

shall be finally settled under the provisions of the Arbitration Act, 1940 as amended or any statutory modification or re-enactment thereof for the time being in force.

The following paragraph is added:

The place of arbitration shall be Karachi, Pakistan.

68.1 Notice to Contractor

The following paragraph is added:

For the purposes of this Sub-Clause, the Contractor shall, immediately after receipt of Letter of Acceptance, intimate in writing to the Procuring Agency and the Engineer by registered post, the address of his principal place of business or any change in such address during the period of the Contract.

68.2 Notice to Procuring Agency and Engineer

For the purposes of this Sub-Clause, the respective addresses are:

a) The Procuring Agency:

Institute of Business Administration (IBA), Main Campus, University Road, Karachi 75270

b) The Engineer:

Project Manager, Planning & Development Department Institute of Business Administration Karachi

70.1 Increase or Decrease of Cost

Sub-Clause 70.1 is deleted in its entirety.

The following subclauses 73.1,73.2,74.1,75.1,76.1,77.1 and 78.1 are added :

The amounts payable to the Contractor, pursuant to Sub-Clause 60.1, shall be adjusted in respect of the rise or fall in the cost of labor, materials, and other inputs to the Works, by applying to such amount the formula prescribed in this Sub-Clause.

(a) Other Changes in Cost

To the extent that full compensation for any rise or fall in costs to the Contractor is not covered by the provisions of this or other Clauses in the Contract, the unit rates and prices included in the Contract shall be deemed to include amounts to cover the contingency of such other rise or fall of costs.

(b) Adjustment Formula

The adjustment to the monthly statements in respect of changes in cost shall be determined from the following formula:-

$$Pn = A + b\frac{Ln}{Lo} + c\frac{Mn}{Mo} + d\frac{En}{Eo} + \text{.....}$$

Where:

Pn is a price adjustment factor to be applied to the amount for the payment of the work carried out in the subject month, determined in accordance with Paragraph 70.1 (a), and with Paragraphs 70.1 (b) and (e), where any variations and daywork are not otherwise subject to adjustment;

A is a constant, specified in Appendix-C to Bid, representing the nonadjustable portion in contractual payments;

b, c, d, etc., are weightages or coefficients representing the estimated proportion of each cost element (labour, cement and reinforcing steel etc.) in the Works or Sections thereof, net of Provisional Sums and Prime Cost; the sum of A, b, c, d, etc., shall be one;

Ln, Mn, En, etc., are the current cost indices or reference prices of the cost elements for month "n", determined pursuant to Sub-Clause 70.1(d), applicable to each cost element; and

Lo, Mo, Eo, etc., are the base cost indices or reference prices corresponding to the above cost elements at the date specified in Sub-Clause 70.1(d).

(c) Sources of Indices and Weightages

The sources of indices shall be those listed in Appendix-C to Bid, as approved by the Engineer. As the proposed basis for price adjustment, the Contractor shall have submitted with his bid the tabulation of Weightages and Source of Indices if different than those given in Appendix-C to Bid, which shall be subject to approval by the Engineer.

(d) Base, Current, and Provisional Indices

The base cost indices or prices shall be those prevailing on the day 28 days prior to the latest date for submission of bids. Current indices or prices shall be those prevailing on the day 28 days prior

to the last day of the period to which a particular monthly statement is related. If at any time the current indices are not available, provisional indices as determined by the Engineer will be used, subject to subsequent correction of the amounts paid to the Contractor when the current indices become available.

(e) Adjustment after Completion

If the Contractor fails to complete the Works within the Time for Completion prescribed under Clause 43, adjustment of prices thereafter until the date of completion of the Works shall be made using either the indices or prices relating to the prescribed time for completion, or the current indices or prices, whichever is more favorable to the Employer, provided that if an extension of time is granted pursuant to Clause 44, the above provision shall apply only to adjustments made after the expiry of such extension of time.

(f) Weightages

The weightages for each of the factors of cost given in Appendix-C to Bid shall be adjusted if, in the opinion of the Engineer, they have been rendered unreasonable, unbalanced, or inapplicable as a result of varied or additional work executed or instructed under Clause 51. Such adjustment(s) shall have to be agreed in the variation order.

The following Sub-Clauses 73.1, 73.2, 74.1, 75.1, 76.1, 77.1and 78.1, 79.1are added:

73.1 Payment of Income Tax

The Contractor, Subcontractors and their employees shall be responsible for payment of all their income tax, super tax and other Federal or Provincial taxes on income arising out of the Contract and the rates and prices stated in the Contract shall be deemed to cover all such taxes.

73.2 Customs Duty & Taxes

The Procuring Agency is not in any way liable to pay any customs duty and taxes payable or paid by the contractor.

74.1 Integrity Pact

If the Contractor or any of his Subcontractors, agents or servants is found to have violated or involved in violation of the Integrity Pact signed by the Contractor as Appendix-L to his Bid, then the Procuring Agency shall be entitled to:

(a) recover from the Contractor an amount equivalent to ten times the sum of any commission, gratification, bribe, finder's fee or kickback given by the Contractor or any of his Subcontractors, agents or servants;

(b) terminate the Contract; and

(c) recover from the Contractor any loss or damage to the Procuring Agency as a result of such termination or of any other corrupt business practices of the Contractor or any of his Subcontractors, agents or servants.

The termination under Sub-Para (b) of this Sub-Clause shall proceed in the manner prescribed under Sub-Clauses 63.1 to 63.4 and the payment under Sub-Clause 63.3 shall be made after having deducted the amounts due to the Procuring Agency under Sub-Para (a) and (c) of this Sub-Clause.

75.1 Termination of Contract for Procuring Agency's Convenience

The Procuring Agency shall be entitled to terminate the Contract at any time for the Procuring Agency's convenience after giving 56 days prior notice to the Contractor, with a copy to the Engineer. In the event of such termination, the Contractor:

(a) shall proceed as provided in Sub-Clause 65.7 hereof; and

(b) shall be paid by the Procuring Agency as provided in Sub-Clause 65.8 hereof.

76.1 Liability of Contractor

The Contractor or his Subcontractors or assigns shall follow strictly, all relevant labour laws including the Workmen's Compensation Act and the Procuring Agency shall be fully indemnified for all claims, damages etc. arising out of any dispute between the Contractor, his Subcontractors or assigns and the labour employed by them.

77.1 Joint and Several Liability

If the Contractor is a joint venture of two or more persons, all such persons shall be jointly and severally bound to the Procuring Agency for the fulfilment of the terms of the Contract and shall designate one of such persons to act as leader with authority to bind the joint venture. The composition or the constitution of the joint venture shall not be altered without the prior consent of the Procuring Agency.

78.1 Details to be Confidential

The Contractor shall treat the details of the Contract as private and confidential, save in so far as may

be necessary for the purposes thereof, and shall not publish or disclose the same or any particulars thereof in any trade or technical paper or elsewhere without the prior consent in writing of the Procuring Agency or the Engineer. If any dispute arises as to the necessity of any publication or disclosure for the purpose of the Contract, the same shall be referred to the decision of the Engineer whose award shall be final.

79.1 Safety Requirements

The Institute of Business Administration (IBA) obliged to provide and maintain, so far as is practicable, an environment for its employees, students and public, that is safe and without risk to health. As a condition of this contract, the IBA requires that any Contractors or subcontractors that may be engaged will at all times identify and exercise all reasonable and necessary precautions for the health and safety of all persons. This includes Contractor employees, IBA employees and public who may be affected by the works or services.

The Contractor will forthwith comply with any and all directions by the Engineer relating to occupational health and safety. This includes the right to carry out site inspections by Engineer.

a). Legislative Compliance: The Contractor must comply with and ensure that its employees, subcontractors and agents comply with local laws and by-laws, Codes of Practice, and the IBA's HS policy and procedures that are in any way applicable to this contract or the performance of the work / services under this contract.

b). Incident Notification: The Contractor must promptly notify the Engineer of any accident, injury, property or environmental damage that occurs during the carrying out of the contract works. All lost time incidents shall be immediately notified to Engineer. The Contractor must and within 3 working days of any such incident provide a report giving complete details of the incident, including results of investigations into its cause, and any recommendations or strategies for prevention in the future.

c). Non Compliance: If during the performance of works under the contract the Engineer informs the Contractor in writing that it is the opinion of the Engineer that the Contractor is:

- not conducting the work in compliance with the Contractor's Health and Safety Plan, health and safety management procedures, or
- conducting the work in such a way as to endanger the health and safety of Contractors employees or the IBA's employees or its Contractors' and subcontractors' employees, plant, equipment or materials,

the Contractor shall promptly remedy that breach of health and safety.

The Engineer may direct the Contractor to suspend the work until such time as the Contractor satisfies the Engineer that the work will be resumed in conformity with applicable health and safety provisions.

During periods of suspension referred to above, the Engineer shall not be required to make any payment whatsoever to the Contractor.

If the Contractor fails to rectify any breach of health and safety for which the work has been suspended, or if the Contractors performance has involved recurring breaches of health and safety, the Engineer may as its option terminate the work forthwith, without further obligation to the Contractor. In this event, the Procuring Agency's liability shall be limited to payment for the work performed and costs incurred by the Contractor up to the time of termination or an earlier suspension of works.

d). Disputes on Health and Safety Matters: Where there is a dispute on health and safety matter between the Procuring Agency and the contractor, then after a reasonable period for negotiation (depending upon the nature and seriousness of the matter), the matter will be referred to the relevant government authority. Only written opinions from the relevant government authority will be accepted.

e). Health and Safety Plan: Prior to commencing the works under the contract the Contractor shall submit to the Engineer a Health and Safety Plan specific to the contract and works. The Health and Safety Plan shall consider and respond to the specific OHS hazards and issues relevant to the contract works and shall document the systems and methods to be implemented for the term of the contract. The Health and Safety Plan shall be reviewed by the Engineer and formal approval to commence the contract shall be provided subject to acceptance of the Health and Safety Plan.

f). Risk Assessment: The Contractor shall prepare and submit a risk assessment prior to commencing the works under the contract. The risk assessment may be in the form of a Job Safety Assessment (JSA) or Safe Working Method Statement (SWMS). The risk assessment shall record the risk assessment and risk control methods to be employed by the Contractor. The completed risk assessment shall be submitted to the Engineer for review and approval prior to commencement of works under the contract.

g). Health & Safety Performance Reporting: The Contractor must when requested by the Engineer provide evidence of ongoing performance of the Contractor's HSP management system. If requested by the Engineer, the information shall apply to all the contractor's operations not just those pertaining to the Engineer. Without limiting the requirements of this obligation, the Contractor shall provide the following information on a monthly basis in the form of a Contractor Health & Safety Performance Report:

a. Number of lost time injuries
b. Working days lost due to injury
c. Current status of any injured personnel, damaged property or environmental damage or pollution
d. Status of the implementation and outcomes of corrective actions undertaken as a result of HS inspections and risk assessments
e. Status of HS management system audits undertaken

The HS Performance Report shall be submitted by the Contactor using the Contractor Monthly HS Performance Report Form. The Contractor shall when requested by the Engineer provide reports on HS inspections, audits or assessments undertaken during the course of the contract.

h). Other Parties and Contractors sharing the contract location: Where the health and safety of other parties or other contractors may be affected by this contract, the contractor is required to ensure adequate communication and coordination occurs on health and safety matters. Where there are matters of issue or concern they must be raised as soon as practicable with the Procuring Agency through the Engineer.

j). Personal protective equipment: Where adequate protection against the risk of accident or injury to health, including exposure to adverse conditions, cannot be ensured by other means, suitable personal protective equipment and protective clothing, having regard to the type of work and risks, shall be provided and maintained by the Contractor, without cost to the workers.

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TECHNICAL SPECIFICATION

ARCHITECT :
M/S MUKHTAR STUDIO ENTERPRISES (MESA)

Address
Suite 302, 52-C, Al Murtaza Commercial, Lane 1, Phase 8, DHA, Karachi

CHAPTER 1. CLEARING & GRUBBING

1. CLEARING & GRUBBING

1.1 SCOPE

The Scope of work includes removal of the bushes, vegetation, debris, garbage, lose material/ earth etc laying at proposed side of constructions and it shall also be inclusive of grubbing stumps, roots and matted roots and disposal of all material resulting from the clearing and grubbing of the proposed site of construction.

1.2 LOCATION OF WORKS

The Engineer shall mark the limit of working space. Normally it will be inclusive of ROW (Right of Way)

1.3 DISPOSAL

The contactor shall dispose off all the rubbish, bushes etc with in fifteen days. No tree trunk, stump or other debris shall be removed from site with out prior written approval of Engineer Incharge.

1.4 PROTECTION AND RESTORATION

The Contractor shall prevent all damages to under ground or on surface, water supply, Sewerage, Power Supply, Communication Cables, ducts, Land Marking Posts, property fences, Official Datum Points. If damaged accidentally during work then it will be restored immediately.

1.5 MEASUREMENT AND PAYMENT

The Measurement and payment for this item including loading unloading and stacking shall be made corresponding to tems as provided in the BOQ of 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.

TECHNICAL SPECIFICATION

CHAPTER 2. EARTHWORK

2.0. SCOPE

The Work to be done under this section "Earth work" consists of performing all earth work in accordance with required levels, elevations and grades shown on the drawings/plans or as established by the Engineer .

a) 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. The method of carrying out earthwork shall be subject to approval of the Engineer-in-Charge in writing.

b) Any excavation made excess than the required shall be filled by lean concrete for which no extra payment shall be made.

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

d) 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-

2.1. CODES AND STANDARDS

The following Codes and Standards shall be followed wherever relevant and as directed by the Engineer-in-Charge.

ASTM D-1556-74 Test for density of soil in place by the sand cone method.
B.S 1377-75 Methods of tests for soils for Civil Engineering purposes.

2.2. CLASSIFICATION OF SOILS

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

2.2.1 ORDINARY SOIL

It includes cutting in earth which in general can be ploughed. Generally, the ordinary soils comprise of:

a) Spoil or rubbish of every description.
b) Earth and sandy loam
c) Any other formation into which a shovel can be entered with foot pressure and can be easily excavated.

2.2.2. MURUM AND HARD SOILS

There are the following two types of hard soils:
It includes a stiff and heavy clay soil having specific gravity of 1.5 and above.

2.2.3. SHINGLE AND GRAVEL/GRAVELLY SOIL

This Includes;
(I) Gravel Formation
(II) Large Boulders Above 20 Percent Which Can Be Individually Lifted By Hand
(iii) Soils which contain more than 50% of larger than 1-2'' size particles of gravel and requires more labour to excavate than the soft or hard soil will be classed as gravelly soil.

2.3. ANTIQUITIES AND USEFUL MATERIALS

Any as ancient carvings, relics of antiquity, coins, fossils or other articles of archaeological value discovered or excavated during progress of work shall be delivered to the Engineer-in-Charge and shall be the property of the IBA /Government.

2.4. SETTING OUT AND SITE PREPARATION

The Contractor shall set out the Works and shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If at any time any error in this respect shall appear the Contractor shall at his own expense rectify such error, to the satisfaction of the Engineer-in-Charge.
The bench marks or datum for setting out the Works will be provided by the Engineer-in-Charge. The Contractor shall however maintain accurate bench marks and survey monuments so that the lines and levels can be easily checked by the Engineer-in-Charge.

2.5. EXCAVATION IN ALL KINDS OF SOILS

2.5.1 EXCAVATION OPERATIONS

TECHNICAL SPECIFICATION

All excavation operations manually or by mechanical means shall include excavation and disposal of the excavated material for, buildings foundations, trenches, basements, water tanks sewers, drains foundations 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.

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, centering, 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 cost with the concrete of the mix used for levelling/ bed concrete for foundations.

2.7.2 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 contractor has to take written permission about place of disposal of earth before the earth is disposed of, from Engineer-in-Charge.

2.8. EXCAVATION IN ORDINARY / HARD ROCK

2.8.1 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.

2.8.2 ORDINARY / SOFT ROCK

The ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be adopted.

2.8.3 HARD ROCK

a) General

EXCAVATION & GRADING OF ROCKS

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a) Excavation Methods for Rock

The Method relates to rock strength and fracture density.

Direct excavation: Possible in fractured lock and in all soils; using face shovel, backhoe, clam shell grab or dragline or as stated..

2.10. CARE OF WATER/ DEWATERING

All water that may accumulate in excavations 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/or pumping out water from excavations. Pumping shall be done directly from the foundations or from a sump outside the excavation or any other appropriate method proposed by Contractor, 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.

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

2.10.3 MEASUREMENTS

The unit, namely, metre /ft depth shall be the depth measured from the level of foul position/ sub-soil water level and upto the centre of gravity of the cross sectional area of excavation actually done in the conditions classified above.

Pumping or bailing out water met within excavations from the sources specified in above where envisaged and specifically ordered in writing by the Engineer-in-Charge shall be measured separately and paid. Quantity of water shall be recorded in kilolitres correct to two places of decimal. This payment shall be in addition to the payment under respective items of earthwork and shall be admissible only when pumping or bailing out water has been specifically ordered by the Engineer-in-Charge in writing.

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.

2.11. FILLING /BACK FILLING

2.11.1. GENERAL

i. For fillings foundation and embankment construction, the 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.

2.11.1. 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.

2.11.2. MEASUREMENTS

The length and breadth of excavation or filling shall be measured with a steel tape and paid as per drawing.. The depth of cutting or height of filling shall be measured, by recording levels before the start of the work and after the completion of the work. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres./Cuft.

In case of open footings up to the depth of 1.5 metres, around excavation of 30 cm. beyond the outer dimension of footing shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

2.11.3. EXCAVATION IN TRENCHES FOR PIPES, CABLES ETC. AND REFILL ING

'a) 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.

b) Refilling /Back filling

Filling in trenches shall be commenced soon after the joints of pipes, cables, 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 20cm in depth. Each layer shall be watered, rammed and consolidated. All clods and lumps of earth exceeding 8cm 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. Excavated material containing deleterious material, salt peter earth etc. shall not be used for filling.. Special care shall be taken to ensure that no damage is caused to the pipes, Cables, Conduits etc. laid in the trenches.

i) **Measurements**

Trenches for pipes, cables, conduits etc. shall be measured in running meter/ft correct to the nearest cm /inch.

Where two or more categories of each work are involved due to different classification of soil within the same stage of trench depth or where the soil is soft loose or slushy requiring increase in the width of trench or sloping sides or shoring, trenches for pipes, cables, conduits,

etc. shall be measured in cubic meters. Extra excavation, if any, on account of collar/ socket of pipes shall neither be measured nor paid for separately.

2.11.4. FILLING IN PLINTH, UNDER FLOOR ETC.

2.11.4.1 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, salt peter earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8cm 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 exceeding 20cm in depth. Each layer shall be watered, rammed and consolidated

a) **MEASUREMENTS**

Filling Side of Foundations: The cubical contents of bed concrete levelling course and masonry/concrete in foundations up to the ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations already measured under the respective item of earth work to arrive at the quantity for filling sides of foundation. The quantity shall be calculated correct to two places of decimal.

Filling in Plinth and under Floors: Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre-measurement correct to the nearest cm and cubical content worked out in cubic metres correct to two places of decimal.

2.11.6. 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. 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.

a) **MEASUREMENTS**

The length, breadth and depth of consolidated sand shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic metres correct to two places of decimal.

2.12 TERMITE CONTROL TREATMENT

2.12.1 SCOPE

The scope of work for anti-termite treatment includes injection of insecticide in sides and bottom of foundation trenches, spraying on stockpiled backfill material and injections of the insecticide in floor sub-grade of the building. Anti-termite treatment can be either during the time of 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 insecticide.

The scope also covers treatment of all wood works with insecticides before installation in position.

2.12.2 CODES AND STANDARDS

All methods of termite protection used herein shall be in accordance with the standard practice of National Pest Control Association, U.S.A. and the British Wood Preserving Association.

2.12.3 SUBMITTALS

Samples of all the materials to be used for termite control for approval of the Engineer and testing in accordance with the specified standards.

2.12.4 Method statement for application of anti-termite chemical.

2.12.5 QUALITY ASSURANCE

2.12.5.1 Manufacturer's Instructions

In addition to the requirements of these specifications, the manufacturer's instructions and recommendations for the work, including preparation of substrata and application shall be complied with.

2.12.5.2 Application

A professional operator shall be engaged who shall have license in accordance with regulations of governing authorities for application of soil treatment solution.

2.12.5.3 Guarantee

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests which cause damage to wood or other organic material for one year from the date of acceptance of the building.

In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damaged material, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

2.12.6 MATERIAL

2.12.6 An emulsible concentrated insecticide shall be used for dilution with water, specially formulated to prevent infestation by termites. Provide a working solution of one of the following chemical with clean portable water in ratio 1:40 unless otherwise specified by the manufacturer/ supplier.

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5.1.1.1 Termidor

5.1.1.2 Biflex

5.1.1.3 Dursban

5.1.1.4 TENEKIL or any other material as specified.

Insecticide shall be obtained from the Sole distributor, in sealed drums in quantity necessary for the requirement of works. All mixing shall be done at site and mixing proportion of insecticide with water shall be as per manufacturer's instructions and verified by the Engineer.

2.12.7 **METHOD AND EXTENT OF APPLICATION**

Insecticide solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150psi to all applications to, on or in earth.

Soil treatment shall begin after all work of preparation of earth prior to installation of concrete has been done. No covering of earth or concrete should be applied over soil treatment until at least 24 hours after treatment has been made. Solution should not be applied during wet weather, or when the earth surface is excessively wet. Application should be made to all areas beneath concrete slabs-on-grade, including sidewalks and paving abutting buildings for distance of at least 2 meter beyond building line. Solution shall be applied in amounts of not less than 6.00 litter /sq.m of area. If applied over gravel or sand fill, application shall not be less than 7.50litre /sq.metre of area. Insecticide shall penetrate to a depth of 25-mm minimum in porous earth at bottom and 50 mm to 75 mm at sides of excavations.

Sides of foundation excavations, grade beam, and similar areas shall be treated with solution at a rate of 0.37 gallon per square feet upon inner sides of such excavations, and at all locations where concrete slabs for platforms and similar work abut the building. Similar treatment shall be made at all locations where expansion joints, control joints, column bases and similar work occur at or below grade slabs.

In the areas of application signs shall be fixed to show that soil treatment has been applied. Such signs shall be removed when areas are covered by other construction.

All woodwork for the entire project is to be insecticide treated (before application of solignum). Insecticide shall be sprayed on all surfaces of all the wooden work viz., door frames, blocking, furring, planks, boards etc. before installation. Spraying is to be done at the site, after delivery and before installation.

2.12.8 **MEASUREMENT & PAYMENT**

General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost there of shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

2.12.8.1 Measurement

Measurement of acceptably completed works of termite control treatment will be made on the basis of number of square feet/Sq meter of area treated by measuring the two dimensions (length & breadth) of treated surface.

2.12.8.2 Payment

TECHNICAL SPECIFICATION

Payment will be made for acceptable measured quantity of termite control treatment on the basis of unit rate per square Feet /Sq meter quoted in the Bills of Quantities & shall constitute full compensation for all the works related to the item.

CHAPTER-3. DISMANTLING (DEMOLITION)

3.0 SCOPE

The work shall comprise dismantling/demolishing whole or part of work including all relevant items consisting of but not limited to , concrete, floorings, roofing and metal work structural steel as specified and or shown on the drawings. Only such work or part of works which are designated on the Drawings or by the Engineer to be removed shall be included in the work to be done under these specifications.

When approved by the Engineer, the contractor shall remove the dismantled/works required to be removed and clear the site, as specified or directed by the Engineer.

3.1. SERVICEABLE AND UNSERVICEABLE MATERIALS

Upon written instructions of Engineer-in-Charge, the Contractor shall make a list of all such items which in opinion of Engineer-in-Charge can be re-used. The Contractor shall take such measures to protect these materials / items from damage during dismantling process. The Contractor shall provide labour and other arrangements to properly stack / store such items safely until handed over to the Engineer-in-Charge.

All unserviceable materials, rubbish etc. shall be disposed off as directed by the Engineer -in-Charge.

3.2. PRECAUTIONS

a) 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.

b) 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 workers, 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.

c) Necessary steps/ precautions should be taken to keep noise and dust nuisance to a minimum

d) 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.

3.3. MEASUREMENT AND PAYMENT

All work shall be measured net in the decimal system, as fixed in its place, subject to the following limits, unless otherwise stated hereinafter in BOQ.

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CHAPTER - 4. PLAIN AND REINFORCED CONCRETE

4.1 SCOPE

The work shall include all Cast –in Place and Precast Concrete including furnishing of all labour, materials, plant, equipment, accessories ,Erection & Removal of Mold/ Form Work , Testing at Site & Laboratory 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.

The Contractor shall submit method statement before starting of concreting operations. The method statement shall provide the procedures and resources planned to be employed for completion of construction. The General Condition, Special Condition of Contract , General Note on Structural and Architectural Drawings shall be a part of this section. Finishing, Curing, protection of Concrete is a part of the Scope of Work.

4.2 CLASSIFICATION OF CONCRETE

In order to meet the strength and durability of the requirements, the concrete is divided into the following categories in the context of this Contract.

4.2.1 VOLUMETRIC PROPORTION (CEMENT: SAND: AGGREGATE)

a) 1:1:2

Concrete made by using Ordinary Portland Cement (OPC) and other basic ingredients i.e. course aggregate, fine aggregate and water. The concrete having Volumetric proportions of 1:1:2 (1 Cement: 1 Fine Aggregate: 2 Coarse Aggregate). Nominal 28 days Cylinder Compressive Strength of such concrete is **28 MPa (4000 psi).** However, it may vary depending on physical and chemical properties of aggregates.

b) 1:1.5:3

Concrete made by using Ordinary Portland Cement (OPC) and other basic ingredients i.e. course aggregate, fine aggregate and water. The concrete having Volumetric proportions of 1:1.5:3 (1 Cement : 1.5 Sand : 3 Aggregate). Nominal 28 days Cylinder Compressive Strength of such concrete is 21 MPa (3000 psi). However, it may vary depending on physical and chemical properties of aggregates.

c) 1:2:4

Concrete made by using Ordinary Portland Cement (OPC) and other basic ingredients i.e. course aggregate, fine aggregate and water. The concrete having Volumatic proportions of 1:2:4 (1 Cement : 2 Sand : 4 Aggregate). Nominal 28 days Cylinder Compressive Strength of such concrete is 16.5 MPa (2400 psi). However, it may vary depending on physical and chemical properties of aggregates.

d) Lean 1:3:6

Concrete made by using Ordinary Portland Cement (OPC) and other basic ingredients i.e. course aggregate, fine aggregate and water. The concrete having Volumetric proportions of 1:3:6 (1 Cement : 3 Sand : 6 Aggregate). Nominal 28 days Cylinder Compressive Strength of such concrete is 10.5 MPa (1500 psi). However, it may vary depending on physical and chemical properties of aggregates.

e). Lean 1:4:8

Concrete made by using Ordinary Portland Cement (OPC) and other basic ingredients i.e. course aggregate, fine aggregate and water. The concrete having Volumetric proportions of 1:4:8 (1 Cement : 4 Sand : 8 Aggregate). Nominal 28 days Cylinder Compressive Strength of such concrete is 8 MPa (1200 psi). However, it may vary depending on physical and chemical properties of aggregates. It shall be used for no structural works like floor underlay, lean concrete etc.

4.3 MATERIALS

4.3.1 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.

Portland Cement

Portland cement shall be of Pakistan origin as per approved brand and manufacturer and, shall conform to Pakistan Standard 232 or to British Standard 12 or to ASTM C 150 Type I or Sulphate Resistant, Type-V or conforming to BS 4027 or ASTM C-150 may also be used in certain parts of the Works as specified or directed by the Engineer-in-Charge. The slag cement conforming to BS 146 or ASTM C 595 may also be used with prior approval of Engineer-In charge.

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,

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

b. 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

c. Sampling, Cement Usage

Sampling of cement shall be in accordance with AASHTO T 127. Mill Test Certificates shall accompany delivery of the material to the work.

4.3.2 AGGREGATES

a) General Requirements

i) Cleanliness.

The aggregates should be free from injurious amount of clay, salt, alkali, organic matter, shale, loam, soft flaky particles and other deleterious substance. Aggregate when not obtained in clean state are invariably washed before use.

Shape.

Crushed aggregate should be sharp, angular and of hard grains, approximately cubical in size and those obtained from natural source be rounded, well-shaped and of hard grains. The fine aggregate should be such shape that it covers the maximum voids between coarse aggregates.

ii) Size.

TECHNICAL SPECIFICATION

To obtain high crushing strength of concrete the maximum size of aggregate should be as large as conveniently possible but it should not be normally greater than one- fourth in plain concrete and one-fifth in reinforced concrete of the smallest dimension in the structure.. Similarly, 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.

iii) Grading.

Aggregate are required to be graded into different size and mixed in desired proportions for producing mortar and concrete of specified quality and strength. The aggregates are graded into minimum of cement per unit volume to give required strength. The aggregates are graded into nominal size by sieving and their fineness Modulus determined. A smaller value of the fineness modulus indicated the presence of large proportions of fine particles.

iv) Durability.

Aggregates should be hard to resist grading actions; tough to withstand impact and sound to remain whole during changes in weather conditions. The soundness test is carried out by means of Sodium Sulphate Test. Crushing strength test is carried out to determine the strength. The specific gravity test is required to determine the density.

vi) Storage.

Storing on dusty, muddy or grassy spots, should be avoided. Aggregate which has deteriorated or which has been contaminated shall not be used for concrete

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b) Test Requirements for Fine Aggregate

The fine aggregate shall consist of sand, stone screenings or other approved inert materials with similar characteristics,

For exposed work, the fine aggregate shall be free from any substance that will discolor the concrete surface.

The fine aggregate shall be uniformly graded and when tested in accordance with AASHTO T 11 and T 27 shall meet the following grading requirements:

Table 4.2

GRADING OF FINE AGGREGATES

Sieve Designation	Percentage Passing by Weight
3 / 8 inch	100
No. 4	95~100
No. 16	45~85
No. 50	10~30
No. 100	2~10
No. 200	0~3

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.

i) 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.

TECHNICAL SPECIFICATION

ii) GRADING TABLE OF COARSE AGGREGATES:

TABLE 4.2
GRADING OF COARSE AGGREGATES

Designated Sizes	Percentage by Weight Passing Laboratory Sieves, in inches, Having Square Openings							
	2 ½	2	1 ½	1	¾	½	3/8	No. 4
½" to No. 4	-	-	-	-	100	90~100	40~70	0~15*
¾" to No. 4	-	-	-	100	90~100	-	20~55	0~10*
1" to No. 4	-	-	100	95~100	-	25~60	-	0~10*
1½" to No. 4	-	100	95~100	-	35~70	-	10~30	0~5
2" to No. 4	100	95~100	-	35~70	-	10~30	-	0~5
1½" to¾"	-	100	90~100	20~55	0~15	-	0~5	-
2" to 1"	100	90~100	35~70	0~15	-	0~5	-	-

- Not more than five (5) % shall pass No. 8 sieve.

Coarse aggregate gradation should conform to the requirements of ASTM C 33

d) Tests & Approval

All aggregates shall be subject to testing which shall be carried out by the contractor at his own expanse upon instructions of Engineer-in-Charge. Aggregates not meeting the requirements of these Specifications as determined by tests or inspection may be rejected.

e) Water

The water for curing, for washing aggregates and for mixing shall be subject to the approval of the Engineer in charge. Generally it should be free from oil and the turbidity limit shall not exceed 2000 parts per million and the pH value shall range between 6.0 to 8.0.

e) Admixtures

An, admixture is added to concrete mix in quantities not more than 5% by mass of cement during mixing or during an additional mixing operation prior to the placing of the concrete, for achieving a specific modification, to normal properties of the concrete..

Classification of admixtures as per ASTM C-494 is given as under

Type A Water Reducing (Normal Plasticizing)

Type B Retarding

Type C Accelerating

Type D Water Reducing and Retarding

Type E Water Reducing and Accelerating

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.

Measurement

Where so specified, Admixture of approved quality shall be added to the concrete mixture in accordance with the manufacturer's specification stating the quantity in litres or kg as specified and will be paid for separately as per item of BOQ or as approved.

f) Water stops

g) **PVC Water-stops**

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. The PVC Stopper confirm the following Properties.

Table 4.3
Physical Characteristics of PVC Waterstop

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 (2.76 Mpa) min
Specific gravity	ASTM D 792	1.37 max
Hardness, Shore A	ASTM D 2240	70 - 80

g) 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-1190 or their equivalents as specified on drawing or as per approval

Measurements

The measurement of the finished work shall be measured as per BOQ and be paid as per approved.

4.1.2 PROPORTIONING & MIXING OF CONCRETE MIX

4.1.2.1 PROPORTIONING OF INGREDIENTS

a) The proportioning of the concrete for its ingredients namely cement, sand and coarse aggregates is specified for BOQ items on volume basis and on weight basis for the specified use. The proportioning and batching of concrete mix shall accordingly be done on volume basis.

Mix proportions and water- cement ratio shall be so determined as to produced concrete having suitable workability, density, im-permeability, durability or strength. The contractor shall not be entitled to any compensation because of these adjustments.

b) The amount of water used in the concrete shall be so regulated as to secure concrete of a proper consistency and to adjust for any variation in the moisture contents, or grading of the aggregates as they enter the mixer. Water shall not be allowed to be added to undo the stiffening of the concrete resulting from excessive over-mixing or objectionable drying before placing. Uniformity in concrete consistency from batch to batch shall be required. Unless otherwise specified or directed by the Engineer-in-Charge the slump of concrete after it has been deposited, but before it has consolidated, shall have the following values under different situations:

Sr. No.	Purpose	Slump (inches)
2.	High strength reinforced and pre-stressed concrete section, paving and mass concrete compacted by vibration.	0 – 1
3.	Normally reinforced concrete sections compacted by vibration, hand compacted mass concrete.	1 – 2

4.	Heavily reinforced concrete sections compacted by vibration, hand compacted concrete in normally reinforced slabs, beams, columns and walls.	2 – 4
5.	Heavily reinforced concrete sections compacted without vibration and work where compaction is particularly difficult.	4 – 6

4.1.3 PROPORTIONING ON VOLUMETRIC BASES

For volumetric proportioning suitable gauge boxes shall be used. Cement shall be taken as weighing 50 Kg as per standard bag of 0.035 cubic meter (1.25 ft^3). The bulking effect of aggregates shall be taken into the consideration.

The Engineer in Charge shall ensure preparations for various strength requirements, based on the availability of local materials. Depending upon the variations in site condition and locally available aggregate (both coarse and fine) the Engineer in Charge shall ensure preparation of Concrete mix designs as specified by the Designer and get them tested from an authenticated Government Material Testing Laboratory at the expense of the contractor before commencement of the Job. The following table shows the proportions of the concrete ingredients on volumetric bases: -

Table 4.5
Estimated Mix Proportions for Regular / Normal Concrete For Various Strength Requirements

Minimum 28 Days Cylinder Compressive Strength	Type	Approximate Concrete Mix for Estimation	Estimated Quantities per Cum		
			Cement Kg	Aggregate (Cum)	
				Fine	Coarse
24 MPa (3500 psi)	B	1:1.5:3	415.5	0.436 (15.4 ft^3)	0.872 (30.8ft^3)
21 MPa (3000 psi)	C	1:2:4	327	0.457 (16.14 ft^3)	0.914 (32.28 ft^3)
10.5 MPa (1500 psi)	D	1:3:6	228.5	0.480 (16.95 ft^3)	0.960 (33.90 ft^3)

Consistency

Concrete shall have a consistency such that it will be workable in the required position. The consistency of concrete shall be determined to be as dry as it is practicable to satisfy the requirements for transportation and placing of the concrete as described hereinafter. Consistency of concrete shall be determined as specified in AASHTO T 119.

c) **Water Cement Ratio**

TECHNICAL SPECIFICATION

The selection of water cement ratio as a basis for designing a concrete mixture involves consideration of both the degree of exposure to which the concrete is to be subjected and the strength requirements of the structure

It is expected that water– cement ratio by weight will vary from 0.45 for concrete in thin sections to 0.65 for mass concrete in severe weather conditions. Maximum permissible water cement ratio will also vary from 0.67 for low strength concrete to 0.38 for the concrete 28 days strength of 4000 Psi and above.

4.2.0. STRENGTH EQUIVALENCY OF CUBE AND CYLINDER STRENGTH

28 days 6 inches x 12 inches (15cm x 30 cm) cylinder strength corresponding to 28 days cube strength in the Table are given hereunder:

28 days cube strength (Psi)	6” x 12” cylinder strength (Psi)
4500	4000
3750	3000
3000	2200
2000	1500

4.2.1 HAND MIXING

No Hand Mix is allowed for Structural Concrete. However for non Structural Concrete
Hand mixing shall not be carried out with the approval of the Engineer in Charge.

Unless otherwise specified or directed, hand mixing shall be done on the following lines:

4.2.2 MACHINE MIXING

Concrete Mixtures

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. The pick-up and throw-over blades of mixer shall be restored or replaced when any part or sections is worn two and a half ($2^1/_2$) cm or below than the original height of the manufacturer’s design. Mixers and agitators, which have an accumulation of hard concrete or mortar, shall not be used

All concrete shall be mixed for a period of not less than one and a half (11/2) minutes after all materials, including water, are in the mixer. During the period of mixing, the mixer shall operate at the speed for which it has been designed.

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.

4.2.3 Plant Mixing

At central mixing plant, batches shall be discharged from the weighing hopper into the mixer either directly by gravity or by an elevating container large enough to contain the batch. The plant shall be arranged to ensure that there is no loss of cement during transfer from weighing hopper to the mixer drum. The mixing time shall neither be less than fifty (50) second, nor more than ninety (90) seconds.

The plasticizer, accelerator or retarder or water-reducing admixture, if required, shall be fed separately at the rate recommended by the manufacture, or as established by laboratory trials.

4.**2.4 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 ACI304. There shall be no vertical drop greater than one metre except where the use of such equipment is approved in writing by the Engineer-in-Charge, in advance of any use

4.2.5 PLACING

(a) General

(I) Concrete shall be placed only in presence of the Engineer-in-charge or his representative.

(II) Any concrete which has become so stiff that proper placing cannot be assured shall be wasted and no payment shall be made to the contractor for such wasted concrete, Concrete shall not be placed during rains unless proper protection is afforded.

(III) Each layer of concrete shall be consolidated to the maximum practicable density so that it is free from pockets of aggregates, and close snugly against all surface of forms and embedded materials.

(IV) In consolidating each layer of concrete the vibrating head of the vibrator shall be secured to form or allowed to penetrate and re vibrate the concrete in the upper portion of the underlying layer. All concrete shall be consolidated with electric or pneumatic power-driven vibrators having a frequency of not less than 5000 cycles per minute.

(V) Special care shall be taken in placing concrete when it has to be dropped from a height, especially when reinforcement is in the way, and every effort shall be made to reduce this drop to the minimum. In any case the drop shall not be more than 5 feet. .

(VI) Ducts, recess, rebates and holes shall be moulded in the concrete during placing at their proper position as shown on the drawing or as directed by the Engineer-incharge.

4.2.6 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.

4.2.7 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. Concrete shall be placed at temperatures as follows:

a)THIN SECTIONS:

Concrete for thin sections shall be delivered to the forms at a temperature in excess of 30oC. Except as otherwise determined by the Engineer-in-Charge, sections to which this provision shall apply shall be less than 20 inches (50 cms) in thickness.

b. MODERATE SECTIONS:

Concrete for moderate sections shall have a temperature of not more than 21°C when placed. A moderate section will be one that is greater than twenty inches (fifty centimetres) but less than 40 inches (one metre) in thickness.

c.MASS CONCRETE SECTIONS:

Concrete having a measure of 40 inches (one metre) or more in thickness shall have a temperature not exceeding 18°C.

4.2.8. Placing Concrete through Reinforcement

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.

4.2.9 Vibration of Concrete

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Recommended Practice given in ACI 309 shall be followed for concrete consolidation.. The duration of vibrations shall be limited to that necessary to produce satisfactory consolidation. Excessive surface working will not be permitted.

4.3.0. EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS

4.3.1 Expansion and Contraction Joints

Expansion and contraction joints shall be provided at the locations indicated and according to the details shown on the Drawings.

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.

4.3.2. Construction Joints General:

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.

4.3.3 Cleaning of Joints :

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.

4.3.4. Vertical Joints:

Vertical construction joints shall be prepared similar to the horizontal construction joints. Where allowed by the Engineer-in-Charge,

4.3.5 Method of Measurement

The measurement shall be taken up to two places of decimal stating the depth and width of joint as per unit mention in BOQ and paid as per rates agreed..

4.4.0 CURING OF CONCRETE

a) **General**

All concrete including concrete repair work shall be cured by an approved method or combination of methods in accordance with ACI 308. Means shall be provided for the protection of concrete from the sun, drying winds and traffic until the specified curing has been completed.

Horizontal concrete surface cured with water shall be kept wet for at least 14 consecutive days or as specified on drawing immediately following placement.

Unless otherwise specified, the curing of vertical surface shall be done initially by leaving the forms in place, hanging canvas or hessian cloth over the completed work and keeping it wet or by covering plastic sheet or membrane up to the period specified..

4.4.1. Methods of Curing

a.) Moist Curing

Concrete shall be moist-cured maintaining all surfaces continuously (not periodically) wet for days specified immediately following the placing or until covered with fresh concrete. Water for curing shall comply with the applicable requirements . 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.

b) **Curing Compound Method**

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.

4.4.2 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 Contractor shall keep the Engineer-in-Charge advised as to when repair of concrete will be performed

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.

4.4.3 FINISHES AND FINISHING

a) **General**

Allowable deviations from plumb or level and from the alignment, profile grades and dimensions shown on the Drawings or specified. Tolerances are defined as tolerances and are to be distinguished from irregularities in finish 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.

b) **Ordinary Finish (OF)**

Ordinary finish (OF) applies to surfaces upon or against which fill material or concrete is to be placed.

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..

d) **Ordinary Slab Finish (OS)**

Ordinary slab finish (OS) applies to floor surfaces which are not intended to receive any floor coverings.

Ordinary surface form finish will follow AASHTO-SS-8.12.2. Non-shrinkable mortar will be used.

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.

4.4.4 Surface Rendering

All faces of concrete that are to come in contact with back fill or pavement materials, shall be applied two coats of hot bitumen of approved quality, before placing any material around concrete.

4.4.5 Cracks

If cracks, which in the opinion of the Engineer in Charge may be detrimental to the stability, strength and durability of the construction, develop in concrete construction, the Contractor at his own expense shall test the structure. If under such test loads the cracks develop further, the Contractor shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto.

If any cracks develop in the concrete construction, which in the opinion of the Engineer in Charge, are not detrimental to the stability of the construction, the Contractor at his own expense shall grout the cracks with epoxy grout or with other better composition as directed by Engineer In Charge and also at his own expense and risk shall make good to the satisfaction of the Engineer in charge all other works such as plaster, moulding, surface finish, which in the opinion of the Engineer in Charge have suffered damage.

4.4.6 Defective Concrete

Badly executed work not conforming to requirements shall be removed wholly and re-executed at Contractor's cost and shall not be incorporated in the works. No plastering or repairs will be allowed to concrete. Decision of Engineer in Charge will be binding on the Contractor.

4.5.0 READY MIX CONCRETE

4.5.1 1. Scope

This specification covers ready-mixed concrete manu-factured and delivered to a purchaser in a freshly mixed and unhardened state as hereinafter specified. Requirements for quality of concrete shall be as hereinafter specified. This specification does not cover the placement, consolidation, curing, or protection of the concrete after delivery to the SITE.

The values stated in either SI units, shown in brackets,or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents ;therefore, each system shall be used independently of the other.

TECHNICAL SPECIFICATION

The product supplied shall be in compliance with ASTM and ACI specifications.

In the absence of designated applicable specifications covering requirements for quality of materials, the following specifications shall govern:

a)Cement

—Cement shall conform to Specification C 150, Specification C 595/C 595M,

b.) Aggregates

—Aggregates shall conform to Specification C 33 spec. C 330 if light wt. conc

C) Water

The mixing water shall be clear and apparently clean.

4.5.2. BATCH TICKET INFORMATION

1The manufacturer of the concrete shall furnish with each batch of concrete before unloading at the site, a delivery ticket on which is printed, stamped, or written, information concerning said concrete as follows

a) Name of ready-mix batch plant,
b) Serial number of ticket,
c) Date,
d) Truck number,
e) Name of purchaser
f) Specific designation of job (name and location),
g) Specific class or designation of the concrete in conformance with that employed in job specifications,
h) Amount of concrete in cubic ft (or cubic metres)
i) Time loaded or of first mixing of cement and aggregates, and
j) Water added by receiver of concrete and his initials.
k) Additional information for certification purposes as designated by the purchaser and required by the job specifications shall be furnished when requested; such information as
l) Reading of revolution counter at the first addition of water
m) Type and brand, and amount of cement,
n) Type and brand, and amount of admixtures,
o) Information necessary to calculate the total mixing water added by the producer. Total mixing water.

4.6.0 TESTING OF COMPRESSIVE STRENGTH

Concrete compressive strength requirements consist of a minimum strength at the age of twenty-eight (28) days and the minimum strength that must be attained before various loads or stresses are applied to the concrete.

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The compressive strength of concrete will be determined from test cylinders /CUBE (As specified), which have been fabricated from concrete sampled and tested in accordance with AASHTO T 23 and T 22.

A set of six (6) cylinders /Cube shall be taken from each fifty (50) cu m of each class of concrete or fraction thereof placed each day, three (3) of the six (6) cylinders to be tested after seven (7) days and three (3) after twenty-eight (28) days.

a) The minimum average twenty-eight (28) days' test result of all samples tested at any time shall be the specified twenty-eight (28) days' strength.

b) No individual samples tested after 28 days shall show a test result lower than eighty-five (85) % of the required twenty-eight (28) days.

.

In case, seven (7) days' strength shows less than seventy (70) % of the twenty-eight (28) days' strength (in case of type-I cement), Engineer in Charge may stop further work on that particular portion of concrete, unless twenty-eight (28) days' strength gives satisfactory results

4.7.0 Rejection of Concrete

If above test result fails to comply with the requirements, concrete or that particular pour will be rejected and removed as directed by the Engineer in Charge.

4.8.0 CONCRETE FORM WORK

4.8.1 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.

4.8.2 SUBMITTALS

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

a) **FORM WORK SAMPLE**

The Contractor shall inform and submit the sample of form work material and supporting scaffolding / wooden supports which he intends to use at site and upon approval the form work shall be used .

b) **Shop Drawings**

Shop Drawings for fabrication and erection of architectural finished concrete surfaces as shown on the Drawings or specified. Design of formwork for structural stability and sufficiency is the Contractor's responsibility.

TECHNICAL SPECIFICATION

4.8.3. FORM MATERIALS

a) **Form liners for Plain Concrete Finish** TIMBER/PLYWOOD:

New Plywood 19 mm or timber planks (PARTAL) 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.

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 in Charge approval shall be submitted before ordering. Spacing of ties and the rate of placement of concrete shall be consistent with the strength of ties. The Contractor 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.

4.8.4. 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.

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.

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.

4.8.5 Tolerances In Form Work:-

- Variation from plumb in lines and surfaces of piers, walls and rises, 6mm (1/4”) per 3 M (10 ft) but not more than 25mm (1”)
- For exposed corners, columns, central joints, grooves and other construction lines, 6mm(1/4”) in any bay of 6M(20 ft)
- Variation in cross sectional thickness of slab & walls be between -6mm(-1/4”) and 12mm(1/2”)
- Variation in footing plan dimensions to be between -12mm (-1/2”) and 50mm (2”).

4.8.6. 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.

Form shall be removed with care so to avoid any injury to concrete. Min. specified time is :

Min Period for Form-work Removal

Beams and Slabs	14 days
Columns and Wall Faces	24 hours
Concrete Pedestal	24 hours
Sides of Beams, Caps, and Other Parts	24 hours

4.8.7. 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. Embedment’s 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.

4.9 CONCRETE REINFORCEMENT

TECHNICAL SPECIFICATION

4.9.1 GENERAL

The work shall include providing, cutting, bending, fabricating, assembling and placing of all concrete reinforcement including rods and fabric in accordance with Drawings, Specifications and Standards as referred hereunder.

4.9.2 SUBMITTALS

The Contractor shall submit the following to the Engineer-in-Charge for his approval/record before execution of work:

a) Contractor shall submit Shop Drawings for fabrication, bending and placement of concrete reinforcement. ACI 315 shall be complied with showing bar bending schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement and special reinforcement required for openings through concrete structures.

b) Mill certificates or laboratory test reports as required.

4.9.3 MATERIALS

a) Concrete reinforcement of diameter smaller than 35 mm shall be hot rolled deformed steel bars conforming to ASTM Designation A 615 and shall have a minimum yield strength of 415 MPa (60,000 psi).

b) Binding wire shall be 1.6 mm dia (16 gauge) soft iron wire.

4.9.4 Deformed Bar

A reinforcing bar manufactured with surface deformations to provide bonding strength when embedded in concrete. The following table showing the different values of deformed bars as per ASTM A-615

4.9.5 Characteristics For the Reinforcing Bar

a) Tensile Requirements

The strain shall be 0.5 % of gage length for Grade 40 and Grade 60 and shall be 0.35 % of gage length for Grade 75 [520

Table from ASTM

Tensile Strength Min MPa (psi)	Steel 280 MPa (Grade 40)	Steel 420 MPa (Grade 60)
	420 (60,000)	620 (90,000)
Yield strength Min Mpa (psi)	280 (40,000)	420 (60,000)
Elongation in 203.2 mm (8 in) min %		
Bar Designation		
10 (3)	11	9
13, 16 (4,5)	12	9
19 (6)	12	9

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22,25 (7,8)	------	8
29, 32,36 (9,10,11)	------	6

b) Bending Requirements

The bend-test specimen shall withstand being bent around a pin without cracking on the outside radius of the bent portion. The requirements for degree of bending and sizes of pins are prescribed in Table.

Bar Designation No	Pin Diameter for Bend Tests		
	280 MPa (Grade 40)	420 Mpa (Grade 60)	520 MPa (Grade 75)
10, 13, 16 (3,4,5)	3 ½ d	3 ½ d	---------
19 (6)	5 d	5d	5d
22,25 (7,8)	---------	5d	5d
29, 32, 36 (9,10,11)	---------	7d	7d
43, 18 (14,18)	---------	9d	9d

4.9.6 Test & Retest

For bar sizes No. 3 to 11 [10 to 36], inclusive, one tension test and one bend test shall be made of the largest size rolled from each heat. If, however, material from one heat differs by three or more designation numbers, one tension and one bend test shall be made from both the highest and lowest designation number of the deformed bars rolled

For all bar sizes one set of dimensional property tests including bar weight [mass] and spacing, height, and gap of deformations shall be made of each bar size rolled from each heat.

If any tensile property of any tension test specimen is less than that specified, and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

4.9.7 EXECUTION

a) Preparation

The Contractor shall furnish, cut, bend, and place all steel reinforcement including rods and fabric, as indicated on the Drawings or otherwise required. All placing and fixing shall be in accordance with Drawings furnished or approved by the Engineer-in-Charge.

b) Cutting and Bending

The Contractor shall ensure that the bars do not get cracked or damaged during bending and fabrication. All bending shall be in accordance with ACI 315 and by approved machine methods. When bending is required, it shall be performed prior to embedding the bars in the concrete. In all such cases, the bars shall be cold bent.

TECHNICAL SPECIFICATION

4.9.7 Tolerances

Cutting for all bars shall be within + 1 inch (+ 25 mm).Bending and placement tolerances for overall or an internal dimension of a bent bar shall be as given in Table 4.7.

Table 4.7
Bending & Placement Tolerances

Description	Tolerances	
	Plus	Minus
Bending		
Bars upto 1.00 meters long	5 mm	5 mm
Bars 1.00 to 2.00 meters long	5 mm	10 mm
Bars over 2.00 meters long	5 mm	25 mm
Placement		
Concrete cover to formed surfaces	5 mm	5 mm
Minimum spacing between bars	5 mm	5 mm
Top bars in slabs and beams		
- Members 200 mm deep or less	5 mm	5 mm
- Member more than 200mm but not over 600mm deep	10 mm	10 mm
- Member more than 600mm deep	25 mm	25 m

4.9.8 (a) Spacing of Bars

The spacing of bars shall be as shown on the Drawings or as directed in writing by the Engineer-in-Charge. The variation from indicated spacing, provided that the total area of reinforcement is in accordance with the Drawings,

4.9.8 (b) Concrete Cover to Reinforcement

The cover for all main reinforcement shall conform to the dimensions shown on the Drawings and in no case less than ½ inch or diameter of the bar whichever is more. The protective covering shall not be less than, and shall not exceed by more than 6 mm the values specified on the Drawings. Unless otherwise specified the following minimum thickness of concrete cover, exclusive of plaster or other decorating finish, shall be provided in all case: -

a) For each end of reinforcement bar, not less than 1 inch or twice the diameter of such bars.
b) For a longitudinal of such bars. In the case of columns with a minimum dimension of 7-1/2inches or less where bars do not exceed ½ inch diameter, one-inch cover shall be used.

c) For longitudinal reinforcement bar in a beam not less than one inch or the diameter of such bar.
d) For tensile, compressive, share or other reinforcement in a slab not less than ½ inches or the diameter of such reinforcement.
e) For any other reinforcement not less than ½ inches or the diameter of such reinforcement.
f) In case of works in saline or corrosive conditions a minimum of 1-1/2inches cover over bars, stirrups or links.

4.9.8 (c) Splicing

Except as otherwise shown on the Drawings or specified herein, all splices, lengths of laps, splice locations, placement and embedment of reinforcement shall conform to the applicable requirements of ACI 318. All splices and locations of laps in reinforcement shall be as shown on the Drawings or as directed by the Engineer-in-Charge. Lapped ends of bars may be placed in contact and securely wired or may be separated sufficiently to permit the embedment of the entire surface of each bar in concrete.

d) Supports

All reinforcement shall be secured in place by use of concrete supports. Chairs, spacers, or ties may be of metal or as approved by the Engineer-in-Charge. Such supports shall be of sufficient strength to maintain the reinforcement in place throughout the concreting operations. Concrete supports shall be manufactured of the same concrete strength as used in the structure to be concreted.

e) Embedded Items

Before placing concrete, care shall be taken to determine that all embedded items are properly placed as required under the Specifications and are firmly and securely fastened in place as indicated on the Drawings or as directed by the Engineer-in-Charge.

f.) **DELIVERY AND STORAGE**

i) All reinforcement bundled, tagged and marked with complete identification shall be delivered at Site.

ii) Reinforcement shall be stored at Site clear of ground and protected from mud and other deleterious materials.

4.10.. MEASUREMENT & PAYMENT FOR CONCRETE

4.10.1 GENERAL

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

Dimensions of length, breadth and thickness shall be measured correct to nearest cm /inch. except for the thickness of slab and partition which shall be measured to nearest 5 mm.

4.10.2. CAST-IN-SITU CONCRETE

It shall be measured in stages described in the item of work, such as:

(a) Rafts, footings, bases of columns etc. and mass concrete.

(b) All other items up to floor two level.

(c) From floor two level to floor three level and so on.

(d) R.C.C. above roof level shall be measured along with R.C.C. Work in floor just below.

4.10.3. Measurement shall be taken before any rendering is done in concrete members. Measurement will not include rendering. The measurement of R.C.C. work between various units shall be regulated as below:

(a) Slabs shall be taken as running continuously through except when slab is monolithic with the beam. In that case it will be from the face to face of the beam.

(b) Beams shall be measured from face to face of columns and shall be including haunches, if any, between columns and beam. The depth of the beam shall be from the bottom of slab to the bottom of beam if beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with beam, the depth of beam shall be from the top of the slab to the bottom of beam.

(c) The columns measurements shall be taken through.

4.13.1. COMPOSITE RATE

The measurement and payment for the items of the work of Plain & Reinforced Concrete hereof shall be made corresponding to the applicable CSR items as provided in Contract Agreement BOQ or as quoted by the bidder 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. No separate payment for form work shall be made but the Reinforcement bar shall be measured and pain separately as per rate quoted in BOQ.

CHAPTER 5 DAMP PROOF COURSE AND WATER PROOFING

5.1 DAMP PROOF COURSE

5.1.1 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.

5.1.2. 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.

5.1.3. DAMP PROOFING MATERIALS

a) Damp Proof Course

i). HORIZONTAL DAMP PROOF COURSE

All Horizontal damp proof courses unless otherwise specified in the drawings shall consists of class 'B' cement concrete (3000 psi) 2" (50mm) thick, and shall be laid at required levels as per drawings and instructions of the Engineer. The D.P.C shall be tamped, consolidated, levelled and edges corners made to the requirements of the relevant drawings including finishing and curing complete. Including two float coat of . Bitumen emulsion protective coating of EXPANPROOF-10 by FOSPAK or equivalent confirming to ASTM C-309-93 or BS 6949-1991 applied at a rate of 2Kg / Square Meter

ii). VERTICAL DAMP PROOF COURSE

All vertical damp proof courses unless otherwise specified in the drawings shall consists of ½" thick cement sand plaster in 1:4, and shall be applied at required elevation as per drawings and instructions by the Engineer, including Bitumen emulsion protective coating of EXPANPROOF-10 by FOSPAK or equivalent confirming to ASTM C-309-93 or BS 6949-1991 applied at a rate of 2Kg / Square Meter .

III) UNDER GROUND WATER TANK& OVER HEAD WATER TANK WATER PROOFING :

For all water retaining Structures concrete not leaner than 1:1 ½ :3 Shall be used if not specified on drawing and pore blocking admixture which alters the microstructure of concrete to stop water transport mechanisms and increase durability like Pudlo Produced by DB Group England or Equivalent as specified. By incorporating **PUDLO** into the. concrete mix, it is possible to build. watertight structures, without the need. for membranes or drainage systems @ 2.5 Kg per 50 Kg Bag or as per manufactures recommendation. The internal surface of the wall and base shall be plastered with 1:4 CSM if not specified on drawing by adding water proofing PUDLO @ 5% by Wt of Cement or as specified on drawing. A 3"x3" Chamfer shall be made at all the Wall and bottom slab and wall & wall joints.

The External side of the wall two float coat of . Bitumen emulsion protective coating of EXPANPROOF-10 by FOSPAK or equivalent confirming to ASTM C-309-93 or BS 6949-1991 applied at a rate of 2Kg / Square Meter or as specified.

Iv) **ROOF WATER PROOFING**

For Flat Roof surface Cold applied bituminous waterproofing membrane **Expanproof* GP** confirming ASTM D412 Product by M/S Fos Pak or equivalent confirming shall be applied in Two Coats minimum thickness 1.0 mm (one mm) per coat but not less than 1.5mm dry thickness of the two coat combined.

INSTRUCTION TO USE

(a) SURFACE PREPARATION

Concrete surfaces should be float finished and free from cavities and projecting nibs. All surfaces shall be dry and free from frost, surface laitance and contamination.

(b) **PRIMING**

Application Smooth transition should be made at wall/floor slab junctions using a sand/cement mortar and internal and external corners at walls and up stands pre-protected with Expanproof Corner Pieces prior to the application of the membrane.

The membrane should be applied to the substrate having first removed the siliconised release paper, pressing the polyethylene film firmly ensuring that the adhesive bitumen compound bonds continuously to the substrate with no air pockets.

(b) **CONSTRUCTION CHEMISTRY**

Expanproof GP is a cold applied self-adhesive sheet membrane comprising of a polymer modified bitumen layer internally reinforced with polyester, bonded on to an outer surface of cross laminated polyethylene film. Expanproof* Primer must be applied to the substrate and allowed to dry until it is tack free, prior to the application of the membrane. All surfaces must be re-primed if left for more than 24 hours prior to the application ofExpanproof* GP.

Allow at least a 75mm edge and a 150mm end lap. All laps should be rolled firmly to achieve a good seal. End laps should be staggered. On vertical or inclined surfaces, the membrane shall be laid from the lowest level upwards. The membrane should be protected immediately after application in accordance with BS 8102:1990 by using Protection Board, or as appropriate with a sand/cement screed.

V) **ROO F SCREED**

SCREEDING /GRADING ROOF WITH CEMENT CONCRETE 1:2:4

i. Materials

Cement, coarse sand and graded stone aggregate 20 mm nominal size, shall be used as specified thickness in the item and slope as per shown on drawing.

The specifications for the materials and method of preparation of concrete shall conform in general to the specification described in Section 4. The grading of aggregates shall be limited between 3/4 inches maximum and 3/16 inches minimum.

ii. Laying

Before laying cement concrete for grading, the level markings to the required slope/gradient shall be made only with cement concrete on the surface of the slab at suitable spacing, 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 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.

iii. Finishing

The minimum thickness of the concrete at its junction with Khurra or parapets shall be 5 cm. or as mentioned on drawing. 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 troweling shall be avoided.

iv. Thickness

Average thickness shall be 2 inches to 3 inches and as specified.

v. 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 kiaries with weak cement mortar, for 10 days. Occasional curing by simply spraying water now and then shall not be permitted.

5.1.5 MEASUREMENT & PAYMENT

Length and breadth shall be measured along the finished surface correct to a cm / INCH and the area shall be worked out to nearest 0.01 sqm /SQFT. And payment shall be made as per item mentioned on BOQ of Contract.

CHAPTER -6 SOLID & HOLLOW CONCRETE BLOCK MASONRY

6.1 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 block/ Fair Faced Hollow Concrete Block masonry work including wall ties, anchors, complete in strict accordance with this section of the Specifications and applicable drawings, and subject to the terms and conditions of the Contract.

6.1.1. MATERIALS

6.1.2. FOR CONCRETE BLOCK

Cement, aggregates and water for concrete blocks shall conform to the requirements as specified in Section 4 for Plain and Reinforced Concrete.

6.1.3. FOR MORTAR

The cement and sand mortar for concrete block masonry shall specified.

6.1.3.1. SAND

Sand for mortar shall comply with the requirements for BS-1200.

6.1.3.2. CEMENT

Cement shall be Ordinary Portland Cement conforming to BS-12.

6.1.3.3. 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 stated in Chapter 4 Plain & Reinforced concrete.

6.1.3.4. MORTARS AND GROUT

Materials for mortar, sand and 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

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.

6.2. CONCRETE BLOCK MAKING

6.2.1 SOLID CONCRETE BLOCK

The Solid blocks shall be factory manufactured/fabricated and be machine moulded. The block making factory 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.

6.2.2 HOLLOW CONCRETE BLOCK

The Hollow Fair Faced Pigmented, Smooth Finished Blocks for External Wall do not require plaster & paint. shall be from approved manufacturer Envicrete, Banu Mukhtar, Izhar in approved shade and colour and laid as per pattern shown on the drawing. 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. Size 390x190x90mm (Tolerance +/- 3mm). Average Compressive Strength 1000 PSI (+/-5%) .The contractor shall submit samples/literature of various manufacturers for Engineer-in-Charge's approval.

6.3 PROPERTIES OF BLOCKS

All Non fair face ordinary Solid 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.

All blocks shall comply with ASTM C-55-03 edition. The compressive strength of various Solid /hollow blocks shall be as follows:

Sr. #	Type of Concrete Masonry	Compressive Strength (Psi)		Block Size
		Average of 3 Units	Individual Unit	
1.	Solid load bearing Masonry units (ASTM-C-145-85)	2000 psi minimum	2000	6"x8"x12" 4"x8"x12" 8"x8"x12"
2.	Solid non load bearing Masonry units	600	500	6"x8"x12" 4"x8"x12" 8"x8"x12"
3	Hollow Fair face, pigmented /Natural Non load bearing Block	1000 psi +/- 5% on net area	1000psi+/-5% on net area	Size of block 390mmx190mmx90mm 390mmx190mmx140mm 390mmx190mmx190mm
4.	Solid Fair face, pigmented /Natural Non load bearing Block	1500 psi +/- 5% on net area	1500psi+/-5% on net area	Size of block 390mmx190mmx90mm 390mmx190mmx140mm 390mmx190mmx190mm

A laboratory approved by the Engineer-in-Charge shall carry out the test. The Engineer-in-Charge will require to test 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 standards.

6.4 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.

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 meter 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.

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. Tooting 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 centers. 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.

6.5 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.

6.6 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.

6.7 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.

6.8 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.

6.9. CAVITY WALL

6.9.1 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 either left as cavity or filled with non load bearing insulating and water proofing material.

6.9.2 MATERIALS

The hollow block shall be as specified in this Section. The mortar shall be cement sand mortar as specified in accordance with the provisions of specification 1 :4 CSM. The laying of block masonry for cavity walls shall comply with provisions of specification. Curing and scaffolding shall be as per specifications.

6.9.3 METAL TIES

These may be of galvanized iron, or mild steel bar as specified. 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 or as specified on drawing & details..

6.9.4 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).

6.9.5 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.

6.9.6 MEASUREMENTS AND RATE

(a) Block work in cavity walls shall be included and measured with general / Fair Face Block work. The cavity wall shall measured as and paid as per BOQ item

(b) The item shall include use of device for keeping cavity clear and forming the requisite weep and vent holes and nothing extra on this account shall be payable

6.10 REINFORCED BLOCK MASONRY

6.16.1 GENERAL

Reinforced BLOCK masonry shall be constructed as specified and shown on drawings.

6.10.1 BLOCK WORK

BLOCK work shall be as specified and conform with the provision for construction of blockwork of this section. The mortar shall be cement sand mortar as specified and shall conform with the provision of Clause of this section

6.10.2 REINFORCEMENT

The reinforcement for brick masonry could be 18 gauge 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.

6.10.3 SCAFFOLDING & CURING

The scaffolding & curing shall conform to applicable provisions of Section

6.10.4 MEASUREMENT

The measurement and rate shall be same as specified in BOQ

6.17 MEASUREMENT AND PAYMENT

Solid Concrete Block Masonry work shall be measured in cubic metres/Cu ft as per unit in agreement unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 m i.e. 1 cm. Areas shall be calculated to the nearest 0.01 sq. mtrs and the cubic contents shall be worked out to the nearest 0.01 cubic metres. Block Masonry Work shall be measured separately in the following stages:

(a) From foundation to floor one level (Plinth level)

(b) Plinth (floor one) level to floor two level

(c) Between two specified floor levels above floor two level

The rate shall include the cost of materials and labour required for all the operations described above except the vertical reinforcement and its encasement in cement mortar or cement concrete. The rate shall also include the following:

(a) Raking out joints or finishing joints flush as the work proceeds;
(b) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.
(c) Rough cutting and waste for block work curved in plan and for backing to stone or other types of facing.
(d) Embedding in ends of beams, joists, slabs, lintels, sills, trusses et

CHAPTER-7 FLOORING

7.1 SCOPE OF WORK.

The works covered under this section of specifications consists of furnishing all labor, materials and equipment and performing all operations in connection with laying flooring including bases, dados and skirting in strict accordance with drawings and as specified herein and subject to terms and conditions of the contract documents.

7.1.1 SAND FILL.

A uniform layer of granular and screened sand shall be laid to the required thickness over the surface of compacted earth as per drawing & details. The sand layer shall be compacted in the manner required by the Engineer prior to execution of subsequent item.

7.1.2 STONE SOLING.

The quality & thickness of stone material shall be as per requirements and specified on drawing ,if not otherwise minimum thickness 150mm (6 inches) shall be adopted, as per drawing & details and shall be approved by the Engineer. The stones shall be laid on edge as approved by the Engineer, the spaces or voids between and around shall be filled with sand

7.1.3 PLAIN CEMENT CONCRETE SUB-BASE.

The base course of lean cement concrete shall be 1:4:8 or as specified on drawing specified shall be laid as per thickness shown on drawing & details or as per BOQ item. The surface of the bed shall be roughened for the grip of the top layer.

7.2 FLOOR FINISHES.

All floor finishes shall be laid on properly cleaned and prepared sub-floors to the thickness as indicated on the drawings and finished to the satisfaction of Engineer. The Contractor shall make sample panels of floors for inspection and approved by the Architect/Engineer before actual flooring works are taken in hand.

7.2.1. PLAIN CEMENT CONCRETE FLOORS.

The concrete ingredients as per specified in Chapter 4 Plain & Reinforced Cement Concrete shall be mixed in a batch mixer for not less than 2 minutes after all ingredients except the full amount of water, are in the mixer The concrete shall be uniform in composition and consistency. Excessive or over mixing or increasing concrete consistency will not be permitted. The concrete ingredients shall be mixed by volumetric measurement in purpose made boxes approved by the Engineer.

The screed may be laid in panels as specified on drawings when the concrete is still plastic, The hardened base should be thoroughly cleaned, wetted, preferably overnight surplus water removed.

7.2.2 TERRAZO FLOORING (IN SITU).

The Contractor shall submit samples of terrazzo flooring required in the various locations and the samples, which Engineer may select for use in the buildings, shall be available for examination and comparison by both the Contractor and the Engineer. The finished floors shall conform in all respects to the characteristics of the samples approved. The size of chips shall be of 3mm to 10mm size and the color will be as selected by the Architect/Engineer.

The Contractor, after tentative color patterns are approved, shall provide sample panels of cast in place terrazzo wear coat and base. The thickness of the wear coat shall be uniform and at no

point shall if be less than 15mm.. Finished surfaces of both floors and walls when completed, ground and polished, shall in air cases show uniformly distributed exposed granules or chips, free of undesirable blotches of matrix without marble granules or chips. Uneven distribution in either floor or wall surface will be required to be resurfaced and/or refinished to the satisfaction of the Engineer. All floors shall be adequately cured for a minimum of 14 days after laying by means of sand bunds in panels or as required by the Engineer. During the course of construction of the floors and up to the time of completion of the Project, the Contractor shall protect the flooring from stains and mechanical damage by his workers or by workers of other Contractors/Sub-Contractors.

7.2.2 TERRAZZO TILE FLOORING AND STEPS.

All tiles shall be of size 300x300mm or 200x200mm size as shown on drawings or as mentioned in the Schedule of Quantifies and shall be perfectly leveled square and true to every surface. Tiles shall be minimum 25mm for 300mm size and minimum 20mm thick for 200mm size with a marble mosaic tapping firmly bonded to a base of cement concrete, manufactured by the dry process and machine pressed hydraulically with a pressure of not less than l50 kg per square centimeter. The thickness of topping shall not be less than 13mm for 300x300mm tiles and 10mm for 200x200mm tiles.

The marble mosaic topping shall be of colors as selected by the Architect/Engineer, including sizes of chips, their color proportion and distribution. All tiles shall be of uniform color and liable to rejection due to difference in any of the above specified conditions.

The Tile shall be vibrated to an extent that it releases air to the surface and consolidates the aggregate at the wearing surface. Proportion of cement to aggregate shall not be leaner than 1:2 by weight in topping layer. All tiles shall be cured after manufacture for not less than three weeks, prior to delivery at site, or setting up in floors.

If the Contractor is allowed to use ordinary tiles for stair risers he will have to cut the standard Tiles for which no payment for the wastage or cutting will be made. The tiles before being used shall be thoroughly soaked in water for 10 to 20 minutes and stood on their edges to dry for about the same length of time, Any tiles, which have hair cracks shall be rejected. Should the cracks be noticed after the tiles are fixed in position, such tiles shall be replaced at contractor's cost and risk.

7.2.3 EXECUTION

The terrazzo Tiles will be laid to the required levels and grades over a setting bed of cement mortar comprising of 1 part of cement and 4 parts of sand by specified. The overall thickness of mortar and tile shall be minimum 50mm. The curing period of the setting bed should be as directed by the Engineer. As large an area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust, oil and other objectionable matters. Tiles shall be laid out from the center line of each space in on outward direction and the pattern should be made symmetrical with a minimum number of cut tiles. Joints between the tiles shall be of uniform width. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Tiles shall be laid to the straight edges. The Contractor is required to submit his shop drawing before actual laying of the tiles to show in detail how and where tiles pieces are planned to be laid. The Drawing shall be approved by the Architect/Engineer. After seven days the terrazzo tile floors shall be machine ground to a true even surface using various grades of abrasive stones as required and directed by the Engineer. After the first grinding, the floor shall be grouted with the same color composition as used for its manufacture. The grout shall be of the consistency of thick cream and shall be brushed over the floor to fill in the joints and after 72 hours the grouting coat shall be removed by grinding till a smooth and even surface is obtained. Areas and portion of the floor inaccessible for the grinding machine shall be ground and rubbed by hand. The final glass shall be given by polishing the surface to the satisfaction of the Engineer. The tile floor shall be kept wet for at least 72 hours and no one should be allowed to walk on the tiles during that period.

7.2.4 **Terrazzo Tiles on Stairs**

The stair risers and treads shall be provided in 3000 psi. Concrete according to exact sizes including the terrazzo topping making allowance for grinding of terrazzo. The nosing shall be flush with the terrazzo toppings, as specified or shown on the Drawings.

Measurement

7.2.5. Measurement of acceptably completed works of Terrazzo Tiles on floor will be made on the basis of net actual area in square feet of floor laid in position to the line, level & grade as shown on the Drawing or as directed by the Engineer.

Payment

Payment will be made for acceptable measured of Terrazzo Tiles floor on the basis of unit rate per Sq feet quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

7.3 CERAMIC TILE FLOORING AND DADO.

7.3.1 The tiles shall be of approved manufacturer. These will be either white or colored as specified in the Schedule of Quantifies or as approved by the Engineer. The tiles shall be free from cracks or crazing, free from twisting and uniform in color and size. Approval of the manufacturer does not relieve the Contractor to carry-out his own checking to ensure that only the best quality tiles are used and all defective tiles are rejected and removed from site immediately.

7.3.2 Soaked Ceramic flies shall be laid on cement concrete base of specified grade and the joints filled with neat white or grey cement or as specified including vertical and horizontal covers. The curing period of the setting bed shall be as directed by the Engineer,. The thickness of setting bed shall not be less than 45mm for floor and 12mm for walls or as specified on drawing.. Floor and wall surfaces to receive the files shall be thoroughly cleaned of all , dust, oil and other objectionable matters. Tiles shall be laid out from the centre line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut tiles. Joints between the tiles shall be of uniform width. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Tiles shall be laid to the straight edges.

7.4 PRE CAST CONCRETE INTERLOCK PAVERS

7.4.1 The pre-cast interlock concrete pavers of specified size, shape and Color of approved manufacturer Envicrete, Megnacrete, BanuMuktar or as specified having minimum Compressive Strength 5000 Psi for non traffic area of minimum thickness 60mm and min. thickness 80mm with minimum compressive strength 7000 Psi shall be laid to the required lines, levels and grades over a well compacted setting bed of 100mm thick sand mixed with 37mm down crushed stone over 50mm thick sand cushion. The joints between the paver shall be filled with neat sand.

7.4.2 The laid paver shall be compacted with the compactor as specified by the Manufactures. Care shall be taken that full pavers are used as far as possible. Where this is not possible, the edge pavers shall be neatly cut with an electric saw and the edges rubbed smooth, in case of patterned pavers, the pavers shall be laid in such a way that the pattern ends symmetrically on two sides.

7.5. MEASUREMENT AND PAYMENT.

Except otherwise specified herein or else wherein the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items or the Bill of Quantities· The cast thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantifies.

Measurement of acceptably completed works of finished floor, dado, skirting, stair finish, etc. will be made on the basis of net finished area laid in position as shown on the drawings or as directed by the Engineer. Exposed edges of tiles, marble, etc. will not be included in the measurements.

CHAPTER -8 PLASTER

8.1 GENERAL.

1.1 Except as may be otherwise shown on surfaces specified, all plaster work, both internal and external, shall be Ordinary Portland cement plaster of the required thickness mentioned in B.O.Q /drawing or as directed by Engineer. Internal plaster for the buildings for the internal surfaces; columns, walls ceilings, partitions, etc. shall be cement plaster finished smooth unless otherwise specified· Whereas the areas like lavatory blocks, bathrooms, stores, or such other places where there is possibility of any dampness occurring, the plaster shall be cement piaster finished smooth with cement niru or as specified in the BOQ. Except as otherwise specified, all plaster work shall be carried out in Conformity with acceptable code of practice for internal and external rendering and finishes and as per specification.

1.2 Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, sills, doors' and windows' 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 works are carried out by other Contractors before starting of plaster work. Chiseling and repairing of cement plaster shall not be permitted without the approval of the Engineer.

8.2 MATERIALS:

8.2.1 Cement: Cement for plaster shall be Portland Cement ordinary, or sulphate resisting cement as specified and shall conform to requirement as described in the specifications & drawing.

8.2.2 Sand: Sand for plaster shall comply with the requirements of BS-812, BS-119 and ASTM C-144. It shall comprise natural sand, crushed stone sand or crushed gravel sand. It shall be hard durable, clean and free from adherent coatings such as clay and from any appreciable amount of clay pellet form. It shall not contain harmful materials to adversely affect the hardening, the strength, the durability or the appearance of the plaster or any materials in contact with it. The quantity of clay, silt and dust shall not exceed 5% by weight for sand or crushed gravel or 10% by weight for crushed stone sand·

The grading of sand for internal piaster work and external rendering shall be within the following limits.

Sieve Size MM	Internal Cement Plaster Work & External Rendering %
5.00	100
2.36	90-100
1.18	70-100
0.6	40-80
0.3	5.40
0.15	0.10

The grading specified above shall be suitable for smooth finishing coats, scraped finishes and for pebble dash or dry dash for textured surfaces, produced by the

treatment of the freshly applied final coat with a tool, the coarser particles shall be removed by screening through a 2mm sieve.

8.2.3 Water: Water for plaster shall conform to requirements as described in the specifications of concrete.

8.2.4 **Additives:** Additives for controlling the setting and working characteristics of plaster, or for imparting anti-corrosion, fungicidal or water proofing properties, shall be added to the plaster strictly in accordance with the particular manufacturer's specifications and instructions· Good quality hair or manila fiber in reasonably well distributed proportion may be added to the piaster to assist application and reduce droppings· No additives shall be used except as specified in the Contract Documents.

8.3 PROPORTIONING AND MIXING.

8.3.1 Measurement of materials by volume shall be by containers of known capacity to maintain consistent proportions. No lumpy or caked material shall be used. Mixing equipment boxes and tools shall be clean. Materials shall be proportioned as specified on the drawings, in the Bill of Quantities or as directed by the Engineer. Mixing shall be continuous until complete and all ingredients are evenly distributed.

8.3.2 Only limited water shall be added for proper workability and such quantity of the mortar shall be prepared as that which will be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other time more than that stipulated above is expressly prohibited, Re-tampering shall not be permitted and all mortar which has begun to stiffen shall be discarded.

8.3.3 Plaster ingredients shall be thoroughly mixed, either by hand on a clean cement concrete platform or by a mechanical mixer, as directed by the Engineer.

8.4 PREPARATION OF SURFACE TO BE PLASTERED.

8.4.1 Concrete surface to be plastered shall be cleaned to remove all grease, oil and other surface impurities, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface of all concrete ceilings, beams and columns shall be lightly hacked by approved means to give the required key for plastering.

8.4.2 All masonry surfaces to be plastered shall be cleaned to remove all matter which will otherwise adversely affect the adhesion of plaster to the surface concerned.

8.5 APPLICATION OF PLASTER.

8.5.1 The plaster shall be minimum 12-20mm thick, as mentioned in BOQ and shall not be less than 12mm thick at any internal surface or 20mm at any external surface. The plaster of thickness less than the specified thickness shall be rejected. If the plaster is to be more than 25mm thick, it shall be done in two coats. The surface of first coat shall be made rough before the second coat is applied. The plaster shall not have wavy surface and shall be perfectly in plumb. The edges and corners shall represent a straight line. The plaster shall be kept wet continuously for at least ten (10) days. The curing/wetting of the plastered

surface shall start immediately after the surface is set i.e. 4-5 hours from the time of finishing. No extra payment shall be allowed for jambs, junctions, comers, edges, round surfaces or for more than one layer of plaster required due to any unevenness in the work done by the Contractor. The plaster work is to cover all conduits, pipes etc. fixed in the walls and ceiling. Wherever specified, metal lath shall be nailed firmly before plastering is commenced. The plaster surface shall be tested frequently with 3 meter straight edge and plumb bob.

8.5.2 Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any such piaster or loose piaster shall be removed and. replaced with plaster in conformity with these specifications and as additionally directed by the Engineer. Contractor shall cut and patch all defective work at his own cost. All damaged plaster shall be patched as directed by the Engineer.

8.6 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. As each room or space is completed, all rubbish, debris, scaffolding and tools should be removed to leave the room clean.

Prior to plastering all aluminum windows and finished metals should be covered by sheet of plastic or tarpaulin to protect them from damage.

Protect finished plaster from injury by any source. Contractor shall also protect walls, floors and work of other trades from plaster materials.

8.7 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 wails and reveals plumb and square.

Maximum permitted tolerances shall not exceed 3mm in 2m variation from plumb or level in any exposed line or surface and 1.5mm variation between planes of abutting edges or ends.

8.8 MEASUREMENT AND PAYMENT.

General

8.8.1 Except otherwise specified herein or elsewhere in the Contract Document, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantifies.

8.8.2 Joints, junctions, jambs, corners, drip course, edges and Rounding.

8.8.3 More than one layer due to any unevenness in the work done by the Contractor.

8.8.4 Cuffing and patching of all defective works.

8.8.5 Surface preparation, cleaning, providing expanded metal lath and protections as specified.

8.8.6 Water proofing agent for water-proof plaster.

8.9 Measurements

8.9.1 Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres/ sqft correct to two places of decimal. Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in masonry work.

The measurement of wall plaster shall be taken between the walls or partitions (the dimensions before the plaster shall be taken) for the length and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any shall be deducted.

The following shall be measured separately from wall plaster.

(a) Plaster bands 30 cm wide and under

(b) Cornice beadings and architraves or architraves moulded wholly in plaster.

(c) Circular work not exceeding 6 m in radius.

Plaster over masonry pilasters will be measured and paid for as plaster only.

Exterior plastering at a height greater than 10 m from average ground level shall be measured separately in each storey height. Patch plastering (in repairs) shall be measured as plastering new work, where the patch exceed 2.5 sqm. extra payment being made for preparing old wall, such as dismantling old plaster, raking out the joints and cleaning the surface. Where the patch does not exceed 2.5 sqm in area it shall be measured under the appropriate item.'

Deductions in measurements, for opening etc. will be regulated as follows:

(a) No deduction will be made for openings or ends of joists, beams, posts, girders, steps etc. upto 0.5 sqm in area and no additions shall be made either, for the jambs, soffits and sills of such openings. The above procedure will apply to both faces of wall.

(b) Deduction for opening exceeding 0.5 sqm but not exceeding 3 sqm each shall be made for reveals, jambs, soffits sills, etc. of these openings.

(i) When both faces of walls are plastered with same plaster, deductions shall be made for one face only.

(ii) When two faces of walls are plastered with different types of plaster or if one face is plastered and other is pointed or one face is plastered and other is un plastered, deduction shall be made from the plaster or pointing on the side of the frame for the doors, windows etc. on which

width of reveals is less than that on the other side but no deduction shall be made on the other side.

Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of plaster and/or pointing as the case may be.

(iii) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.

(c) For opening exceeding 3 sqm in area, deduction will be made in the measurements for the full opening of the wall treatment on both faces, while at the same time, jambs, sills and soffits will be measured for payment.

In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

CHAPTER -9 PAINTING AND POLISHING

9.1 SCOPE OF WORK.

The work covered by this section of the Specification, consists of furnishing all materials, plant, labor, equipment, appliances and performing all operations in connection with surface preparation, mixing, painting concrete works, gates, frames, structural steel works, steel pipes, valves, steel and wooden doors, windows, louvers, wait ceilings and all such surfaces as shown on the drawings/or as directed by the Engineer, the scope of this section of specification is covered with detailed specifications as laid down herein.

9.2 GENERAL

Where the work or term 'point' and 'polish' is used or referred to 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 coat, emulsion varnish, shellac, wall paper paste, stain or enamels as more specifically defined hereinafter as to kind and quality and function for various surfaces and finishes.

All paint, polish and necessary materials incorporated in or forming a part thereof shall be subject to the approval and selection for color, tint or finish by the Architect / Engineer.

9.2.1 Where a 'two color' or tint combination may be selected or approved for the treatment of any particular surface in any space or room, no additional payment shall be made thereof to the Contractor in any instance.

9.2.2 Painting of wood work and for plaster surfaces shall be minimum 3 coats work except otherwise specified. Painting of metal surfaces required to be painted, shall be minimum 3 coats work, in addition to the shop protection coats.

9.2.3 All paints shall be as manufactured locally and approved by the Engineer and shall be brought on to the site in sealed containers and used without any admixture or adulteration except where recommended in the Manufacturer's printed instructions,

9.2.4 Surfaces of stainless steel aluminum, bronze, and machines surfaces adjacent to merci work being cleaned or painted shall be protected by effective masking or other suitable means, during the cleaning and painting operations.

9.3 PREPARATION AND WORKMANSHIP

9.3.1 Prior to start of any work the Contractor shall, as a part of his contract, carefully inspect oil surfaces to be painted or finished and notify the Engineer in writing of any defective workmanship, materials, or any other conditions, which in his opinion, will affect the satisfactory execution and /or performance of his work. No work in this section shall be initiated until all such surfaces or conditions have been corrected. The absence of any such notification will be construed as an acceptance by the Contractor of all such surfaces and later claims of defects in these surfaces that may result in finished surfaces being unsatisfactory to the Engineer will not in any way relieve the Contractor from the responsibility and/or accountability under his guarantee. No work should to be done under the conditions that are unsuitable for the production of good results, nor at any time when the plastering is in progress or is drying, or not dry. Neither paint nor any other finish treatment is to be applied over wet or damp surfaces unless specifically required, nor shall succeeding coats be applied until the proceeding coat is thoroughly dry.

9.3.2 Before proceeding with any painting or finishing thorough cleaning and removing of all dust from surfaces, which would affect either the satisfactory execution or permanency of the work is necessary.

9.3.3 All painting materials are to be applied evenly spread and thoroughly brushed -out only by skilled workers. All workmanship shall be executed in accordance with the best acceptable practices applying to the class of work and grade, type and kinds of materials specified.

9.3.4 Plastered surfaces shall be primed before speckling. After application of primer coat, Contractor shall check all surfaces and do all necessary speckling of cracks, indentations and other imperfections in any approved manner.

9.3.5 Wood work that is to have a finish treatment, whether executed as field work or shop finished, shall be smooth and free from raised grain or other surface imperfections that affect its appearance and shall be lightly sanded or steel wool during finishing operations. After filler has been applied, if required all nail holes or other similar blemishes shall be carefully stopped with linseed oil puffy.

9.3.6 Shop coats provided by others, where required or necessary, shall have all bare spots touched up by the Contractor, using same materials as used for shop coat, or other equivalent material, if approved by the Engineer.

9.4 **MATERIALS.**

9.4.1 All materials shall be stored and mixed only in spaces assigned for this purpose by the Engineer and all necessary precautions shall be taken to prevent fires by complying with all applicable local fire prevention and safety ordinances. The contractor shall provide galvanized iron pans of suitable size in which all mixing paints shall be placed and no mixing shall be permitted outside of these pans.

9.4.2 The basic materials entering into the compounding and/or manufacture of all paints, polishes and other treatments referenced herein shall be of the best grade and quality of their respective kinds for the intended purposes. These shall be the products or formula of recognized and reputable manufacturers of known reliability and integrity subject to the approval of the Engineer and shall conform to the applicable requirements of the British Standard Specifications or approved local standards regarding kind, qualify and finish, Reference herein to specific paint materials is for the sole purposes of establishing a basis of "Minimum Standards" of quality and shall not be construed to be a limit of perfection or quality for any of the materials, ingredients to be furnished or utilized in this work. The Engineer reserves the right to select and / or accept only the best grades of standard products, which in his opinion, will provide a finish of recognized performance and characteristics suitable for their respective surfaces, irrespective of minimum standards reference herein.

9.4.3 All materials shall be delivered to premises in their original sealed containers or package bearing the manufacturer's name, label and brand, and be mixed and applied in accordance with manufacturer's directions and /or instructions. The mixing of all paint or other covering finish treatments shall be done in premises as and when, if required, under the supervision and direction of the Engineer.

9.5 **PAINTING TO METAL WORK.**

9.5.1 All metal work shall have, in addition to shop primer coats, minimum three (3) coats of enamel paint or as incorporated in the Bill of Quantifies, in the manner as specified herein.

9.5.2 All exposed ornamental and miscellaneous iron and steel shall receive over the shop primer coat, minimum three (3) coats of enamel paints as specified herein or as incorporated in the Bill of Quantities.

9.5.3 Galvanized iron not previously shop coated shall receive minimum 4 coats, the first coat to be of an approved galvanized iron primer and minimum three finish coats of enamel paint or as incorporated in the Bill of Quantifies.

9.5.4 Where shop coals and/or priming coats are found to be scratched or abraded they shall be touched up with appropriate paint.

9.6 **OIL BOUND DISTEMPERING.**

9.6.1 Distempers shall be of approved quality and make as directed by the Engineer.

9.6.2 Before work of distempering is commenced, the surface should be cleaned. The surface then must be sized with a priming coat of petrifying liquid of approved manufacture. Distemper shall be applied quickly and boldly with broad stiff brushes of approved make. The brush is to be dipped and stroked cross-wise info the wails and them immediately stroked up and down. This shall be considered to be one coat of distempering. The distemper shall be mixed in the manner specified by the manufacturer and each coat shall be inspected and passed by the Engineer before the next coat is applied.

9.6.3 The Contractor shall carry out as many coats as specified in the Schedule of Quantities in accordance with the above specifications. The number of coats specified is enough for producing the uniform smooth finish and if the finish produced by the Contractor is not up to the satisfaction of the Engineer, the Contractor will be required to apply more coats, as may be required to produce the specified finish without any additional charges.

9.7 **SURFACE PREPARATION AND FILLING.**

All plaster and masonry surfaces that are to be finished with vinyl emulsion, plastic emulsion or enamel paint shall be prepared as under prior to application of paint finish.

9.7.1 **NEW SURFACES:** Rub down the surfaces with a sand paper or carborandum stone to remove any 1case material. Check that the surface is thoroughly dry before painting.

9.7.2 OLD SURFACES: For previously painted surfaces especially white - washed surfaces, scrape down to the bare surface and ensure that the surface is free from any contaminant like grease, oil, etc. and any loose material or dust is completely removed before painting.

9.7.3 **SEALING:** Apply 1 coat of Alkali Resisting Masonry Sealer and allow to dry overnight. Alkali Resisting Masonry Sealer may be thinned with 10-15% good quality mineral turpentine or white spirit if required due to surface absorption.

9.7.4 FILLING: Puffy for filling the walls should be made by mixing 4 parts of good quality chalk and one part of Zinc Oxide Powder with Alkali resisting masonry sealer till a smooth knifing paste is formed. Putty should be applied after sealing the walls with Alkali Resisting Masonry Sealer, and after the tilling work is completed and prior to application of the finish paint, the filled surfaces should be dry and properly finished, No filling should be carried out on external surfaces. Each coal of paint shall be allowed to become dry before any subsequent coat is applied. The finished surface shall be free from runs and sags, defective coverage and clogging of lines or angles. Edges of paint adjoining other materials or other colors shall be full and clean - cut without overlapping.

The Contractor shall carry out as many coats as are specified in accordance with the above specifications. The number of coats specified should be enough for producing uniform smooth finish and if the finish produced by the Contractor is not up to the requirement, he will be required to apply as many more coats as may be required to produce the required uniform finish, and no payment for the extra coats applied to produce the desired uniformity will be made.

9.8 **LACUER POLISHING.**

9.8.1 Clear polyurethane lacquer used on the work shall be of ICI / Berger or an approved make.

9.8.2 The surface to be lacquer polished should be sand papered and a staining compound should be applied if required.

9.8.3 When the stain coat dries up the surface should be rubbed down with sand paper. Approved polyurethane lacquer of a proprietary brand shall then be applied.

The surface shall then be wiped with o dry cloth and the process repeated several times in succession until the surface assumes the desired degree of gloss as approved by the Engineer.

9.8.4 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 by the Engineer. The sizes of the sample paint and finishes shall be as determined by the Engineer.

9.8.5 PROTECTION.

The Contractor shall protect all the work against damage or injury by his employees or by the materials, tools used in connection with the work of this contract. Any and all work damages as a result of the execution of this shall be repaired at Contractor's expense or if in the opinion of the Engineer it cannot be properly repaired, it shall be replaced with new work by the Contractor without additional compensation. At all times, the general and liberal use of drop cloths shall be a primary requirement for protection purposes.

9.8.6 TOUCHING UP.

At the completion of all work specified herein, all painted work shall be touched up and restored where damaged or defected and the entire work left free from blemishes, to the complete satisfaction of the Engineer.

9.8.7 CLEANING.

The Contractor shall clean all paint, spots, dubs, oil and stain from all floors, wood work, glass hardware, metal work, electrical fittings and all similar items, and leave the work in perfect condition, upon completion in every respect to the satisfaction of the Engineer.

9.9 EMULSION PAINTING

9.10.1 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

9.10.2 MATERIALS

Emulsion paints shall be of make and type as specified and approved by the Engineer-inCharge.

9.10.3 EMULSION PAINT APPLICATION

For emulsion paint application the specifications laid for distempering under clause 15.5 shall apply.

9.10.4 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.

9.10.5 FRENCH POLISH (SPIRIT POLISH)

It is a spirit varnish applied to the prepared wood surface with a polishing pad of soft cloth and not with a brush with quick and light strokes along the grain. The cloth contains absorbent cotton filling. Several coats will be necessary before the desired shine and finish is achieved. The pad may be dabbed with a drop of olive or mustard oil after each coat to allow a smooth working and finish. The wood to be polished is first painted with a filler composed of 5 Lb. of whiting mixed with 1/2 gallon of methylated spirit and then sand papered, when dried. Fillers can also be made in any of the following ways:

i) Whiting mixed with water.

ii) Linseed oil and bee's wax (3:1) boiled. ii) Plaster of Paris either in water or raw linseed oil.

French polish is worked upon the surface of hard wood to obviate the effect of grain.

9.10.6 WAX POLISH

The surface of wood work is smeared with wax polish and rubbed with a soft flannel to a fine polish after 24 hours of its application. Wax polishing is mostly used for polishing the cement concrete floors.

9.10.7 PAINTING IRON WORK (NOT UNDER WATER)

In order to protect metallic products from corrosion, surface treatment is extremely essential, and painting is one of the many methods employed for this purpose. In addition, it improves the appearance of the article or structure.

PREPARING IRON WORK FOR PAINTING-

It is essential to remove all rust, scale and dirt and have the surface absolutely cleaned before painting. Special attention is paid to the cleaning of corners and re-entrant angle. Usually anyone of the following methods is employed depending upon the nature of surface to be cleaned:-

1) Loose dust is removed by bristle or wood fiber.
2) Rust scale and perished old paints are burnt off by the application of flat oxyacetylene flame and then rubbed off with wire brushes and scrapers,
3) Oil and grease can be removed by gasoline (petrol) or benzene, excess of which shall be wiped off from the surface.
4) Old paint can be loosened by applying a solution of country soda and fresh slaked lime in equal parts.

No chemical of any kind will be allowed to be used for cleaning the metal.

PRIMING OR UNDER COAT:

Priming coat can be a mixture of pure linseed oil and dry red lead in the proportions of 1 gallon of oil to 33 Lbs. of red lead. It is applied by brush or spraying machine immediately after cleaning the surface of the metal when it has completely dried up. If this coat is spoiled by rain within 24 hours of its application, it is removed and another coat is applied.

SECOND AND SUBSEQUENT COATS:

The second coat is applied when the priming or first coat has thoroughly dried and set i.e. after about four days. It may be red oxide paint or paint with aluminum or graphite base (red oxide paint may consist of 6 Lbs. of red oxide paint, 1lb of lamp black and 1 gallon of boiled linseed oil). The third coat is applied when the second coat has dried completely. It may consist of 7 Lbs. of red oxide paint, and 1 gallon of boiled linseed oil. For less important iron works or for roof coverings red oxide paint can be made up of the following constituents.

a) Red oxide powder dry 10 parts by weight
b) Raw linseed oil 4 parts by weight
c) Boiled linseed oil 1 parts by weight
d) Turpentine 1 parts by weight

One gallon of this paint will cover about 400 square feet of surface in two coats. Standard paints available in market should be used as specified and approved by the Engineer-inCharge.

9.10 SCHEDULE OF MEASUREMENT OF PAINT AREA.

Irrespective of prime coats and number of paint coats applied to exposed painting surfaces, area of column, walls, projections, ceilings and other surfaces (except gates, doors, windows and ventilators) shall be measured as per actual paint surface area for single time only and paid in accordance with quoted rate of Bill of Quantities

CHAPTER -10 GLASS AND GLAZING

10.0 SCOPE OF WORK.

The work covered under this section of the Specifications consists of furnishing all labor, equipment, scaffoldings and providing glass, gaskets, sealants, compounds and accessories required for performing alt operations in connections with the installation and setting of glass, glazing and glass blacks and butt jointed glazed partitions complete in every respect in accordance with the Drawings or as directed by the Engineer. The scope of this section of specifications is covered with detailed specifications as fold down herein.

10.1 GENERAL.

1.1 The glazier must examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing is to be performed. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to the Glazier.

1.2 The Contractor shall submit two samples of each type of glass required. These samples shall be of 300mm x 300mm size or as directed. He will also submit lengths of installed (mock-up) glazing materials together with samples of glazing sealants and glazing gaskets.

10.2 DELIVERY, STORAGE AND HANDLING

1.1 Contractor shall handle the materials in a manner to prevent breakage of glass and damage to surfaces, and shall exercise exceptional care to prevent edge damage to glass.

10.3 MATEIRALS,

1.1 Plain and Tinted Glass: Glass shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to fit the rebates so as to have a uniform clearance round the panels between the edges of glass and the rebates.. Glass shall be of plate or float type, in thickness and size as shown on the drawings or Bill of Quantities. All glass shall be of such quality that surface deterioration' will not develop under normal conditions of use. Glass shall have parallel surfaces and without physical impurities.

10.4 Glazing Sealants and Materials.

10.4.1 General: Provide color of exposed sealant/compound indicated or if not otherwise indicated, as selected by Architect from manufacturer's standard colors, Comply with manufacturer's recommendations for selection or hardness, depending upon the locations of each application, conditions at the time of installation, and performance requirements as indicated. Select materials, and variations or modifications, carefully for compatibility with surfaces contacted in the installation.

10.5.0 INSTALLATION OF GLAZING.

1.1 Glazing work shall comply with the recommendations of the glass and glazing materials manufacturers.

1.2 Examine each piece of glass and discard and replace glass with edge damage or face imperfection.

1.3 Cure glazing sealants and compounds in compliance with manufacturer's instructions, to obtain high early bond strength internal cohesive strength and surface durability.

1.4 No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass.

1.5 While glass operation is in progress, great care shall be taken to avoid breakage or damage to the glass and adjoining glazing. The Contractor shall make good, at his own cost, all glass broken by his workmen while cleaning or carrying out other operations. On the completion of the glazing work, all glass that has been set by the Contractor shall, if it becomes loose, within the maintenance period, be re-fixed at Contractor's expenses.

10. 6. PROTECTION AND CLEANING OF GLAZING.

Remove all smears, labels and excess glazing sealant, leave clean inside and outside and free from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with new glass of no additional expense to the Owner. All glazed surfaces shall be washed clean both inside and outside prior to final acceptance.

10. 7 MEASUREMENT AND PAYMENT.

General: No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities.
The cost thereof shall be deemed to be included in the quoted unit rate of the relevant items of the Bill of Quantities.

10.7.1 Measurement: Measurement of acceptably completed works will be made on the basis of net actual area in square meter / square feet of glozing material provided and installed in position as shown on the drawing or as directed by the Engineer.

10.7.2 Payment: Payment will be made for acceptable measured quantity of glazing material on the basis unit rate quoted in the Bill of Quantifies. The unit rate shall include the cost of glazing, wastage, sealants and compound for fixing the glass, all hardware fittings as per manufacturer's recommendations or as shown on the drawings. Payment shall constitute full compensation for all the works related to the item.

CHAPTER -11 WOOD CARPENTRY AND JOINERY

11.1 SCOPE OF WORK.

The work covered by this section of specifications consists of providing all labor equipment and materials including performance of all operations in connection with fixing and installation of all wood work and mill work, construction, assembly and surface finish treatment and building in of all cabinet type items, complete in every respect and all related items support, etc., of wood or metal and incidentals, associated wood work appurtenances, the application of all Finish Hardware in connection with finished wood work, strictly in accordance with the requirements and drawings, as specified herein or as required by the Engineer and subject to the terms and conditions of the contract.

11.2 GENERAL REQUIREMENTS.

11.2.1 All materials specified herein shall be the products of one mill as for as possible. Only first class cabinet type workmanship will be admissible in execution of this work, performed by artisans skilled in this trade, so as to provide cabinet work of the highest grade, quality, finishing, fixing and installation as per drawings.

11.2.2 Care shall be exercised to avoid strong contrasts in color and graining of finished wood for all wood surfaces.

11.2.3 All cuttings, framing and fitting shall be done as required for accommodation of work of other trades. Use of wood chips, or other shrinkage material for leveling or plumbing will not be permitted in any form. Mortise and tennon joints, shall be set in an approved type of glue with wedges and/or pinned. No wood work in the building shall be allowed until such time plastering is entirely dry. As for as practicable, all wood work shall be assembled in shop, painted and finished throughout before fixing/installation in the building.

11.2.4 In addition to machine sanding, all interior, trim, paneling and wood work shall be smoothened by hand, using ZERO No. sandpaper to give all wood work the required smooth surface for exposed finished treatment and free from machine and tool marks, abrasions, raised grains and other undesirable defects. All wood work shall be fitted to plaster or other finished work in a careful manner so as not to injure these surfaces in any way. Where plaster or other work is damaged or disturbed, it shall be made good and/or restored to its original conditions at the expense of the Contractor.

11.2.5 The whole of the timber shall be of good qualify, properly seasoned, "free from large, loose or dead, knots, or tight knots, the diameter of which exceeds one quarter of the width of the exposed face, or one inch whichever is less, or injurious open shakes" and shall not contain sap wood and having a moisture content of not more than 15 percent, nor less than 12 percent of the dry weight at the time of fixing.

11.2.6 All work shall be accurately set out and properly framed together with close fitting mortise and tennon joints accurately cut and carefully fitted and wedged solid in the best and most substantial manner. The joinery work shall be started after the commencement of the construction of the building but not wedged up until required, for fixing in position within the building. No lathery shall be wedged or built into position until it has been accepted and approved by the Engineer.

11.2.7 Door frames built into the structure before the surrounding carcass is built shall be set plumb & true and shall be adequately braced and protected against damage during subsequent building operations.

11.2.8 All timber shall be of first class soft wood /deodar) except those specified in the Bill of Quantities and as shown on the drawings.

11.2.9 Plywood used for doors, paneling and other similar works shall be shown on the drawings or directed by the Engineer. The grade shall be first quality and the face and back shall be free from end joints, dead knots, overlaps, patches and other similar defects. The surfaces shall be free, smooth for painting or polishing. The veneer shall be of the required thickness and quality including base veneer and shall be impregnated with on approved adhesive and machine compressed. Such machine pressed veneered wood shall be fixed on all sides of the inner core wood (soft wood of approved qualify) after it has been treated with water resistant hot setting glue.

11.3.0 DOOR AND WINDOW FRAMES,

11.3.1 The door and windows frames shall be of the first class soft wood or hard wood as specified in the Bill of Quantities and description of works. These shall be fabricated to the exact sizes and dimensions as provided in the drawings, where the door frames are not to have any sills, the vertical length shall be embedded in the floor. The Contractor shall also fully protect door and window frames from damage or injury during construction and shall replace the damaged or injured frames at his own cost, the frames must have primary coat painted on or before fixing. All framing members shall be properly mortised, tennoned and all joints properly wedged and glued and pinned. The door and window frames shall be secured in place by means of galvanized steel anchors bent up against the back of the iambs and screwed in place and built into the masonry as if is being constructed. There shall be one such anchor near the top and bottom of each jamb not over 90 cms intervals between the top and bottom anchors, Frames shall be secured to the anchors by means of two counter-sunk screws per anchor.

11.3.2 Wherever the drawings and Bill of Quantities require door and/or frame of metal, these shall be constructed of prime quality galvanized steel of 16 swg unless otherwise specified. The width and shape shall be as indicated on drawings. The frames shall be recessed at the point of location of hinges and shall have integral reinforcement to allow the butt hinges, pivot hinges, door closers and other finish hardware to be screwed on, The door frames shall also have a provision to allow recessed installation of door lock strike plate with a back up boxing to keep concrete away from the lock strike plate. The number and type of anchors shall be as per wooden frames. These anchors must not be welded onto the inner side of the exposed surface of the frames as indicated in the drawings. Under no circumstances must the Contractor manufacture the metal frames prior to approval of a sample by the Architect/Engineer. The protection of the metal frames from the plastered surface if shown on the drawings must be uniform throughout the project.

11.3.3 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.

11.4 FLUSH WOOD DOOR SHUTTERS.

11.4.1 The door leaf has to be flushed type on both sides manufactured as approved. It shall be of well-seasoned solid core black board. Flush door shall be screwed to the frames by means of butt hinges. Hinges where provided shelf be countersunk in the order for veneered leaves shall intimate the Engineer and also a sample of the leaf of the proposed manufacturer, Completed doors shall be sound, rigid and free from defects and warp. All edges shall be aligned and smooth, Joints shall be close fittings, hardwood doweled or mortised frames and of strength to maintain the structural properties of the members connected. All adjoining faces and edges shall be flush and smooth. Edges shall be rectangular and solid. If a lipping is required on the edges of the flush door shutter, this shall be of the required size and shall be recessed and glued and nailed info the edge frame of the shutter.

11.4.2 GLAZED DOORS AND WINDOWS.

All doors and windows Leaves shall be cut out and framed together as soon as possible after the commencement of the works and stacked in the shade for seasoning. These ore not to be wedged and glued for four months where possible and where the contract time permits. If it is not possible, these should be wedged and glued just prior to being hung. Any or all portions, in which defects appear, shall be replaced by the contractor before final gluing up the same. All tennons at the final assembly of the doors (top and bottom) shelf be glued and wedged. Immediately after gluing, the frames shall be tightly clamped and so Jeff till the glue has set. Unless otherwise specified, leaves are to be hung on hinges of the size and numbers required. The hinges shall be countersunk info the frames as well as in the leaf, the recesses being cut of the exact size and depth of the hinges. No subsequent packing shall be allowed.

11.5 WOODEN HAND RAIL.

The wooden hand-rail shall be in accordance with the dimensions and shape shown in the drawings. If shall be fixed to the balustrades with counter screws at maximum 250mm centers or with bolts in an approved manner and the top neatly covered in with an appropriate wood stopper. The wood shall be carefully selected and shall be free from all knots in addition to conforming to the specifications for wood work section.

11.6 WOODEN CABINETS.

All cabinets including fittings and fixtures shall be as approved and shall be of best quality.

11.6.1 The Contractor shall submit a finished sample of each type of cabinet including all lettings and fixtures and the same shall be got approved from the Engineer before fabrication. Samples of materials to be used in cabinets together with specifications and literature shall be supplied to the Engineer for his approval. The color shade shall be as approved.

11.6.2 All cabinets shall be installed in position by the skilled workmen. The Contractor shall inspect delivered cabinets and related parts for indication of location, size required by field measurements, finishing hardware and similar preliminary works. Verify locations for installation, required floor and wall finishes, painting and all other related work. Unsatisfactory conditions shall be repaired. Concealed fasteners, all joints surfaces shall be smooth and even. Doors and other moving parts shall exactly fit in the frame. Refit, as necessary to ensure proper and easy operations. Refit, if necessary, all cabinet hardware, test for proper operation, remove

for painting and other finishing and properly replace in position with all fittings and accessories. All work shall be thoroughly protected from damage at all times by suitable methods approved by the Engineer, Adjacent work shall similarly be protected from damage. Any damage or disfigurement shall be immediately made good at Contractor's expense.

11.7.0 WOOD SKIRTING/DADO AND PANELLING.

Wood skirting/dado and paneling shall be provided where shown on the drawings and the schedule of finishes. These shall be installed in position conforming to detailed drawings and as per direction of the Engineer. Shop drawings and sample shall be submitted to the Engineer for approval. In the event of non-conformance to specifications and drawings, the work shall be rejected by the Engineer and the Contractor shall remove and replace the rejected work by new work as per specification,

Surfaces shall be prepared in the manner as directed by the Engineer for clear polish finish or as specified.

11.8 HARDWARE.

Hardware shall be of best qualify and make, strong and fine finished according to the weight/dimension, material as per specified hardware schedule. The Contractor shall obtain prior approval from the Engineer for quality, shape, pattern and brand of all hardware materials by providing samples and catalogue etc. and shall provide and fix only the approved hardware materials.

Hardware shall be carefully and securely fitted. Upon handing over the work, hardware shall be demonstrated to operate freely. Keys shall be placed info respective lacks and upon acceptance of the work keys shall be tagged and delivered to the Engineer.

11.9 MEASUREMENT AND PAYMENT.

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities, All finished hardware/fittings in carpentry and joinery works.

CHAPTER -12 ALUMINUM WORKS

12.1 SCOPE

The work under this section of specification includes furnishing all labor, equipment, appliances and materials and performing all operations in carrying out the work of natural, anodized and powder coated aluminum windows, doors, ventilators and louver with fly proof shutters and aluminum false ceiling of polycarbonate sheet on swimming pool. All related items such as sealants, rubber gasket for glazing, netting, rollers, latches, fastenings, glazing, anchor bolts and all items supplied by other trades and customarily built in and/or installed in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

12.1.1 APPLICABLE STANDARDS

Latest editions of following ISO and British Standards are relevant to these Specifications wherever applicable.

ISO (International Organization for Standardization 6612

Windows & Doors - wind resistance tests.

6613 Windows & Door - Air permeability test.

BSI (British Standard Institution)

1227 Hinges

4873 minum alloy windows.

12.2 SUBMITTALS

a. **Shop Drawings**

The contractor shall submit shop drawings which shall show full construction details, quantities and locations, fastenings and attachment to adjacent construction and materials. Shop drawings shall be submitted at the proper time to allow for checking, revisions and to permit manufacturer's product delivery and start of site work to suit the building programme.

b. **Samples.**

Prior to execution of work and sufficiently in advance, the Contractor shall submit representative samples of finished Doors, windows and ventilators, anchoring mechanism, embedded parts, fastenings, glass panes, accessories and other materials for the Engineer's approval.

c. **Manufacturer’s Certificate**

The Contractor shall on request get certificate signed by the manufacturer stating that each lot has been sampled tested and inspected and has met the requirements in accordance with these specification and the same shall be furnished to the Engineer.

d. **Guarantee**

The manufacturer shall furnish his standard written guarantee against leakage of rain water, excessive infiltration of dust, air and all defects in materials, workman ship covering all the work under this section.

12.3 PRODUCT DELIVERY AND STORAGE

12.4

12.4.1 Deliver doors, windows, ventilator and louvers in a manner preventing damage to units. Store materials off the ground under cover in a manner preventing deterioration or damage.

12.4.2 All embedded parts and anchor bolts shall be delivered to the site carefully and keeping the fabricated shape and configuration. All these parts shall be suitably marked for identification.

12.5 MATERIAL

All the sections used for Doors, windows, ventilators & fly screens shall be of best quality aluminum products such as equal and unequal angles, channels, tubes, corrugated strips, moldings etc.; in accordance with international standards conforming to ASTM B 308 & B221.

12.6 Frames

The frames of aluminum doors, windows, ventilator, louvers and fly proof shutters shall be formed from rolled, strip or extruded aluminum and be at least 2mm thick deluxe section. Fastenings bolts and screws shall be made from hardened aluminum.

12.7 Fasteners shall be stainless steel of a type selected to prevent galvanic action with the components fastened. Gaskets shall be vinyl glazing channel gasket to commercial standard CS230-60.

12.8 Hardware as required shall be manufacturer's standard hardware of aluminum, stainless steel or other corrosion resistant materials and shall blend in design with the frame finishes.

12.9 Joint sealant shall be approved elastomer.

12.10 Fittings and fixtures shall be as per approved samples.

12.11 Joint sealant shall be approved elastomer.

12.12 Finished Coating

General

The finished coating shall be as stated on the Drawings and applied strictly in accordance with the manufacturer’s instructions.

The color of the coating shall be selected from available ranges if not stated if not stated in the drawing and or bill of quantities. The Contractor shall offer samples for approval prior to the final selection and the manufacture of these elements.

12.11.1 Anodized coating

The aluminum anodizing shall comply with BS 3987 and be integral color hard coat anodizing 550kp/mm^2 hardness, minimum 25 microns thick.

The color of anodizing shall be as described on the drawings.

Samples of color including limits of color variation shall be submitted to the Engineer for his approval before work commences. The Engineer reserves the right to reject the products of any supplier who cannot guarantee a reasonable limit of color variation, the acceptable limit of variation being at the Engineer’s discretion.

12.11.2 **Polyester Powder coating**

All aluminum works shall be finished in colored electrostatic polyester powder coating as per DIN standard 53151, 53153, 53156 or equal and approved to RAL Color subject to the Consultant’s approval.

12.11.3 **Coating Thickness**

As and when instructed by the Consultant, the Contractor shall provide certificates from independent laboratories that the minimum thickness as stated in these Documents has been applied to the aluminum sections. Failure to provide such information shall result in the complete installation being rejected and replaced at the Contractor's expense.

12.11.4 **Dissimilar Materials**

All aluminum surfaces that are to be in contact with cured concrete, mortar, steel and other metals shall have the contact surfaces protected wherever they may entrap moisture or corrosive elements. Metals that are to be in contact with mortar or concrete shall be protected with a two coat bituminous coating.

Prime paint steel parts of anchors, anchor inserts, reinforcement, supports, and all parts after field welding or blotting with zinc chromate. Minimum dry film thickness of 1 mil for zinc chromate.

12.13 FABRICATION

12.12.1 **General**

All nuts, bolts, washers and screws used for assembly and fixing shall be of adequate strength for their purpose within the design and shall be stainless steel grade 18/8. All sealants used in the assembly of, and in the fixing of cladding and window framing, shall be non-setting to allow thermal movement without detriment to those joint sealants used for peripheral caulking and shall be one part silicone sealant and shall conform to BS 4245. All spliced joints between mullions will be sealed with an approved silicone product, compatible with other sealants and packing used.

All ironmongery which is to have the same finish as the frames and shall be approved by the Engineer.

At all opening of windows and doors and where there are louvered screens and doors, a fly screen shall be provided to the approval of the Engineer, constructed following the principles and specifications as described elsewhere in this specification.

Glazing sections shall be set in special heat resisting PVC and of channel type. Separate glazing sections on each side of the glass will not be permitted.

The following table indicates the basic requirements for window construction. The weights of framing make no allowance for beads, glazing bars, opening light framing, coupling mullions or transoms.

Classifi- 1. Catio n	Min. weight Of basic Frame Kg/m run	Max. superficial Area of window In m2	Max. Dimension Either way Mm	Remarks
Light	0.60	1	1500	
Light	1.00	3	2000	
Medium	1.50	5	2500	
Medium	2.00	9	3000	
Heavy	2.50	12	3500	
Heavy	3.00	12	3500	With door

12.12.2 **Sliding Windows and doors**

Weather stripping - high density acrilan wool weather pile shall be used. There should be double brushes at every contact between shutter and frame sections for complete insulation. These should be present consistently throughout the unit between the inside and the outside and no portions without it are permitted.

The rollers for sliding shutters for both windows as well as doors shall be of the adjustable type. The adjusting screws must be accessible in the assembled state of the shutters and a vertical adjustment of 7 mm should be possible.
All sections for sliding windows and doors should be hollow section and the cross section dimensions of the sections should not be less than 60 x 40 mm.
The outer frame must be suitable for accommodating sliding fly screens as required.

The handle-latch set should have all visible surfaces finsihed as the aluminum sections. The handle must have a proper grip. A small projecting flange or recess in the shutter sections cannot be accepted to serve as handles. The latching mechanism should not be surface mounted but should be concealed within the sections.

Sash rails of vertical sliding windows are to be of tubular box sections with corner joints of outer frames and sashes interlocked, and the balance mechanism is to be an approved proprietary product.

12.12.3 **Side hung windows, doors and ventilators**

All windows and doors should be weather-stripped with heat resistant PVC sections. The weather protection should be achieved by a positive compressive action against the PVC section and should not depend on external contact with the PVC section. At every contact between two profiles two weather-stripping section should be provided to complete weather protection.
The bottom sections for hinged doors must be capable of being adjusted vertically if necessary. The gap between the bottom section and the floor should be covered with a pair of special splay-type PVC sections.
The shutter sections for both windows as well as doors shall be hollow section type and shall be overall size 57 x 45 mm and door sections shall be overall size 81 x 45 mm (including flanges).

The shutters of the windows and doors should be assembled with concealed corners of high rigidity. Hinges should be concealed within the sections.

Hinges shall be anodized aluminum with stainless steel pins and nylon washers. Handles shall be anodized aluminum finished to match the aluminum sections and mounted with self-lubricating nylon washers.

A mortise cylinder rim automatic deadlock of high quality with double pin tumbler is to be used.

Windows shall have anodized aluminum handles, color as framing and a latching mechanism securing the shutter to the frame both at the top and bottom.

Fitting where required:

a. Single action door closer concealed in the head bar of the outer frame and mounted on an adjacent pivot at the threshold and deadlock fitted.
b. The left hand leaf of double doors with flush bolts at head and sill with deadlock fitted to the right hand leaf.
c. Escape doors to have panic bolt assembly with vertical elements concealed in the stile and door closer as in (a).

12.12.4 Fly screens

Fly screens shall be fitted to all opening leaves of windows or sliding doors, consisting of a separate metal sub-frame in with aluminum mesh fly wire. The Fly screens shall be adequately secured with suitable clips, set screws or turn buckles and shall be removable for maintenance purposes. Fly screen doors shall consist of similar section to metal casement doors and shall be fitted with removable panels of fly wire.

The aluminum frame to the Fly screen shall be finished to match the framing of the window or sliding door. Color and type of mesh to Engineer's approval.

12.12.5 Aluminum Doors, Windows and Ventilators

12.12.5.1 Measurement &Payment

Measurement of acceptably completed works of aluminum doors, windows and ventilators will be made on the basis of net actual area in square feet provided and installed in position as shown on drawings or as directed by the Engineer. Payment will be made for acceptable measured quantity of all finished aluminum doors ,windows and ventilators on the basis of unit rate per square feet quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

CHAPTER -13 MISCALLENOUS WORKS

13.1 FALSE CEILINGS

13.1.1 GENERAL

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. These channels snap together in a regularly spaced pattern of cells.

13.1.2 MATERIALS

i) **Gypsum Board False Ceiling** Standard Gypsum Board ½" thick unless otherwise indicated on the Drawings, ends square cut, tapered edges as manufactured by US Gypsum or approved equivalent and of approved pattern, size and thickness as per approved shop drawings.

ii) **Lasani Board /MDF False Ceiling**

Lasani Board / MDF false ceiling shall be of the approved manufacturer and of approved pattern, size and thickness as per approved shop drawings.

iii) **Plaster of Paris False Ceiling**

The Plaster of Paris false ceiling comprise of POP tiles 1/2" thick size 2'-0"x2'-O" or as shown on the Drawings, reinforce with hessian-mat.

iv) **Dampa AL-15**

Suspended aluminum false ceiling shall be standard products offered by the manufacturer / supplier DAMPA grid system shall be 0.5mm thick aluminum strips. They shall be profiled units available in standard foil and a pad of mineral wood 12mm thick. The approved manufacturers shall be DAMPA. The type of ceiling used shall be DAMPA AL-15 perforated.

v) **Hangers**

Hangers shall be of 5/8"x1/8" M.S. flat. It shall be the responsibility of the Contractor to get the sample of hanger approved by the Engineer-in-Charge.

vi) **Angles and Tees**

Angles and Tees shall be of Aluminum section 1.6mm of approved pattern as per shop drawings approved by the Engineer-in-Charge.

13.1.3 SUBMITTALS

The Contractor shall submit the following for approval of Engineer-in-Charge.

- The shop drawings showing reflected ceiling plan, locations of built-in products and access facilities, dimensions, layout arrangements, hanger locations, structural connection, details of level changes, direction of pattern and panel-joint details.
- Samples of false ceiling panels, suspension system, and accessories including sealant, furring and runner channel etc.

13.1.4 DELIVERY AND STORAGE

- Material shall be delivered in original, unopened, protective packaging, with manufacturer's labels indicating brand name, pattern, size, thickness and fire rating.
- Material shall be stored in original protective packaging to prevent soiling, physical damage or wetting.
- Cartons shall be stored in the installation area, opened at each end to stabilize moisture content and temperature, for 48 hours prior to installation.

13.1.5 QUALITY ASSURANCE

Installer Qualifications: Engage an experienced Installer who has successfully completed false ceilings similar in material, design and extent to those indicated for this Project

Fire Performance Characteristics: Provide these ceilings that are Identical to those tested for the following fire performance characteristics, per ASTM test method indicated below, by Underwriters Laboratories, Inc. (UL) or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify acoustical ceiling components with appropriate markings of acceptable testing and inspection organization.

Surface burning characteristics: tested per ASTM E84 and complying with ASTM E1264 for Class A products.

Flame spread: 25 or less

Some developed: 50 or less

Single Source Responsibility for Ceiling Panels: Obtain each type of acoustical ceiling unit from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

Single Source Responsibility for Suspension System: Obtain each type of suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress in the Work.

Coordination of Work: Coordinate layout and installation of acoustical ceiling units and suspension system components with other construction that penetrates ceilings or is supported by them, including lighting fixtures, HVAC equipment, fire-suppression system components, if any, and partition systems.

13.1.6 TOLERANCES:

Deflection:

Suspension system components, hangers and fastening devices supporting light fixtures, ceiling grilles, and acoustical panels, maximum deflection 1/360th of the span.

Deflection test: ASTMC635.

Field Constructed Mock-Up: Install acoustical ceiling in designated area.. After the acceptance of the Engineer-in-Charge, retain mock-up as a standard of quality for entire acoustical panel ceiling installation.

13.1.7 MEASUREMENT:

Length and breadth of the False Ceiling shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

13.2 KITCHEN CABINET

All wooden kitchen cabinet works shall be fabricated by approved subcontractor/manufacturer and shall be of best quality.

A) Shop Drawings

The details of these items shown on the drawing are tentative and show basic configuration and design of these items.

The contractor shall submit detailed shop drawings of these items on the basis of tentative detail shown on the drawings including all fitting, fixtures and hardware for the proper execution of kitchen cabinet for the approval of the Engineer before fabrication.

B) **Installation** All the works shall be installed in position by the manufacturer's skilled workmen specialized in the job. Works shall be executed in accordance with approved shop drawings and or as directed by the Engineer.

All work shall be thoroughly protected from the damage at all times by suitable methods approved by the Engineer. Adjacent works shall similarly be protected from damage. Any damage or disfigurement shall immediately made good at contractor's expense.

13.2.1 MEASUREMENTS AND PAYMENT:

Length and width of the cabinet shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

The payment for the items of the work 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.

CHAPTER – 14 PLUMBING, SANITARY, PIPINGS , FITTINGS & INSTALLATIONS

14.0 SCOPE

The work shall include, furnishing and supplying as required all labour, materials, fittings, fixtures, accessories, equipment and services for the execution, completion, testing and commissioning of plumbing, sanitary installation & Gas fitting works as shown on drawings, specified herein or as directed by the Engineer-in-Charge.

14.1 PLUMBING, SANITARY PIPING, FITTINGS &INSTALLATIONS

14.1.1 SUBMITTALS

The Contractor shall submit samples of materials such as fittings, fixtures and accessories to be incorporated into the works to the Engineer-in-Charge for approval.

14.1.2 SOIL, WASTE AND VENT PIPES

All soil, waste and vent pipes and fittings shall be UPVC , The range includes traps, push-fit waste systems, solvent weld systems, soil and vent systems and a full range of floor gullies.

Specification as:

Specific gravity	1,4 g/cm^3
Inflammability	Self-extinguishing
Specific heat	1,00 Kj/kg 60 ^{0}C long term, 100 deg C short term
Thermal conductivity	Coefficient of heat conduction = 0, 16 W/m ^{0}K (or ^{0}C)
Co-efficient of linear expansion	0, 08mm/m K (or C)
Vicat softening point	79 ^{0}C
Impact strength	2-5 mJ/mm^2
Modulus of elasticity	Emod=3000 N/mm^2
Poisson's ratio	0,39
Tensile strength	45 N/mm^2
Elongation at break	=>80%

Pipe shall be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds.
PVC pipes exhibit excellent resistance to a wide range of chemical reagents in temperatures up to 50 0 C.

14.1.3 INSTALLATION

Installation shall comply with the latest installation instructions published by the Pipe manufacturer and shall conform to all applicable plumbing, and building requirements. Buried pipe shall be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cement joints shall be made in a two-step process with primer conforming to ASTM F 656 and solvent cement conforming to ASTM D 2564. The pipe shall be protected from chemical agents, plasticized vinyl products, or other aggressive chemical agents not compatible with PVC compounds.

i) All soil waste and vent pipes and fittings shall be installed plumb and true to lines and grades shown on the drawings or as directly by the Engineer-in-Charge.

ii) Where installed vertically, pipes shall be supported from wall by metal clamps of approved type and make at each floor just below the Horizontal branch pipe connection and at intermediate levels.

The spacing of vertical and horizontal pipe supports shall be 1.5 mm to 3 mm respectively and dia of steel support shall be 13 mm.

iii) Pipes passing through walls, floors or roof shall be placed in metal sleeves of approved design. The annular space between the sleeve and pipe shall be at least 15 mm. The space shall be packed with approved filler and shall be sealed at both ends with approved sealant .

iv) Drainage pipes shall be installed with a slope of not less than 1% unless specifically indicated otherwise on the drawings. Drainage pipes installed underground shall be minimum 2" diameter. Before installing any pipe, it shall be internally cleaned from dirt, debris, etc, by passing through it a cleaning cloth.

v) Pipes shall be installed in a neat manner with runs parallel and branching or changes in direction at 90 or 45 degrees. Change in direction and size, branching and jointing of pipes shall be made with regular pipe fittings (elbows, tees, reducers etc...). Pipe bending shall not be accepted. All elbows shall be long radius. All drainage fittings shall be long radius sweep type.

vi) Sleeves shall be supplied and installed wherever pipes cross slabs, walls, partitions, etc, Sleeves shall be cuts of galvanized steel pipes having an internal diameter of not less than 1 1/2" (4cms) larger than the outside diameter of the bare sleeved pipe or the insulated sleeved pipe.

vii) Floor sleeves shall protrude about 3/4" (2cms) above finished floor level and shall be flush with finished walls. Gaps between sleeves and pipes shall be filled with non-flowing plastic or waterproof mastic filler or paste.

14.1.4 STORAGE & HANDLING

14.1.4.1 PIPES

Handling Care should be taken when handling pipe and fittings. Excessive scratching or scoring harms the appearance and can also affect the joint sealing. Take extra care when handling pipe and fittings in wintry conditions. Cold weather reduces the impact strength of plastics. Use nylon belt slings, or forklifts with smooth forks, for mechanical unloading of block bundles. Metal slings, hooks or chains must not come into contact with pipes (see Figure A). Load and unload loose pipe by hand. Avoid using skids. When loose pipes have been transported one inside the other, always remove the inner pipe first.

14.1.2 STORAGE

Always store pipe on a reasonably flat surface free from sharp projections.

BLOCK BUNDLES

Block bundles can be stored up to 3m high without extra side supports or bearers. Block bundles will remain free-standing when cut. Take care when releasing bundles as the straps are under considerable tension and may flail when cut. Loose Pipes Loose pipe requires side supports at least every 2m. These supports should consist of battens at least 75mm wide. Ideally, support loose gutter or pipe uniformly throughout its entire length. If this is not possible, place timber supports at least 75mm wide at 1m maximum centers beneath the pipe different size pipe separately, or, if not possible, stack with larger diameters at the bottom. Maximum

stack size 7 layers or 2m high . Stack Socketed Pipe with sockets protruding and placed at alternate ends to ensure pipe is evenly supported.

14.1.3 FITTINGS

Store fittings supplied in plastic bags away from direct sunlight. If this is not possible, open bags to prevent a build-up of temperature. Fittings in cardboard packaging (e.g. Fire Stop Seals and Air Admittance Valves) should be stored under cover until required. Store degreasing cleaners, silicone lubricant, solvent cement and fillers in a cool place away from any heat source and out of direct sunlight.

14.1.4 JOINTING :

For jointing there are two types adopted as follow :

14.1.4.1.**RUBBER RING JOINTS**

The rubber ring joint is integrally moulded on one end of the pipe. The joint incorporates a factory fitted rubber sealing ring which is retained in position by a polypropylene lock ring. The opposite (spigot) end of the pipe is chamfered and has a “depth of entry’’ mark near the end. Each joint is capable of handling some expansion and contraction as well as angular deflection. The seal ring is designed to provide a watertight joint at high and low pressures.

14.1.4.2 **SOLVENT WELD JOINT**

Solvent cement jointing is a welding process and not a gluing process. If done correctly, separation will not be possible after the curing period. Jointing of pipe should be an interference fit between the components before solvent cement is applied. There are different solvent cements available for applications. Be sure to use the correct cement and that it has not “dried out’’ prior to use.

14.1.5 **TRAPS AND CLEANOUTS**

14.1.3.1 FLOOR TRAPS

Traps shall be of self-cleaning design, provided with water seal. Traps of the specified size used for underground installation shall be UPVC confirming specification EN 1329 & EN 1401 as under :

14.1.3.2 Floor Drains - Type FDV, FD

Supply and install all floor drains wherever shown on drawings and as specified .
Floor drains are to be bottom outlet for FDV, and horizontal outlet for FD, of type suitable for connection to UPVC non-pressure pipes, or approved equal.

14.1.4 FLOOR CLEAN OUTS

Supply and install all clean-outs wherever shown on the drawings and as specified herein. Each clean-out shall be of the same material and dimension as the pipe shall conform with the following requirements:

a. For pipes exposed or in false ceilings, clean-outs shall consist of a threaded cap screwed onto pipe end.

b. Floor **FCO** and wall clean-outs **WCO** shall consist of capped wide elbows ending under a chrome plated bronze tile 20 x 20cms with screwed cover or .

All cleanouts in the sewerage system shall be closed with brass screw caps. All brass screw caps shall be extra heavy and not less than 3 mm thick. Each screw cap shall have solid square or hexagonal nut not less than 25 mm high, with a minimum diameter of 38 mm. The body of the clean out ferrule shall be at least equal in weight and thickness as of the caulking ferrule for the same size of pipe as shown in the following table:

14.1.6 Roof Vents and Vent Caps

Supply and install all roof vents and vent caps wherever shown on the drawings and as specified herein.

a. Vent cap shall be full size of stack connected to it and provided with cap. UPVC with hooded vent cap.

b. Vent shall be provided with an extension nipple for fixing onto the vented stack.

14.1.7 INSTALLATION OF TRAPS, DRAINS AND CLEAN OUTS

i. Floor traps shall have openings for connection of inlet pipes from fixtures. The invert level of inlet pipes shall be at least 25 mm above the trap weir level.

ii. Floor traps shall be well set in position so that there is no leakage at the joint between trap and the floor. The requirements specified above for floor traps are equally applicable for floor drains except that no water seal is required and it shall be of the specified size.

iii. Roof drain shall have strainers extending at least 10mm above the roof surface immediately adjacent to them when installed on flat part. Bottom of strainer shall be flush with the roof surface when installed on vertical part. Strainer shall have an available inlet area, above roof level, of not less than 1-1/2”
times the area of the down-pipe to which the drain is connected. The connection between roof and roof drain shall be made watering by use of proper flashing material.

iv. Clean outs shall be turned up through floors by long sweep fittings, wherever the space so permits. Top finish of clean outs shall be flush with the floor when located in open area. They may not be flush with the floor when installed near wall and levels are not deep enough to make them flush.
Clean out shall be so installed that there is a clearance of at least 300 mm for pipe less than 75 mm diameter and at least 450 mm for pipes of 75 mm and larger diameter for the purpose of rodding. Permanent finishing material shall not be placed over clean out plug.
Clean out in open areas shall be placed in concrete boxes with access cover of heavy duty 300 x 300 mm size. Clean out near wall shall be embedded in concrete, and excepting cast iron pipe used with cleanout all other work of ferrule, plug, concrete work, frame and cover etc. shall be included under clean out item.

v. Gulleys shall be fixed on concrete foundation 300 mm square and not less than 150 mm thick. A brick curb in cement mortar about 75 mm high from the ground level shall be built round top edge of gulley in such a manner that surface water shall not be

allowed to enter the gulley. It shall be used for waste water only before entering into the manhole.

14.1.7 MEASUREMENTS

Traps, Vent Caps and Cleanouts shall be measured in numbers as per BOQ

TRAPPED FLOOR TRAP

- The floor gully is manufactured in robust ABS and complies with the relevant sections of BS 4514.
- Minimum 70mm deep-water seal providing maximum protection against seal loss due to evaporation and siphonage. Prevents possibility of foul air escape.
- Redesigned boss shoulders eliminate the use of adaptors for inlet connections.
- Can be used with both imperial and metric sized pipework.
- Accepts either plastic or stainless steel tile and grating.
- Simply extended by using 110mm plain ended pipe.
- The gully will not rust or corrode and is unaffected by domestic detergents.
- High temperature resistance.
- The unique design allows for the gully to be reduced in height when installed in shallow floor slabs.
- Manufactured as per approved manufacturer.

CHAPTER -15 WATER SUPPLY

15.0 PRESSURE PIPE FOR POTABLE WATER SUPPLY

15.1.1 PRESSURE UPVC PIPES AND FITTINGS

Supply and install all pressure UPVC pipes and fittings as specified& shown on Drawing as herein.

a. All pressure UPVC pipes shall be of extruded unplasticized Polyvinyl Chloride to BS 3505 class E or UPVC pressure pipes conforming to Pakistan Standard PS 3051 : 1 991 or approved equal International Standards. Fittings shall be of same material and pressure as pipe.

b. All joints shall be of the solvent weld joint.

15.1.2 Polypropylene Random (PPR)

Polypropylene pipe shall be of high grade polypropylene random (PPR), to comply with DIN 16962 appropriate to the service working pressure. The tube shall be provided in straight lengths form.

Joints and fittings shall be welded type, of the Saul material and type of the tube. Fittings shall consist of gunmetal bodies coated with polypropylene suitable to be welded to the tube at one end and to receive a threaded coupling at the other end.

Welding shall in all cases be carried out by skilled craftsmen who are in possession of a current certificate of competency issued by an approved authority. Specimen welds, representative of the thickness and diameter of the joints and the condition of site welding, shall be submitted as required by the Engineers in request of every craftsman employed in such work.

When the general hydraulic tests of the completed systems are carried out, each weld shall be lightly hammered whilst pressure is maintained. If any leaks occur, the portion of the weld near the leak shall be cut out and re-welded. Should a considerable portion of the welded joints made by a particular operative be found to be defective due to faulty workmanship, all such welds shall be cut out and re-welded by another operative whose work has proved satisfactory.

All expansion loops shall be proportioned such that the total stress set up in the material of the pipe wall; taking into account the components due to internal pressure, torsion and bending; is taken up in the geometry of the changes of direction.

All expansion loops shall be generally inserted in the pipe lines in such a manner that cold draw to extend of one-third of the anticipated expansive movement is taken up. Such conditions shall be agreed on the site with the Engineer at time that erection is taking place.

Expansion loops shall be factory fabricated of similar materials to the pipe work

15.1.3 PIPE HANGERS AND SUPPORTS

General Requirements

a. Supply and install pipe hangers and supports to properly carry weight of pipes and accessories without sagging as specified and required.

b. Hangers and supports shall be designed and tested to sustain a load 8 times the actual supported load, and shall be easily adjustable.

c. Hangers and supports shall be steel with smooth flat bearing surfaces and shall allow free movement of pipes due to expansion and contraction without any deformation. Hangers and supports for UPVC Pipes shall be of material, type and spacing strictly in accordance with manufacturer's recommendations.

d. Hangers and supports on insulated pipes shall have galvanized steel sheet protection saddles or shields, 3mm thick, 30cms long to fit outside diameter of insulation and cover 180° of arc.

e. Pipe anchors and guides shall be 3/4" diameter U-bolt.

f. Piping to be independently supported of equipment and located at adequate intervals to avoid air pockets and dirt traps. All branching shall be directly supported.

g. Spring cushions shall be used where pipe is subject to considerable vertical movement or vibration.

h. Insulated hot pipes shall be supported on a clevis hanger or pipe clamp lined with protection shields.

j. The contractor shall submit shop drawings for all types of supports showing construction details.

k. Hangers and supports locations shall be shown on shop drawings.

The following shall be used as a guide line. Manufacturer's recommendations shall be strictly followed:

Pipe Diameter	Maximum Support Spacing		Minimum Size of Hanger Rod
	Horizontal Pipes (cm)	Vertical Pipes (cm)	
1/2"	60	120	10 mm
3/4"	70	140	10 mm
1"	75	150	10 mm
11/4"	80	160	10 mm
11/2"	90	180	10 mm
2"	105	210	10 mm
3"	135	270	13 mm
4"	150	300	16 mm
6"	180	360	16 mm
8" and larger	215	360	16 mm

15.2.0 GAS UTILITY SERVICES

SCOPE

The work for piped utility services in buildings shall include furnishing of all labour, plant, equipment, materials and services and supplying, installing, testing and commissioning of cold and hot water supply and gas supply systems in the buildings as shown in the drawings, required as per specifications and or directed by the Engineer-in-Charge.

The gas pipeline and fittings shall be carried out strictly complying with the regulations of Gas Authority. Where required, the Contractor shall be responsible for their acceptance certificate for gas connection.

15.2.1 SUBMITTALS

The Contractor shall submit samples of fittings, fixtures and accessories to be incorporated into the works.

15.2.2 G.I. PIPES

i) The galvanized iron pipes shall conform to BS specifications No. 1387 for “Steel tubes and Tubulars, suitable for screwing to BS-21 pipe threads”.

ii) All screwed tubes and sockets shall have threads in accordance with BS-21. In order to prevent damage to the leading thread, the end of the sockets shall be chamfered internally.

iii) A complete and uniform adherent coating of zinc shall be provided for galvanized iron pipes.

iv) Every tube shall be tested at the manufacturer's works to a hydraulic test pressure of 5 MPa and shall be maintained at the test pressure sufficiently long for proof and inspection.

v) The threads of all tubes shall be effectively covered with good quality grease or other suitable compound, and each tube above 50 mm nominal bore shall have a protecting ring affixed to the un-socket screwed ends.

15.2.3 MEASUREMENT

G.I. Pipes shall be measured in Running Meters correct to cm.

15.2.4 FITTINGS AND SPECIALS

15.2.5 G.I FITTINGS

i) Malleable Iron Galvanized Fittings (i.e. coupling, elbows, tees etc.) for G.I pipes of diameter lower than 75 mm shall conform to BS-143/BS-1740 and shall be at least same thickness and quality as G.I. pipe.

ii) Cast Iron Threaded Flanges for joining G.I pipe of dia 75 mm and above shall conform to BS-4504.

iii) Cast Iron Flanged Fittings for G.I. pipe 75 mm and above shall conform to BS-2035, a working pressure 122 meters of water.

15.2.5 MEASUREMENTS

Cost of G.I fittings and Specials is included in cost of Pipes

15.3.0 SANITARY FIXTURES

15.3.1 WASH BASINS

The wash basins shall be glazed earthen ware in sizes and colours as specified and as per shown on drawing. The wash basins shall be of specified make as approved and the following shall generally be provided at the time of manufacture;

- A slot for the overflow shall be 6.3 cm (2.5") long and 13 mm (0.5") deep so designed as to facilities cleaning.
- Soap tray or sinking shall be provided as to drain into the basin.
- Tap holes shall be square to fit pillar taps shall be bevelled around the opening. They shall be so situated as to allow supply pipes to be clear of waste and vent pipes and shall have enough space to prevent the users striking the head on the tap.
- Waste hole shall have a minimum diameter of 6.3 cm (2.5"). The outlet shall be bevelled or rebated. The hole shall be square in shape and each side shall be 2.86 cm (1-1/8") length.
- Plug chain stay hole shall not be lower than the over flow slot. Back skirting shall be true to receive splash back.
- Stud slots shall be monolithically cast with the wash basin. These shall receive the brackets on the inside of the basin, shall be so situated that the brackets remain 5 cm (2") away from the face. These shall not exceed 13 mm (1/2") in dia 8 mm (5/16") in height and shall be 13.5 cm (12") from the back of the basin to the centre of the side.

b) Brackets

The length of the brackets shall be such as to enable 10 cm (4") embedding in the wall or fixed to the wall with the help of screws. Bracket shall be of painted iron on white porcelain enameled.

c) Pillar Taps

Pillar taps shall be manufactured from gun metal and shall be chromium plated. These shall be of screw type with jam nut. Internal dia of the tap shall be 13 mm (1/2").

d) Plug and Chain

Plug shall be of rubber. The diameter of the plug shall be such as to fit snugly in the waste hole. The chain shall be of brass, chromium plated, one end fixed to the plug and the other held in the chain stay hole.

e) Combined (Mixes) Supply and Waste Fitting

This shall comprise of 13 mm (1/2") combine taps with discharge nozzle and 3.17 cm (1-1/4") pop up waste. Waste outlet shall be screwed 3.17 cm (1-1/4") to B.S pipe male. All of these fittings shall be of gun metal with chromium plating.

f) Waste Pipe

This shall be either of PVC, nickel or C.P Brass and shall have diameter to fit at the bottom of the waste fitting flange. Its length shall extend from the bottom of waste flange to the floor.

g) Pedestal

Pedestal shall conform to the corresponding specifications of wash basin for composition, manufacture and quality. It shall be completely recessed at the back for the reception of supply and waste pipes. It shall be such that the basin is tightly and adequately supported and shall be so arranged that the height from the floor to the top of the rim of basin is 79 cm (31"). The Wash Basin shall be supplied complete with fittings and accessories as specified.

h) MIRROR (LOOKING GLASS)

One beveled 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.

i) KITCHEN SINKS

a) Sinks

Kitchen sink shall be stainless steel or glazed earthenware of approved make, single or double bowl with integral drain board. The sizes of the sinks shall be either 61 cm x 45 cm x 25 cm (24"x18"x10") or 51 cm x 101 cm x 25 cm (20"x40"x10") or 51 cm x 122 cm x 25 cm (20"x48"x10") or 82.5 cm x 4.5 cm x 2.5 cm (33”x18”x10”).

b) Brackets

The Brackets shall be either of such a length as to enable 10 cm (4") embedding in the wall or shall be such as to be fixed to the wall with the help of screws. The bracket shall be of painted iron or porcelain enameled.

c) Pillar Taps

Pillar taps shall be manufactured from gun metal and shall be chromium plated. These shall be of screw down type with jam nuts. Internal diameter of the taps shall be 13 mm (1/2"). **d) Plug**

The rubber or vulcanite plug shall fit in the waste pipe.

e) Waste Fitting Flanges

The waste fitting flanges shall be 85 mm (3-3/8) diameter, the tail 87 mm (3-1/2") long, screwed with 37 mm (1-1/2") B.S parallel thread and the sliding flange of back-nut of 81 mm (3-1/4") diameter.

f) Waste Pipe

This shall be either of PVC, nickel of C.P Brass and shall have diameter to fit at the bottom of the waste fitting flange. Its length shall extend from the bottom of waste pipe flange to the floor.

15.3.2 WATER CLOSETS

a) European Type Water Closets

The W.C shall be pedestal type white glazed earthen ware or of color as specified durable non-absorbent material with a water pool of good effective seal not less than 5 cm (2"). There shall be no sharp angles, the surface shall be so rounded as to be easily cleaned. The closets shall be of syphonic action or washed down type or as directed by the Engineer-in-Charge. Four holes 6 mm (0.25") shall be provided in the pedestal for fixing the W.C to the floor.

b) Indian Type Water Closets (Orisa Type W.C)

The water closets shall be of glazed earthen ware of color as specified nonabsorbent durable material. There shall be no sharp angles, the surface shall be so rounded as to be easily cleaned. The closets shall be embedded below the flow in lean concrete with its stop level with the floor. The foot rest shall be either integral part of the W.C or shall be provided separately in which case shall be of the same material as the pan.

c) Trap

The trap P or S for European type W.C shall be self- cleaning with a minimum water seal of 50 mm

(2") and made of the same materials as the pan. For squatting type W.C it shall be of cast iron.

d) Seat

The seat for the European type W.C shall be of approved quality backlite plastic seat with lid hinged and fixed to the closets by pillar bolts. The hinged device and pillar and nuts shall be of non-corrosive material. The pillar bolts shall be 6 cm (2-3/8") long and shall be held securely by the nuts underneath the pan seat plugs. The backlite seat should have rubber buffers securely fixed to the under-side to prevent damage to the pan. The seat cover shall be of the same material as that of the seat. The backlite cover shall have rubber buffers.

e) Flushing Cistern

i) Low Level Flushing Cistern

The low level cistern shall be of 10 liters (2.9 gallons) capacity. It shall be either of glazed earthen ware or PVC as approved by the Engineer-in-Charge, complete with all internal fittings. The bottom of the cistern shall be 30 cm (2.5 feet) above ground level.

The inlet to the cistern shall be controlled by 13 mm (1/2") ball wall and 13mm (1/2") stop cock both made from gun metal or brass. The cistern shall be silent filling with an over flow arrangement.

The cistern shall be supported on M.S or C.I cantilever brackets and painted with approved enamel paint with 10 cm (4") support in the wall or it may be attached to the wall with the help of rowl plugs.

The flush pipe shall be 30 mm (1-1/4") G.I or PVC painted with approved paint. Moulded rubber cone shall be provided for connection with the pan.

ii) High Level Flushing Cistern

High level cistern shall be manufactured from cast iron or pressed steel. It shall be painted with corrosion resisting paint. It shall discharge at the rate of 9 liters in 5 seconds.

The inlet to the cistern shall be controlled by 13 mm (1/2") ball wall and 13 mm (1/2") stop cock both made from gun metal or brass. The cistern shall be silent filling with an over flow arrangement 5 ft. – 6 inches from top of pan to bottom of cistern unless otherwise.

The cistern shall be supported on M.S or C.I cantilever brackets on wall at 5 ft. 6 inches from top of pan to bottom of cistern unless otherwise shown on drawings or approved by the Engineer-in-Charge and painted with approved enamel paint with 10 cm. (4") supports in the wall.

The flush pipe shall be 30 mm (1-1/4") G.I or PVC painted with approved paint. Moulded rubber cone shall be provided for connection with the pan.

The flush shall be operated by pulling a chain handle preferably by a thin rod with as few joints as possible.

a) **Soil Connection**

Ordinarily in case of European type W. C the closet shall have trap above the floor and the connection with the soil pipe through an external wall.

b) **Size of Closet**

Ordinarily the closet shall be 40 cm (16") on shorter side. For schools, nurseries 35 cm (14") 30 cm (12") and 25 cm (10") be adopted as per instructions of the Engineer-in-Charge.

c) **Connection of Water Closet with Soil Pipe**

If the trap is of earthen ware, it shall be connected with the water closet with 1:2 cement sand mortar joint. If the trap is of cast iron, it shall be connected with gaskets and 1:2 cement sand mortar joint.

d) **Connection between Trap and Soil Pipe**

Soil pipe is the pipe leading from trap to manhole.

If the trap is of earthen ware and the soil pipe is of cast iron then it shall be connected through C.I piece the joints between earthen ware and C.I piece be as per para (h) above. If the trap is of C.I it shall be connected with C.I soil pipe with ordinary lead metallic joint through a C.I connecting piece.

15.3.3 TOILET ACCESSORIES

a)TOILET PAPER HOLDER

The toilet paper roll holder shall be wooden/ plastic with either glazed earthenware or CP brass or plastic brackets and screws etc and shall be fixed in the wall adjacent to water closet.

b)SHOWERS

A shower head shall consist of corrosion resisting cast or fabricated sheet metal rose having perforations and shall be adjustable to give varying degrees of spray. Shower unit shall be complete with or without hot and cold water mixing arrangements and stainless steel rigid or flexible pipe extension and an additional low down water trap.

C) TAPS, COCKS AND MUSLIM SHOWER

All the taps, cocks and muslim shower shall be of brass, gun metal or other equally suitable corrosion resisting alloy conforming to BS 1010 and shall be chrome plated. The nominal size specified shall be the nominal bore of the seating. The water area of the way throughout the body shall be not less than the area of a circle of diameter equal to the nominal size of tap/cock/muslim shower. 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 1.96 MPa (284.4 psi). During test it shall neither leak nor sweat. The connecting pipe of muslim shower shall be of C.P Chain or of make approved by the Engineer-in-Charge.

d.) TOWEL RAIL, SOAP DISH& TUMBLER HOLDER

The towel rail shall be ¾ inches round or square C.P brass or stainless steel rod with end brackets and screws of similar material. Soap dish shall be straining type heavy duty glazed earthen ware, chromium plated stainless steel or plastic complete with screws. Tumbler holder shall be of glazed earthen ware, chromium plated, stainless steel or plastic complete with screws. Tooth brush holder with tooth paste dish shall be of glazed earthen ware, chromium plated stainless steel or plastic complete with screws etc

e) ABLUTION TAP/ SPRINKLER

Adjacent to the water closet, a water connection of ½ inch diameter for ablution will be either a C.P brass water tap or a water sprinkler with flexible pipe armoured with stainless steel strip.

f) GLASS SHELVES

Glass shelves may be provided below the mirror above the wash basin. The length of the shelf shall depend on the size of the mirror its width shall be 5 inches (130 mm) & thickness 6 mm and shall be held by 2 Nos. CP brackets. The shelf may be provided with CP railing.

15.4 MEASUREMENTS

All fixtures shall be measured in numbers

15.5 VALVES

A. General Requirements

Supply and install, wherever shown on the drawings and as specified herein, all valves and specialties. In addition to valves proper, this section is applicable to the strainers, safety valves, automatic air vents, float valves, etc,

The drawings indicate locations of major valves only. This does not limit the Contractor's responsibility to supply and install all valves and specialties specified separately under equipment or systems and in full compliance with the requirements of this section and the following stipulations:

a. Valves shall be designed for a working pressure of not less than 125 psi steam working pressure rating and 200 psi cold water non-shock pressure rating unless otherwise specified.

b. Valves 2" diameter and less shall be bronze, threaded ends.

c. Valves 2 1/2" diameter and larger shall be cast iron, flanged ends.

d. Valves on fire service pipes are to be of the indicating type.

e. Unless specifically stated otherwise, valves shall be of the same size as the pipes on which they are installed.

Whenever the pipe size on which valves are to be installed is larger or smaller than the equipment connection provided, an enlarger or reducer shall be first installed at the equipment connection to the required pipe size, after which the valves can be installed

f. A conical union shall be supplied and installed with each threaded valve.

g. Install silent check valves on pump discharge pipes.

h. Approved Manufacturers: As per specified or approved equal.

B. Gate Valves

Supply and install, wherever shown on the drawings and as specified herein, all gate valves.

Each gate valve shall conform with the following requirements:

a. Bronze gate valves shall have bronze body and trim and shall be non-rising stem, screwed bonnet and solid wedge disc.

b. Cast iron gate valves shall have cast iron body and shall be inside screw, non-rising stem, bolted bonnet, wedge disc and bronze trimmed.

C. Globe Valves

Supply and install, wherever shown on the drawings and as specified herein, all globe valves.

Each globe valve shall conform with the following requirements:

a. Bronze globe valves shall have bronze body and trim and shall be inside screw, rising stem, screwed bonnet and renewable composition disc.

b. Cast iron globe valves shall have cast iron body and shall be outside screw and yoke, rising stem, bolted bonnet, renewable bronze disc and seat ring and bronze trimmed.

D. Check Valves

Supply and install, wherever shown on the drawings and as specified herein, all check valves.

Each check valve shall horizontal or vertical lift, non-slam type and shall conform with the following requirements:

a. Bronze check valves shall have bronze body and bronze trim and shall be screwed bonnet and renewable composition disc.

b. Cast iron check valves shall have cast iron body and shall be bolted bonnet, renewable bronze disc and seat ring and bronze trimmed.

c. Silent check valves 2" diameter and under shall be non-slam, spring loaded, screwed, with bronze body, seat and disc, 18-8 stainless steel spring with body having 300 psi working pressure rating.

d. Silent check valves 2 1/2" diameter and above shall be non-slam, spring loaded, flanged, with cast iron body, bronze seat and disc, 18-8 stainless steel spring, with body having 250 psi working pressure rating.

e) Strainers

Supply and install, wherever shown on the drawings and as specified herein, all strainers.

Each strainer shall conform with the following requirements:

a. Strainers 2" diameter and under shall be bronze body, 150 psi steam working pressure, screwed, "Y" type with 20 mesh stainless steel screen and screwed end-cleaning cap with 1/2" tapped hole for blow down valve.

b. Strainers 2 1/2" and larger shall be flanged, cast iron body, 125 psi steam working pressure "Y" or basket type with 20 mesh stainless steel screen and bolted end-cleaning cap with 3/4" diameter tapped hole at bottom for blow down valve.

f) Float Valves

Supply and install, wherever shown on the drawings and as specified herein, all float valves.

Each float valve shall conform with the following requirements:

a. All bronze construction including levers and arms suitable for 150 psi cold water working pressure.

b. Balancing piston type flow control mechanism.

c. Adjustable bronze rod.

d. Copper float.

g) Safety Valves

Supply and install, wherever shown on the drawings and as specified herein, all safety valves. Each safety valve shall conform with the following requirements:

a. Bronze body and trim, suitable for 150 psi steam working pressure.

b. Adjustable, spring loaded relief mechanism testing arm.

c. Spring pressure adjusted locknut.

d. Relief outlet for piped connection.

Setting of safety valves shall be at 125% of the system operating pressure. After adjustment, the adjusting screw shall be locked by an adequate lead sealed wire.

h) Expansion Joints

Supply and install, wherever necessary and as specified herein, all expansion joints.

Expansion joints shall be installed on piping to relieve expansion stresses and shall be located at all structural expansion joints and on all straight runs of pipes at 30 meters intervals.

U-bends expansion joints may be accepted under certain conditions after written Engineer's approval.

Each expansion joint shall conform with the following requirements:

a. Pack less bellows type, monel metal for pressure pipes services suitable for 150 psi steam working pressure.

b. Packing type for gravity piped.

c. Expansion joints shall have screwed flanged or welding ends as required for the pipe size and system served.

I. Automatic Air Vents (AAV)

Supply and install, wherever shown on the drawings and as specified herein, all automatic air vents.

Each automatic air vent shall be completed as specified herein:

a. Cast iron body.

b. Standard float.

c. Single lever orifice vent.

d. Vent test cock.

e. Isolating valve.

J) Hose Bibs (HB)

Supply and install, wherever shown on the drawings and as specified herein, all hose bibs.

Each hose bib shall conform with the following requirements:

a. All brass, chrome plated construction.

b. 3/4" threaded end connection with serrated hose bib nipple for 3/4" hose connection.

K) Flexible Connections

Supply and install, wherever shown on the drawings and as specified herein, all flexible connections.

Flexible connections shall be installed on all pipe connections to rotating equipment. Each
flexible connection shall conform with the following requirements:

a. Seamless bronze tubing with annular corrugations covered with high tensile bronze braid suitable for 200 psi cold working pressure. Screwed ends for pipes 2" diameter and smaller and flanged ends for pipes 2 1/2" diameter and larger.

15. 6 MEASUREMENTS

Float Valve, Level Controller, Flow Switch, Fire Hydrants shall be measured in numbers

15.7 INSTALLATION OF FIXTURES

i) 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 painted so that there is no chance for dirt or vermin to collect.

ii) Where practical, all pipes from fixtures shall be run to the nearest wall.

iii) Where fixtures shall be rigidly supported by metal supporting members so that no strain is transmitted to the connections. Flush tanks and similar appurtenances shall be secured by approved non-corrosive screws or bolts.

iv) Fixtures shall be set level and in proper alignment with reference to adjacent walls. No water closet shall be set closer than 400 mm from its center to any side wall. No urinal shall be set closer than 300 mm from its center to any side wall or partition nor closer than 1200 mm center to center. No wash basin shall be set closer than 100 mm to the side wall or partition nor closer than 600 mm center to center.

v) The supply lines or fittings for every plumbing fixture shall be so installed as to prevent backflow.

vi) All cuttings and holes shall be made good.

16.0 SEWERAGE

SCOPE

The work covered by this section of the specifications consists in furnishing all reinforced concrete pipes, plant, labour, equipment, appliances and materials and in performing all operations required for installing and testing the sewer pipes in strict accordance with the specifications of this section and the applicable drawings and subject to the terms and conditions of the contract.

16.1.0 RELATED WORKS SPECIFICATIONS

- Section 3 – Earthwork
- Section 4 – Plain & Reinforced Concrete

16.1.1 SEWER LINES

MATERIALS

All materials used in the manufacture of reinforced cement concrete pipes for use shall conform to ASTM Designation C-76-03 or latest revision .

16.1.2 NON-REINFORCED CEMENT CONCRETE PIPES

The non-reinforced cement concrete pipes shall conform to ASTM C-14, latest revision Class II equivalent. Pipe ends shall be thus tongue and groove or bell and spigot. The physical dimensions shall be as described in applicable provisions of ASTM C-14.

16.1.3 REINFORCED CONCRETE PIPES

16.1.4 CLASSES OF PIPE

The reinforced cement concrete pipes to be furnished and installed shall be of the strength Class II or specified otherwise on the Drawings.

Following technical criteria shall be adhered to:

Class of Pipe	:	Class-II
Concrete Strength	:	4000 Psi (Cylinder Test)

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-76-82 or latest revision.

For pipes smaller than 12 inches dia BSS 556, Class-L shall be strictly followed:

16.1.5 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-76-79 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., and also pay for the carriage of such samples and all other expenses contingent to tests.

16.1.6 PIPE DIMENSIONS

The internal diameters and wall thicknesses of reinforced concrete pipes under this contract shall be as set forth in ASTM Designation C-76-82 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:

12 inch dia pipe	:	2.00 inch
15 inch dia pipe	:	2.25 inch
18 inch dia pipe	:	2.50 inch
21 inch dia pipe	:	2.75 inch
24 inch dia pipe	:	3.00 inch

16.1.6 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.

16.1.7 JOINTS FOR CONCRETE PIPE SEWERS

The joints for concrete pipes shall be as specified and could be as follows:-

a) 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.

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 exfiltration limits set forth hereinafter.

b) 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.
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 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.

16.1.8 INSTALLATION

a) 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.

b) 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.

C) Laying of Sewers

Neither any sewer pipe nor the bedding shall be laid or placed till the alignment of the sewer and its levels and gradients have been carefully checked and tested with the trench excavation and found correct.

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 open pipe shall be closed with a tapered wooden plug to keep out foreign matter.

16.1.9 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

.

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 timing the 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, it is not prohibited that it be repaired and retested 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 tested shall not exceed 700 ft.

ii) Determine the groundwater elevation at both ends of the test section. If the groundwater 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, it is not prohibited that it be repaired 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 permission 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 site Engineer-in-Charge prior to handing it over to the Owner.

16.2.0 MEASUREMENT

The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

16.2.1 UN PLACTICIZED POLYVINYL CHOLRIDE PIPES

The UPVC pipes to be furnished and installed shall be of the Class B to Class E, as specified on the Drawings. The design requirements for these classes of UPVC pipes shall be as described in Pakistan Standard Designation PS 3051 or British Standard BS 3505.

16.2.2 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.

16.2.3 PRESSURE TESTING

It is recommended to test the pipeline in accordance with PS standards 3051 and BS 3505.

16.2. 4 MEASUREMENT

The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed. The length shall be taken along the centre line of the pipes over all fittings such as bends, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

16.2. 5 MANHOLES

16.2. 6 MATERIALS

Portland cement concrete, and other materials shall meet the specified requirements of the relevant sections of the specifications, listed under clause 25.2 and elsewhere as necessary. Cast iron frame shall conform to the specifications as per B.S.S. 497, Manhole steps shall be of galvanized mild steel.

16.2.7 CONSTRUCTION REQUIREMENTS

Manholes shall be constructed built on 1:2:4 concrete base slab and as specified. The cover slab shall be 1:2:4 reinforced cement concrete, fitted with cast iron frame which shall have reinforced cement concrete cover as shown in the drawing. Reinforcement and concrete shall conform to the requirements or Section 4 – Plain & Reinforced Concrete. The outside and inside of the walls shall be plastered (½ inch thick) with 1:3 cement sand mortar and two coats of hot PB-4 bitumen shall be applied outside. At the bottom of manholes for sewers, a proper channel as per Drawings, shall be constructed in the whole length of the manhole along the centerline of the sewers, to lead the sewage from one sewer to the other. Galvanized mild steel steps shall be installed at 12 inches interval inside the manhole during the construction of the manhole walls. Cutting holes into the wall for the steps after construction will not be permitted. Top rung shall be 18 inches below the manhole cover and the lowest not more than 12 inches above the benching (floor).

Depth of manhole shall be from invert level of sewer to the top of manhole.

Where specified cast iron manhole covers conforming to the dimensions and weights as shown on drawings shall be used.

16.2.8 DROP MANHOLE

The Contractor shall construct drop manholes wherever shown in the drawings or ordered by Engineer-in-Charge. The Contractor shall make the drop connection as shown on the drawings or ordered by the Engineer-in- Charge.

16.2.9 MEASUREMENT

The manhole covers shall be enumerated under relevant items.

Manholes shall be enumerated under relevant items. The depth of the manhole shall be reckoned from the top level of C.I. cover to the invert level of channel. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

CHAPTER-17 ELECTRICAL WORKS

17.1 GENERAL

17.1.1 SCOPE

The work shall include furnishing of all labour, materials, equipment tools and plants as required and providing the internal electrification and other works as specified consisting of but not limited to conduits and pipes, wires and cables, wiring fixtures, lighting system, power distribution, fans, fittings, earthing system. The Contractor shall execute the works as shown on the Drawings specified herein and or as directed by the Engineer-in-Charge, and shall be responsible for proper functioning, testing, commissioning and satisfactory operation and performance during the maintenance period.

The Tender drawings, Specifications and bills of Quantities are to be considered as supplementing each other to jointly define and describe the Scope of work.

17.1.2. CODES AND STANDARDS

The work shall conform to the requirements of the following Codes and Standards, unless otherwise specified:

BS 31-79	Steel conduit and fittings for electrical wiring.
BS 3505-82	Un-plasticized PVC pipe for cold water services
BS 4607-71 (P- 2)	Rigid PVC conduits and Conduit fittings
BS 4752-77	Circuit breakers
BS 6004-84	Specification for PVC insulated cables for electric power and lighting.
BS 6360-81	Specification for conductors in insulated cables and cords
BS 6500-84	Specification for insulated flexible cords and cables
CP 1013-65	Earthing

17.1.3 QUALIFICATIONS

a) The Electrification Works shall be carried out by licensed workmen authorized to undertake such works under the provisions of Electricity Act, 1910 and the Electricity Rules 1937, as adopted and modified by the Government of Pakistan from time to time and registered with Pakistan Engineering Council PEC under relevant Category.

b) The installation in general shall be carried out in conformity with the Electricity Rules 1937, and the latest edition of British/Pakistan standard.

c) Any defective electrification work carried out by the Contractor shall be rectified or made good by the Contractor.

d) The electrical works shall keep pace with the civil works and the works of any other specialist contractor. The Engineer-in-Charge shall be kept informed about the programme and the progress of work so that there is no hindrance in the progress of work at Site.

17.1.4 SUBMITTALS

The Contractor shall submit for approval of the Engineer-in-Charge:

a) All drawings of equipment, appliances, fixtures and accessories that are to be furnished under the Contract. These shall include detailed electrical drawings, wiring diagram, foundation details, etc. for all electrical switchgear, fuse gear and all other systems.

Drawings and data for each equipment to be furnished before commencement of fabrication and manufacture. The drawings to be supplied by the Contractor shall be as follows.

b) Manufacturer's installation, operation and maintenance manuals wherever applicable.

c) Specimens of all wiring accessories, fittings, fixtures, conduits, pipes, wires, cables and all the materials to be incorporated into the Works along with specifications of each.

17.1.5 GUARANTEE

The Contractor shall furnish written guarantee against performance of each equipment. Such guarantee shall be for replacement and repair of a part or whole equipment which may be found defective in material or workmanship. The guarantee shall cover a minimum period of 12 months after commissioning of the equipment.

17.1.6 SHOP DRAWINGS

The Contractor shall provide following shop drawings for approval of the Engineer, well in time before commencement of work :

a.) Complete Conduit route between Distribution panels.
b.) LT Panel and distribution boards
c.) Equipment lay outs in Electrical and IT Room, including incoming and out going race ways & Connections.
d.) External Routes of LV and ELV services including Conduits and Man holes /Chambers.

17.1. 7 RECORD / AS BUILT DRAWING

The Contractor Shall submit the as built drawing in triplicate with Soft Copy for which no additional payment shall be made. The drawing shall provide an accurate and complete record of the work as installed.

17.1.8 CLEARING & PROTECTION

After Completion of the Project, the Contractor shall clean the exterior surface of equipment and fixtures including Concrete and Paint residue.
The Contractor shall protect the completed work from damage through out the contract period.
Deliver all the equipment & panels with Standard factory finish or as specified.

17.1.9. TEST, ACCEPTANCE & CERTIFICATES

All tests necessary and directed shall be performed before final acceptance of work in presence of the Engineer.

17.2 PRODUCTS

17.2.1 CONDUIT PIPES

a) PVC Conduit Pipe

The conduit for wiring of lights, socket outlets and other systems shall be made of PVC conforming to BS 3505 Class-0 electrical grade.

The conduit shall have following wall thickness and standard weights:

Pipe dia.	Weight / metre	Wall thickness
20 mm	0.111 kg	1 to 1.3 mm
25 mm	0.148 kg	1.1 to 1.4 mm

Bigger diameter PVC pipes shall conform to BSS 3505 and shall be Class-B which can withstand pressure of 6 Kg/ Sq.cm.

b) Steel Conduit Pipe

Steel conduit shall conform to BS 31. The conduit shall be enamelled with good quality noncracking and non-flaking black paint. Pipe bigger than 25 mm in dia shall be MS galvanized both inside and outside and shall conform to BS 31.

c) Flexible Pipe

Flexible conduit shall be spiral interlocked type made of steel strip construction and coated with zinc.

d) PVC Pipe and Accessories

The PVC pipe shall be rigid. All pipes shall be electrical grade, unless otherwise stated on drawings or bill of quantities. The buried PVC pipe should be able to withstand the external load acting upon it by continuous movement of heavy duty vehicles such as trucks. Cranes, forklift, etc. Where pipe change direction, manufactured smooth bends shall be used. Bending of pipes by heating or otherwise will be allowed in special cases only where bends cannot be installed as approved by the Engineer-in-Charge. The use of sharp 90-degree bends and tees will not be allowed. The bends shall conform to same specifications as given for PVC conduits for joining of pipe all precautions and procedures recommended by manufacturer shall be followed.

17.2.2 CONDUIT ACCESSORIES

a) Junction boxes shall be of the similar quality and properly sized to perfectly matched with the sizes of the conduit to which these are installed. Each junction box shall be provided with one piece cover which shall be fitted on the box with chromium plated screws.

b) Conduit accessories such as switch boxes, socket outlet boxes, pull boxes and inspection boxes shall be made of 16 SWG sheet steel having dust proof covers. All boxes shall have required number of conduit entry holes and earth terminals for connecting E.C.C. All the rectangular or square shaped boxes shall have nipples to receive PVC conduit with force fit. All these boxes shall be painted inside and outside with black enamel, over a base coat of red oxide antirust paint. Shapes and sizes of these boxes shall be determined on each application.

c) Manufactured smooth bends shall be used where conduit changes direction. Use of sharp 90 degree bends and Tees is prohibited. Bends shall have enlarged ends to receive the conduit without any reduction in the internal diameter of the PVC pipe.

d) All accessories e.g. boxes, couplings, bends, solid plugs, bushes, reducers, checknuts etc. shall be equal in quality to the specified conduit.

e) Where inspection boxes occur in floor slabs a special non- ferrous metal floor trap shall be required.

17.2.3 LT. CABLES

a) The Low Tension cables shall be manufactured to the requirements of B.S. 6004, B.S. 6500, B.S. 6346 or VDE 0271 and rated at 250/400, 300/500, 450/750 and 600/1000 volts as the case may be. The cables shall be manufactured by M/s Pakistan Cables limited, Fast Cables, Pioneer cables or M/s Newage Cables limited or equivalent as approved by the Engineer-in-Charge.

b) The conductors shall be annealed copper conductors single or standard, circular or shaped as the case may be, conforming to B.S. 6360.

c) The conductors specified for use in the cables shall be of at least 98% IASC conductivity.

d) The conductors shall be insulated with poly-vinyl chloride insulation. The minimum thickness of the insulation shall be in conformity with the specifications to which it is manufactured.

e) On all multi core cables proper markings for core identification shall be provided according to B.S. Specifications.

f) Power cables shall be multicore cables, insulated and sheathed, armored or unarmored as required.

g) Complete identification of the cable shall be embossed on the final over-sheath of the cable at every metre length.

h) All flexible cables shall have multi-stranded copper conductors insulated with PVC insulation. Where flexible cables are liable to rough handling, they shall have PVC sheath.

i) The following tests if required shall be carried out by the manufacturers:

- Dielectric Strength Test
- Instantaneous and long time break down strength test - Temperature rise test - High voltage test.

Test certificates covering all these tests shall accompany the cables supplied by the Contractor.

After carrying out the tests as laid down in these Specifications both ends of the cables shall be scaled at the manufacturer's works.

17.2.4 WIRING ACCESSORIES

a) Switches

i. ONE-WAY SWITCHES - INDOOR TYPE:

Switches for controlling light and fan points shall be single pole, rated for 5 Amps, 250 Volts A.C. The body of the switches shall be of Bakelite with white face plate suitable for flush mounting on a sheet steel outlet box. The switches shall be piano type having silver tipped contacts and shall operate with snap action. Switches manufactured by an approved manufacturer (M/s CLIPSAL, LEGRAND, BOCH or equivalent approved by the Engineer-in-Charge shall only be used.

a. Unless otherwise specified, wherever switches control only the light points, these shall be plate type gang switches installed on common outlet boxes.
b. Where specified metal front plates shall be used with single switches, the plate shall be finished in golden matt colour or as otherwise directed by the Engineer-in-Charge.
c. For locations where switches and fan regulators/Dimmer are installed together, single switches shall be grouped and fixed on 4 mm thick plastic sheet screwed to a sheet steel box of appropriate dimensions. Except for switches controlling light points, all single switches for fans, sockets, etc., shall have identification symbols on the operating levers.

ii. TWO-WAY SWITCHES – INDOOR TYPE:

Two-way switches for control of lights shall be of same make and specifications as for One-way switches except these shall be of use to control light circuit from two different locations.

SCREWS:

The fixing of switch plate on outlet boxes shall be by means of flat head countersunk galvanized screws with the head of the screw finished flush with the surface of the plate.

SWITCHES - OUTDOOR USE/WEATHER PROOF:

The switches shall be pole rated for 5 Amps, 250 Volt with cast iron or steel body and gasketed cover. The conduit entry hole in the body shall have long threads to provide watertight fitting. Sealing compounds for water-tight connection shall be used at conduit entry in the body of the switch.

b) Switch-Socket Outlets

Switch socket units shall be combined 2 and 3 pin 5 Amp or 3 pin 15 Amp 250 Volt A.C. molded type with switch and socket on white face plate conforming to the requirements stated above for switches-indoor type. The outlets shall be heavy duty type suitable for mounting on sheet steel outlet box. The 3 pin 15 Amps sockets shall have shrouded live contacts and be designed such that the earth pin of 3 pin plug is engaged to socket earth before mating of live contacts.

Where metal plate switches are installed, the outlets shall also be provided with front plate of similar design as the switches.

In general use of 2 pin 5 Amp 250 Volts socket outlets shall be avoided. Where such outlets are specifically required, these shall conform to the Specification of switches and/or switch socket outlets as applicable.

The 2 pin/5 Amps, 250 Volts sockets outlet, if required for mounting on board in the given areas, shall be of the same shape and dimensions as the piano switches installed with it.

The switch – Socket Outlets shall be of CLIPSAL, LEGRAND, BOCH or other equivalent approved by the Engineer-in-Charge.

c) Outlet Box

The outlet boxes for installation of switches, fan regulators/dimmer and socket outlets shall be 16 SWG sheet steel or of PVC as specified having appropriate dimensions. The box shall have suitable arrangement for receiving the conduit. An earth terminal shall be provided for connecting the earth wire. The outlet box shall be given two coats of anti-rust red oxide paint.

d) Ceiling Rose

The ceiling rose shall be suitable for 5 amps 250 volts single phase A.C. It shall have white plastic molded base plate, copper or brass terminals for wiring with 2.5 sq.mm cable. The ceiling rose shall have a cover with cable inlet hole.

The ceiling rose shall not embody any fuse terminal as an integral part of it.

e) Switches for Group Control of Lights

The switches for group control of lights shall conform to the same specifications as stated for miniature circuit breakers in section "*Distribution Boards"* of these Specifications. However, these shall not be provided with over-current protections. The switches shall be installed on sheet steel box with front plate and where stated in the Drawings.

f) Push-Button Station for Remote Control of Lights

These shall comprise of momentary contact ON - OFF push buttons, which shall control lights through contractors in L.T. Switch Boards/Distribution Boards. The push buttons shall have manufacturer furnished front plate suitable for mounting on an appropriate size sheet steel outlet box.

g) Lamp Holder

i. All lamp holder shall be 2 pin type and suitable for 5 watt to 200 watt 250 volts incandescent lamp.
ii. Lamp holder to be used with wall bracket shall be of brass pendant with good quality of porcelain assembly for connection cable and holding lamp.
iii. The holder of hanging lights shall be of backlite with ½" nipple to provide grip to the cord connected to the holder.
iv. For incandescent lamp 500 watt and 1000 watts screw type brass holder with good quality of porcelain assembly shall be used. The top of the holder shall have the porcelain nipple for isolating the cable from holder.

h) Screws

i. For fixing switch plates on the metallic boxes brass machines screw flat head not less 4 mm thick shall be used.

To cover the junction/pull boxes with plastic/MS Cover galvanize machine screw 5mm shall be used.

17.3.0 ELECTRICAL FIXTURES

17.3.1 FANS

a) Ceiling Fans

Ceiling fans shall be capacitor type, Energy Saver 55~60 watts, five speed suitable for 250 volts single phase 50 Hz. The air displacement shall be 330 cubic metre per minute for 1422 mm (56") sweep. The fan motor shall be capacitor type and bearing shall be groove type to give noiseless operation.

Fan dimmers rated for 100 W, 250 Volts of approved make (PAK fans, GFC, Millat or as approved by the Engineer-in-Charge could be used.

The fan hook shall be made of 16 mm diameter mild steel rod. It should be in the form of a loop about 75 mm long and about 50 mm wide. The rod should be bent to have at least 200 mm extension on both

sides for tying to reinforcement steel of slab. The fan and Dimmer shall be the first quality product from an approved manufacturer as above.

b) Wall Bracket Fans

Fan motor shall be capacitor type and bearing shall be groove type to give noiseless operation. The fan regulator shall be built-in type with high grade steel laminations and shall have five speed marks and one "OFF" mark. The fan shall be of an approved make.

c) Exhaust Fans

Exhaust fans shall be direct driven type complete with motor, angle iron frame, back draft dampers and mounting accessories. Blades shall be of steel and factory adjusted for pitch. Blades of back draft damper shall have a link rod and the design shall be such that damper remains in full open position without rattling when the fan is operating.

17.3.2 LIGHTING FIXTURES

a) Incandescent Light Fixtures

The glass globes/shades/diffusers of the incandescent light fixtures shall be of first class quality glass free from any air bubbles or voids. The glass shall generally be of opal white colour unless otherwise specified.

Surface mounted fixtures shall have white stove enamelled sheet steel body. It may also be satin brass or aluminium anodized finish as required. The fixing holes shall match the outlet box. Wall bracket light fixtures shall have back plates with matching holes of the outlet box and decorative finish as required.

All light fixtures shall have bi-pin brass lamp holders and LED Bulbs of approved type and make and shall be from an approved manufacturer conforming to BS 161. Light fixtures clear or frosted, shall have a minimum useful life of 1000 hours.

b) Fluorescent light Fixtures

All the light fixtures shall have LED lamps of the wattage specified. The fluorescent lamp shall be either 600 mm - or 1200 mm and the colour shall generally be day light, cool day light and/ or warm white with an average output pf 2600 lumens + (5%) for 1200mm and 1030 lumens (+ 5%) for 600mm. The fluorescent lamps shall be from an approved manufacturer conforming to BS 1853 and having a minimum useful life of 5000 hours.

The manufacturer shall be called upon to guarantee a trouble free life of 3 years, effective from the date of Completion Certificate.

The internal wiring of the light fixture shall be carried out at manufacturer's factory with heat resistance wires of size not less than 1.5 mm square.

The louvers of light fixtures shall be made of anodized aluminium and/or moulded plastic. The diffusers shall be made of acrylic perspex with a minimum sheet thickness of 3 mm.

The body of the light fixture shall be white or grey stove enamel as required. The industrial reflector shall have white stove enamel finish inside and grey / green stove enamel finish outside. Appropriate-sized bushed entry holes and fixing holes shall be provided. The thickness of the sheet steel used in the fabrication of the body and reflector shall not be less than 20 gauge.

The materials for louvers and paint of metal parts shall not deteriorate due to ultra-violet radiation from lamp with a minimum guarantee of 5 years. Pendent type fixtures shall have 2 Nos. 13 mm dia chromium plated pendent tubes for suspension or as per detail shown on the Drawings.

17.4.1 MAIN LT. SWITCH BOARD

a) General

The LT. switchboard shall be indoor type, free standing, self supporting, floor mounted, totally enclosed, sheet steel clad, dust and vermin proof, completely wired, factory assembled and suitable for operation on 3 phase 4 wire system, 415 V, 50 Hz, AC supply. The board shall be suitable for installation and capable of front attendance. The switchboard shall comprise of multi panels suitable for housing air circuit breakers, moulded case breakers or load break switches as shown on the Drawings. The switch board shall be designed to suit service conditions and ensure security and safety during operation, inspection, operation, cleaning and maintenance. The switch board shall be designed and tested to International Electro Technical Commission (IEC) recommendations. Each panel shall withstand a voltage of 2000 volts insulation level for one minute power frequency test. The switchboard shall be divided into panels and panels divided into compartments to accommodate the required number of circuit breakers of fuse switches, bus bars, instrument transformers, protective relays metres, etc.

b) Air Circuit Breakers

The Air Circuit Breaker (A.C.B) shall be triple pole of specified rating, fixed type, trip free, spring charged, quick make, quick break manually operated mechanism and visual ON/OFF position indicator. The circuit breaker shall be suitable for continuous duty for the rated current for indefinite period of time under service conditions. The circuit breaker shall have specified breaking capacity.

The A.C.B. shall conform to BS 4752. The contacts of the A.C.B. shall be heavy duty, spring charged and silver plated. Replaceable electric arc contacts and arc chutes shall be provided. The operating handles if made of metal shall be either earthed or additionally insulated to withstand full insulation voltage. A certified copy of full type tests carried out by an independent agency on identical breakers shall be acceptable in lieu of the following type and routine tests:

- Making capacity, breaking capacity and short time current tests.
- Mechanical and electrical life endurance tests.
- Temperature rise test.
- Power frequency withstand test. - Milli volt drop test.

c) Meters

The following instruments shall be included in the main switchboard unless otherwise specified: -

1 - KWH metre
- 1 - Voltmeter 0-500 volts
- 1 - Voltmeter phase selector switch
- 1 - Ammeter commensurate with rating of ACB
- 1 - Ammeter phase selector switch

All the instruments shall be flush mounted and back connected in a transparent dust proof cover with 96 mm or 144 mm Square dial which shall have prominent black graduations on white surface. The instruments shall be manufactured and tested in accordance with IEC Publications 51 or B.S. 89 Part 1.

d) Moulded Case Circuit Breakers

The moulded case circuit breakers (MCCB) shall be triple pole and of the rating specified on the drawings. The MCCB shall be fixed type, having trip-free, manually operated mechanism and on/off/trip position indicators. The MCCB shall comprise of adjustable hydraulic magnetic releases for overload protection and instantaneous adjustable electro-magnetic releases for short circuit protection. The tripping devices shall have related time current characteristics so that positive discrimination and selective tripping is obtained assuring the tripping under fault conditions of only the breaker in the circuit ahead of the fault location. The MCCB shall have a rupturing capacity of

35 KA (or as specified) and shall be manufactured and tested to IEC Publication 157-1 Part I or BS 4752 or BS 3871 Part I.
The MCCBs shall be of BOCH, CLIPSAL, LEGNOL or equivalent approved by the Engineer-inCharge.

e) Load Break Switches

The load break switches shall be on load type having quick make and quick break mechanism with spring loaded handles and ON/OFF visual indications. The load break switches shall be designed for continuous operation on rated current, rated voltage and rated frequency to BS 5419. The contacts shall be heavy duty made of silver plated copper having 98% I.A.S.C conductivity. When the operating mechanism is in "OFF" position, the fuses shall be completely disconnected. If the handle is metallic it shall be properly earthed. Electric arch chambers with replaceable arch chutes shall be provided.

The load break switches shall be of BOCH, CLIPSAL, LEGNOL or equivalent approved by the Engineer-in-Charge.

f) HRC Fuses

The HRC fuses shall be manufactured and tested to BS 88. A supplement of 100% spare fuses of each size shall be supplied with the switch-board.
The fuse carriers and bases shall be made from moulded phenolic compound and/or porcelain.

g) Bus Bars and Connections

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.

h) Enclosures

The enclosures shall be fabricated from 3 mm thick high grade sheet steel and shall be designed to house all the live parts which shall be accessible through front doors. The enclosures shall be tropical in design completely dust and vermin proof and liquid repellent, with special regard to danger of flashover both in service and in isolated position. Hinged lockable doors shall be provided on the front and bolted plates at the rear. Adequate air circulation by means of vent covered with suitable metal gauze shall be provided in the enclosures. All exterior and interior surfaces of the enclosure shall be thoroughly cleaned and freed of dust, rust and greasy matter. The enclosures shall be given three coats of paint. The primer shall be zinc chromate and/or iron oxide. The second and third coats shall be top quality battleship grey enamel. Enclosures for each panel shall be provided with designation labels as directed by the Engineer-in-Charge.

i) Earthing

The switchboard shall be effectively earthed at two points by means of a copper strip of suitable cross-section bolted to connections near the bottom of the switchboard.

j) Accessories

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

17.4.2 SUBMAIN BOARDS

The sub-main boards shall be similar to the Main L.T. Board and the components in its fabrication may differ and shall comprise of the components as shown on the Drawings. The rupturing capacity of each component for sub-main boards shall be as specified.

All other details and specifications as provided in sub-section 17.4.1 shall be applicable.

17.4.3 DISTRIBUTION BOARDS

a) General

The distribution boards (DBS) shall be either free standing, cubicle type or wall mounting type suitable for surface and/or recessed mounting. Each distribution board (d.b.) shall be tropical in design, fully dust and vermin proof and liquid repellent. The cabinet housing the main components shall be fabricated from mild steel sheets 16 SWG thick and reinforced with structural steel members welded to it. Front access, mechanically locked and hinged doors, fully gasketted, having one or two leafs depending upon the size of the cabinet shall be provided on each cabinet. All openable parts shall be provided with gaskets or lining and screwed to the main body with chromium plated screws. The cabinets after fabrication shall be thoroughly cleaned, completely derusted and degreased before applying one coat of zinc or lead-based primer. Two coats of top quality synthetic emulsion or stove enamel paint in battleship grey colour shall then be applied. All exposed parts of the dbs shall be covered with 5 mm thick bakelite sheet. A load distribution chart shall be provided in each db showing the areas fed by each circuit and a suitably sized pocket inside the front door shall be provided for the purpose. Each db shall be delivered complete with all instruments, accessories, rating plates as approved by the Engineer-in-Charge.

Suitable cable entry glands shall be provided as required for floor mounted boards on the incoming cables but for outgoing cables and/or wall mounted boards exact number of conduit entry holes as are required shall be provided with male brass bushes. The bushes shall be tin plated and fully shrouded or housed in gasketted compartments.

b) Components

The main components e.g. moulded case circuit breakers, load break switches, HRC fuses and instruments that are required for db's as shown on the Drawings shall be the same as described in sub-section 30.2.7.

c) Miniature Circuit Breakers (MCB)

The incoming line shall have triple pole mcb's suitable for use on 415V 50 Hz, AC whereas the outgoing line shall have single pole or single phase mcb's for use on 220V, 50 Hz, AC. The ratings shall be as shown on the Drawings and/or as directed by the Engineer-in-Charge.

The mcbs shall be moulded case type having hydraulic magnetic short circuit releases, contacts, operating mechanism and arcing chambers.

The mcbs shall be manufactured and tested to BS 3871 and shall have a rupturing capacity of 7.5 KA. The final circuit mcb, on the outgoing, shall however, be rated 5 KA. The mcb's shall be manufactured by an approved manufacturer whereas the distribution boards shall be manufactured by any approved manufacturer.

17.4.4 DISTRIBUTION BOARD DETAILS

17.4.4.1

LOCATION : BLOCK -1 GROUND FLOOR DB CODE : MDB-0/B1

IP CLASS	**1P-42**	**SUPPLY TYPE**	**NORMAL**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**60 A TP MCCB**	
CT		**3 X 60/5**	
INSTRUMENTS		**AMMETER, 0-60 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIP TO R3P	**15**	**SP MCB**	**GENERAL POWER**
Y3P	**15**	**SPMCB**	**SPARE**
B3EXL	**15**	**SPMCB**	**EXTERNAL LIGHTING**
C1	**20**	**TP MCB**	**DB-1 /B1**
C2	**20**	**TPMCB**	**DB-2/B1**
C3	**20**	**TP MCB**	**SPARE**

17.4.4.1

LOCATION : BLOCK -1 GROUND FLOOR DB CODE : MDB-0/B1

IP CLASS	**1P-42**	**SUPPLY TYPE**	**EMERGENCY**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**30 A TP MCCB**	
CT		**3 X 30/5**	
INSTRUMENTS		**AMMETER, 0-30 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIP	**15**	**SP MCB**	**WATER DISPENCER**
Y1P	**15**	**SPMCB**	**WIFI OUT LETS**
B1P	**15**	**SPMCB**	**SPARE**
RIL TO BIL	**10**	**SP MCB**	**LIGHTING**

R & Y	10	SPMCB	SPARE
B1EXL	10	SP MCB	EXTERNAL LIGHTING
C1	20	TP MCB	DB-1 /B1
C2	20	TPMCB	DB-2/B1
C3	20	TP MCB	SPARE

17.4.4.2

LOCATION : BLOCK -1 FIRST FLOOR DB CODE : DB-1/B1

IP CLASS	1P-42	SUPPLY TYPE	NORMAL
FORM TYPE	2A	Ics (kA)	15
CABLE ENTRY	BOTTOM	CABLE EXIT	BOTTOM /TOP
MOUNTING	SURFACE		
A INCOMING			
CIRCUIT BREAKERS		20 A TP MCB	
CT		3 X 20/5	
INSTRUMENTS		AMMETER, 0-20 I NO + ASS	
B OUT GOINGS			
CIRCUIT NO	CIRCUITBREAKER RATING (A)	CIRCUIT BREAKER TYPE	REMARKS
RIP TO R3P	15	SP MCB	GENERAL POWER
R4P TO B4P	15	SPMCB	SPARE

LOCATION : BLOCK -1 FIRST FLOOR DB CODE : EDB-1/B1

IP CLASS	1P-42	SUPPLY TYPE	NORMAL
FORM TYPE	2A	Ics (kA)	15
CABLE ENTRY	BOTTOM	CABLE EXIT	BOTTOM /TOP
MOUNTING	SURFACE		
A INCOMING			
CIRCUIT BREAKERS		20 A TP MCB	
CT		3 X 20/5	
INSTRUMENTS		AMMETER, 0-20 I NO + ASS	
B OUT GOINGS			
CIRCUIT NO	CIRCUITBREAKER RATING (A)	CIRCUIT BREAKER TYPE	REMARKS
RIP	15	SP MCB	WATER DISPENSER
YIP	15	SPMCB	WIFI OUTLETS
BIP	15	SPMCB	SPARE
RIL TO BIL	10	SPMCB	LIGHTING

17.4.4.3

LOCATION : BLOCK -1 SECOND FLOOR DB CODE : DB-2/B1

IP CLASS	**1P-42**	**SUPPLY TYPE**	**NORMAL**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**20 A TP MCB**	
CT		**3 X 20/5**	
INSTRUMENTS		**AMMETER, 0-20 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIP TO R3P	**15**	**SP MCB**	**GENERAL POWER**
R4P TO B4P	**15**	**SPMCB**	**SPARE**

LOCATION : BLOCK -1 SECOND FLOOR DB CODE : DB-2/B3

IP CLASS	**1P-42**	**SUPPLY TYPE**	**NORMAL**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**20 A TP MCB**	
CT		**3 X 20/5**	
INSTRUMENTS		**AMMETER, 0-20 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIP	**15**	**SP MCB**	**WATER DISPENSER**
YIP	**15**	**SPMCB**	**WIFI OUTLETS**
BIP	**15**	**SPMCB**	**SPARE**
RIL TO BIL	**10**	**SPMCB**	**LIGHTING**
R2L	**10**	**SPMCB**	**CENTRIFUGAL FAN**
Y2L & B2L	**10**	**SPMCB**	**SPARE**

17.4.4.4

LOCATION : BLOCK -2 GROUND FLOOR DB CODE :EMDB-0/B2

IP CLASS	**1P-42**	**SUPPLY TYPE**	**NORMAL**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**40 A TP MCCB**	
CT		**3 X 40/5**	
INSTRUMENTS		**AMMETER, 0-40 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIP	**15**	**SP MCB**	**WIFI OUT LET**
Y1P	**15**	**SPMCB**	**WATER DESPENSER**
BIP	**15**	**SPMCB**	**SPARE**
RIL TO R2L	**10**	**SPMCB**	**LIGHTING**
Y2L	**10**	**SPMCB**	**SPARE**
B2EXL	**10**	**SPMCB**	**EXTERNAL LIGHTING**
C1E	**20**	**TP MCB**	**DB-1 /B2**
C2E	**30**	**TPMCB**	**DB-2/B2**
C3E	**20**	**TP MCB**	**SPARE**

17.4.4.5

LOCATION : BLOCK -1 FIRST FLOOR DB CODE : DB-1/B2

IP CLASS	**1P-42**	**SUPPLY TYPE**	**NORMAL**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**20 A TP MCCB**	
CT		**3 X 20/5**	
INSTRUMENTS		**AMMETER, 0-20 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIP TO R2P	**15**	**SP MCB**	**GENERAL POWER**
Y2P TO B2P	**15**	**SPMCB**	**SPARE**

17.4.4.5

LOCATION : BLOCK -1 FIRST FLOOR DB CODE : EDB-1/B2

IP CLASS	**1P-42**	**SUPPLY TYPE**	**NORMAL**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**20 A TP MCB**	
CT		**3 X 20/5**	
INSTRUMENTS		**AMMETER, 0-20 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIEP	**15**	**SP MCB**	**WIFI OUT LET**
Y1EP	**15**	**SPMCB**	**WATER DESPENSER**
RIL TO R2L	**10**	**SPMCB**	**LIGHTING**
Y2L & B2L	**10**	**SPMCB**	**SPARE**

17.4.4.6

LOCATION : BLOCK -2 FIRST FLOOR DB CODE : DB-2/B2

IP CLASS	**1P-42**	**SUPPLY TYPE**	**NORMAL**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**20 A TP MCB**	
CT		**3 X 20/5**	
INSTRUMENTS		**AMMETER, 0-20 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIP TO R2P	**15**	**SP MCB**	**GENERAL POWER**
Y2P & B2P	**15**	**SPMCB**	**SPARE**

17.4.4.6

LOCATION : BLOCK -1 SECOND FLOOR DB CODE : DB-2/B2

IP CLASS	**1P-42**	**SUPPLY TYPE**	**EMERGENCY**
FORM TYPE	**2A**	**Ics (kA)**	**15**
CABLE ENTRY	**BOTTOM**	**CABLE EXIT**	**BOTTOM /TOP**
MOUNTING	**SURFACE**		
A INCOMING			
CIRCUIT BREAKERS		**30 A TP MCB**	
CT		**3 X 30/5**	
INSTRUMENTS		**AMMETER, 0-30 I NO + ASS**	
B OUT GOINGS			
CIRCUIT NO	**CIRCUITBREAKER RATING (A)**	**CIRCUIT BREAKER TYPE**	**REMARKS**
RIEP	**15**	**SP MCB**	**WIFI OUTLETS**
Y1EP	**15**	**SPMCB**	**WATER DISPENCER**
B1EP	**15**	**SPMCB**	**SPARE**
RIL TO R2L	**10**	**SPMCB**	**LIGHTING**
Y2L	**10**	**SPMCB**	**CENTRIFUGAL FAN**
B2L	**10**	**SPMCB**	**SPARE**
CIE	**25**	**TPMCB**	**LIFT**

17.5.0 EARTHING SYSTEM

a) General

The earthing system shall consist of earth electrodes, earth connecting points, earthing leads, earth continuity conductors and all accessories necessary for the satisfactory operation of the associated electrical system. The earthing system shall also comply with the requirements of CP-1013.

b) Earth Continuity Conductor

The earth continuity conductor (ECC) shall be green or green/yellow coloured PVC insulated copper wire of sizes indicated on the Drawings. The ECC shall comply with the specifications as given for single core cable in Section 30.2.3. For bonding of miscellaneous metalwork, the size of ECC shall be as specified. All sockets, lugs, thimbles etc., shall be provided for a complete earthing installation.

c) Earth Electrodes

The earth point shall comprise of a 600 x 600 x 5 mm electrolytic copper plate, tinned for protection against corrosion. The edges of the copper plate shall be chamfered. The plate shall have holes for connecting each earthing lead or tape to earth terminals. The terminals shall comprise of 16 mm dia. copper bolts and nuts and double spring washers. 13 mm dia G.I. Pipe with a tee at the top end shall be provided for watering purpose during dry season.

d) Earth Connecting Point

The earth connecting points shall comprise of tinned copper bar, rectangular in shape, having dimensions of 350x50x6mm, if not otherwise specified. Terminals for connection shall be arranged as required.

The terminals shall have brass or tinned copper bolts, nuts and washers for protection against corrosion. A hole shall be provided in the centre of the copper bar for fixing to the wall by means of 10 mm dia nut and bolt using brass or tinned copper washers.

e) Earthing Lead

The earthing lead shall connect the earth electrode to the earth connecting point. It shall be of round hard drawn bare electrolytic copper wire of the size shown on the Drawings.

f) Earthing by Earth Rods

The earth rod shall be of mild steel and shall be protected against rusting by a thick exterior layer of copper (not less than 0.33 millimeter), permanently molten or electrolytically deposited on a high strength steel core which shall provide rigidity for easy driving without bending.

g) Earth Rod Dimensions

The earth rod shall have a nominal dia of 16mm with chamfered head of 2mm x 45 chamfer. The overall length of earth rod shall be 3000 + 5mm.

17.6.0 LIGHTING PROTECTION SYSTEM

a) Applicable Standards/Codes

Latest editions of the following standards and codes shall be applicable for the material specified within the scope of this section.

BS 6651	:	Protection of structures against lightning
CP 326	:	Protection of structures against lightning (code of practice).
IEC 1024-1	:	Protection of structures against lightning

b) Material

i) General

The installation of lightning protection system shall comprise; -

Lighting arrestors - Down/Roof conductors.

- Testing terminals
- Earth electrodes ii) Air Terminals

The Air Terminals for lightning protection system shall be solid copper to ensure good corrosion resistance. The thread should be roll formed for maximum strength, with a bronze nut. The terminal base and the plate type test clamp shall be cast gun metal, designed with appropriate section thickness, mechanically strong, corrosion resistant with low electrical resistance. All other accessories for fixing of air terminals to the concrete surface and/or roof conductor/down conductor shall be of copper or brass, as approved by the Engineer-in-Charge.

iii) Down/Roof Conductors

The down/roof conductors for lightning protection system shall be bare copper conductor of sizes as per approved shop drawings. All connections between metal work on the roof shall be with the same conductor sizes and material as for roof conductor. All accessories for fixing of copper conductor to concrete surface shall be of copper or brass as approved by the Engineer.

iv) Testing Terminals

For each down conductor, a testing point shall be provided. It shall be installed 1.5 meters above the finished floor level or as convenient for testing purposes and as directed by the Engineer-inCharge. The testing terminals shall have removable connections.

v) Earth Electrode

The earth electrode for lightning protection system shall comprise 3 meter long, 14 mm dia. copper clad or galvanised steel rod having flat head at drive end and pointed conical tip at the driven end.
The tip shall be hardened to facilitate driving. At the top of the pipe, a clamp for bolted connections shall be provided suitable for connection to the down conductor.

a) Air Terminals

The Air Terminals shall be installed on the roof as per approved shop drawings. The terminal base shall be firmly secured to the concrete surface. It should be ensured that air terminals and/or roof conductors/down conductors shall be firmly fixed together, so that electro dynamic or accidental mechanical forces will not cause any damage to the clamping. The materials used shall withstand the electromagnetic effects of lightning current and predictable accidental stresses without being damaged.

The Contractor shall submit the fixing arrangement for the approval of the Engineer-in-Charge. **b)**

b.) 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.

c) 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.

d) Earth Electrode

In case the soil conditions at site permit, the earth electrodes may be installed by hammering the electrode in soil, until the top of the pipe is about 300 mm below the proposed ground level. If hammering down is not possible due to site conditions, a pit shall be first excavated in bare ground upto the required depth and electrode shall be installed upright in the pit. The excavated pit shall be backfilled in layers of 500 mm, each layer tamped and compacted. At the ground level an inspection chamber of cement concrete shall be constructed having dimensions as shown on the drawings. The inspection chamber shall have a cover supported on angle iron frame. The cover shall be approved by the Engineer-in-Charge and shall finish flush with the ground level.

17.7 Fire Alarm System

17.7.0 GENERAL

17.7.1 RELATED DOCUMENTS

A. Manuals, brochures, technical submittals and general provisions of the Contract, including general and Special Conditions, apply to this Section.

17.7.2 SUMMARY

A. This section includes the intelligent addressable fire alarm and detection system for ensuring safety and asset protection.

17.7.3 SUBMITTALS

A. Submit the product information for approval and final documentation in the quantities listed.

B. Documents for Approval:

1. Bill of material
2. Technical specifications of all the material
3. Connectivity diagrams
4. Any variance (in case of deviation from the given specifications)

C. Final Documents: Record documentation to include:

1. Documents listed above.
2. Recommended spare parts list for start-up support

3. Instruction manual

4. Testing Certificates

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm with at least 15 years experience in manufacturing fire alarm detection system.

B. Supplier is to have a local service team with available spare parts in Lahore, Pakistan.

C. Service personnel are to have at least 10 years in the installation, start-up and servicing of the said system.

1.6 WARRANTY

A. The manufacturer's standard warranty shall in no event be for a period of less than 36 months starting from beneficial use of the equipment. Submittals received without written warranties as specified will be rejected in their entirety. Maintenance during reliability period shall also be covered in the warranty section.

17.7.2 SCOPE OF WORK

17.7.2.1 GENERAL

The contractor shall supply and test the complete fire alarm system as described herein and as shown on the plans. The system shall include Intelligent Addressable main control panel, Addressable smoke sensors, Multi/heat sensors, wiring, termination, electrical boxes, and all other necessary material for a complete operating system.

The supplier has to verify that complete installation shall confirm to the applicable sections of NFPA72, NFPA-71, EN-54 and BS-5839.

The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of storing, and downloading while the system is in operation, a second set of operating software resident in the control panels as backup in case primary operating software is corrupted. In addition, the system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operation shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate changes in, for instance, sensing of normally open contact devices to sensing of normally closed contact devices or from sensing of normally open contact devices to sensing a combination of current limited and non-current limited devices on the same circuit.

The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of creating an event history of 600 events.

The activation of any system smoke detector shall initiate an alarm verification operation whereby the panel will reset the activated detector and wait for a second alarm activation. If within one minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described in the sequence of operation. If no second alarm occurs within one minute the system shall resume normal operation. The Alarm verification shall operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately. The Alarm verification operation shall be selectable by zone.

A manual evacuation switch shall be provided to operate the alarm indicating appliances without causing other control circuits to be activated. However, should a true alarm occur, all alarm functions service conditions including the time of each occurrence.

The system shall have a single key that will allow the operator to display all alarm, troubles, and supervisory service conditions including the time of each occurrence.

The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

The system batteries shall be supervised for disabling and enabling all circuits individually for maintenance or testing purposes.

The panels shall be capable of networking upto 99 more nodes as nodes as and when required without modification of hardware except adding network cards.

17.7.2.2 SEQUENCE OF OPERATION

Upon actuation of any manual station, or automatic detector or sprinkler flow switch, or air conditioning and ventilation duct return and exhaust air smoke detector. The system is to operate as follows:

On the Main Panel the green normal LED is to extinguish and the red alarm LED is to light. The first line is to display the user specified message indicating the floor and zone that initiated. The first line is to display the user specification message indicating the floor and zone that initiated the alarm. The second line of the LCD is to indicating real time, number of messages waiting, type of alarm, zone of alarm and time the alarm occurred. Red LED corresponding to the zone in alarm in the main panel shall also be lit.

The alarm indicators on the FACP and repeater panel to continue to flash until the alarm is acknowledged . If a subsequent alarm is received after acknowledgment, the alarm is to sound again. The operator is to acknowledge the alarm by pressing a dedicated button and the buzzer is to silence provided that isn't an additional alarms the operator is to acknowledge all pending alarms before the buzzer is to silence. To reset the system the device is to be cleared first then the reset button is to be pressed.

The alarm shall consists a "slow whoop" alarm tone, for ten second. The tone shall repeat continuously (unless manually silenced) until the alarm initiating device is restored to normal and system reset. The silencing of an alarm condition is not to prevent the resounding of alarm devices if a subsequent condition occurs. A time delay feature is to be provided to sound a general evacuation alarm automatically throughout the building if the initiating alarm condition is not responded to within a predetermined time. Visual indication at the panels, corresponding to activated voice alarm circuits is to illuminate.

17.7.2.3 POWER REQUIREMENTS

The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 230VAC power in a normal supervisory mode for a period of 24 hours with 30 minutes of alarm operation at the end of this period. The system shall automatically transfer to the stand-by batteries upon power failure. All battery charging and recharging operations shall be automatic. Contractor shall submit standby and alarm power calculations in support of the selected battery size. The batteries used for the system shall be maintenance free type.

17.7.2.4 FIRE ALARM CONTROL PANEL

The control panel shall be Intelligent Addressable type of adequate point capacity with 20% spare and the construction shall be modular with solid state, microprocessor based electronics. It shall display only those primary controls and display essential to operation during a fire alarm condition.

A local audible device shall sound during alarm, trouble or supervisory conditions. The audible device shall sound differently during each condition.

The following primary controls shall be visible through a front access panel:

- Eighty character liquid crystal display.
- Individual red system alarm LED.
- Individual yellow supervisory service LED.
- Silent Walktest with History Logging

The system shall be capable of being tested by one person. While in testing mode the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. The panel shall automatically reset itself after logging of the alarm. The panel shall also be capable of giving an alert alarm in case if any addressable device is not in operation or requires maintenance.

17.7.2.5 MULTIPLE ADDRESSABLE PERIPHERAL NETWORK

The system must provide communication with initiating and control devices individually. All of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:

- Alarm
- Trouble
- Open
- Short
- Device missing/failed
- Automatic environmental compensation.
- Variable Sensitivity setting
- Day & Night mode of operation
- Automatic dirty sensor indication

All addressable devices shall have the capability of being disabled or enabled individually.

Each loop to have a minimum capacity of 200 devices with detector & control modules in any combination. System that require factory reprogramming to add or delete devices are unacceptable. Each loop to have 25% spares available. Vendor to increase the no. of loops, if required.

Each addressable device must be uniquely identified by an address code interred for each device. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact. The system must verify that proper type device is in place and matches the desired software configuration.

17.7.3 -ADDRESSABLE DEVICE TYPES

17.7.3.1 GENERAL

The system control panel must be capable of communicating with the types of addressable devices specified below. Addressable Devices will be located as shown on the drawings. The system shall identify when a smoke sensor becomes too dirty to operate properly. It shall also identify sensors which are almost dirty which need cleaning before they drift beyond their selected sensitivity. In short, a review of the front panel display or the printed status report quickly identify sensor that need cleaning.
Sensitivity of the sensor shall a programmable, photoelectric shall be variable from 0.2 to 37 percent and ionization sensitivity from 0.5 to 1.7 percent. It shall also be possible to programme for timed, automatic sensitivity selection such as less sensitive during working hours and more sensitive when quite.

The panel shall provide the following features:

- Individual sensitivity selection for each sensor

- Peak value logging allowing accurate analysis for sensitivity selection
- Automatic, once per minute individual; sensor calibration check to verify sensor integrity
- Display of sensitivity directly in per cent per foot
- Multi-stage alarm operation
- Ability to display and print detailed sensor information

17.7.3.2 ADDRESSABLE SENSOR BASES

The addressable sensor bases shall contain integral addressable electronics that constantly monitor the status of the detachable photoelectric, ionization or heat sensors. Each sensors output shall be digitized and transmitted to the control panel every four seconds.

It shall be possible to use different sensor types with the same base. The base shall have integral LED for power-on (pulsing), or alarm or trouble (steady on). The bases shall be available with connections for remote LED alarm indicator or connections for supervised remote replay. The sensor bases shall be size not more than 125mm diameter.

Address of the device shall be set in the base using dip switches so that removal or replacement of the sensor head will not affect the operation of the system. Device addressed through software or address set in the sensor head are not acceptable. Soft addressable sensors are also will be acceptable subject to compliance with other requirements of the specifications.

17.7.3.3 ADDRESSABLE OPTICAL SMOKE SENSORS

Optical sensor shall use a stable, pulsed infra red LED light source and a silicon photodiode receiver to provide consistent and accurate low power smoke sensing. Seven levels of sensitivity shall be available for each individual sensor, ranging from 0.2% to 3.7% per foot of smoke obscuration. It shall be possible to select and monitor the sensitivity at the control panel.

The head be designed to allow 360 deg. Smoke entry for optimum response to smoke from any direction. A built-in screen shall keep insects from entering the smoke chamber.

17.7.3.4 ADDRESSABLE OPTICAL HEAT SENSOR

The addressable type heat sensor shall be self restoring and provide a combination of rate and fixed temperature rate compensated sensing. It shall have low thermal mass to accurately and quickly measure the local temperature at the fire alarm panel.

It shall be possible to select the rate of rise temperature detection for either 15 ºF or 20 ºF per minute. Fixed temperature sensing and shall be programmable to operate at 135 °F or 155 °F. It shall be possible to program these sensors as a utility device to monitor for temperature extremes in the range from 32 ºF to 120 ºF (optional).

17.7.3.5 INTELLIGENT OPTICAL MULTI SENSOR

The Addressable Multi Sensor gathers analog information from one photoelectric fire sensing element and one heat sensing element and converts it into digital signals. The sensitivity of the Device shall be variable. The Addressable code for the Device shall be electronically programmed and stored in the Sensor and be non-volatile. The programming of this code shall be facilitated by a digital electronic hand held Device.

•	Sensitivity	variable
•	Operating voltage	24VDC
•	Standby Condition	≤100µA
•	Alarm Condition	≤7mA
•	Transmission Method	Digital Communications

- Maximum Humidity 93% RH- Non Condensing (at 40◦C)
- Temperature range -10◦C - + 50◦C
- Smoke Sensing Element: Photoelectric - Light Scattering Principle
- Heat Sensing Element: Fixed temperature alarms at 135°F (57°C) ambient **3.6**

17.7.3.6 ADDRESSABLE PULL STATION

They shall be manufactured from high impact red lexan. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations shall be double action type requiring smashing glass and pulling a lever to initiate an alarm.

The device shall integral electronics for constantly monitoring the status of the device and communicating the same to the control panel. Address of the device shall be set by dip switches in the associated electronics.

17.7.3.7 ADDRESSABLE DEVICE SUPERVISION

All devices shall be supervised or trouble conditions. The system control panel will be capable of displaying the type of trouble condition (open, short, device missing, failed). Should a device fail it will not hinder the operation of other system devices.

17.7.3.8 NOTIFICATION APPLIANCES

Notification appliances shall include visible, audible or Audible / visible as shown in the drawing. Audible appliance shall be loudspeaker or dc vibrating bells and the visible appliance shall be strobes. The sounders must be capable of projecting the pre-recorded voice messages. The prerecorded messages shall be in various languages i.e English , Urdu or any other as specified by the end user.

17.7.3.9 STROBES WITH SOUNDER (SINGLE UNIT)

Strobes shall be suitable for wall or ceiling mounting as shown in the drawings. Xenon flash tubes shall be 24VDC powered from the panel. Visible output shall be 30 candela. The reflective design shall provide light output in key axis directions allowing vertical or horizontal mounting. The unit shall be of red finish with white 'FIRE" lettering . Flash rate shall be 1 Hz.

17.7.4 INTEGRATION

Fire Alarm system shall be integrated with Emergency Voice Evacuation system, Access control system and Building Management system for sequential operations and status monitoring.

17.8 DATA & VOICE SYSTEM

17.8.0 GENERAL

17.8.1 DESCRIPTION:

A. The Work shall consist of furnishing and installation of voice and data communication cabling as shown on the drawings and specified herein.

17.8.2 REFERENCES:

A. ISO – International Standards Organization

ISO/IEC 11801 Information Technology – Generic Cabling for Customer Premises

B. IEC - International Electrotechnical Commission

IEC 60603-7 Connectors for Electronic Equipment – Part 7-1 & 7-7

IEC 60332 Test on electric cables under fire conditions

IEC 60754 Tests on Gases Evolved During Combustion of Material from Cables

EIA/TIA 568-B.3 Optical Fiber Cabling Components (ANSI)

C IEEE - Institute of Electrical and Electronic Engineers

ICEA S-83-596 Standard for Fiber Optic Premises Distribution Cable

1.3 SUBMITTALS:

A. General: Submit the necessary complete sets of documentation indicating type, size, rating, style, catalog number, Manufacturers names, photographs and / or catalog data sheets for all items to ensure compliance with Specifications. This documentation shall be subject to the approval of the Owner Representative and no equipment shall be ordered without his approval for all equipment and devices, which are shown on documents (drawings, BOQ, etc). During technical submittal stage, contractor shall submit all required technical document for study and approval.

B. Product Data: Submit manufacturer's technical product data, including:

1. Compliance sheet to the specification with cross reference to related items in data sheet, point by point, indicating deviations, if any, with reasons for such deviations, also indicate any extra features / specifications.

2. Complete one-line riser diagram(s) showing all system components

3. Complete description data including UL listing or any equivalent standards for all system components

4. Provide all system related calculations supported by manufacturer specific software and perform all necessary calculations validating the shop drawing system distribution and related installations.

5. Complete description and data including related standards for all system components.

6. Submit Wi Fi Coverage patterns and accordingly modify, add, relocate wi fi outlets to provide full coverage of the building enabling VOIP over Wi Fi network in all building areas.

C. Shop Drawings: Provide shop drawings & Composite drawings showing equipment, device locations, labeling, part number and connecting wiring of the systems, including riser diagrams, rack elevations etc. Shop drawings shall include, but not be limited to the following:

1. Installation details for all system components. Installation details drawings shall show all accessories used in installation such as back boxes, glands, washers, etc.

2. Complete Grounding details as per system manufacturer requirements.

D. Manuals: Submit complete manufacturer Installations, maintenance and operation manuals including spare parts list for each system component, including furnished specialties and accessories. Include this data, product data, and shop drawings in the manuals in accordance with other relevant documentation.

1.4 WARRANTY:

A. The manufacturer must guarantee to the End User that the products referenced within the specific Warranty Modules (Class E System) when correctly installed in accordance with installation guidelines for a duration of 20 years

B. All components including the patch cords have to be produced by the same cabling system manufacturer to ensure warranted performances and applications against the standards.

1.6 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: The items provided under this contract will be from manufacturers that have a minimum of 5 years experience in producing the types of systems and equipment specified.

B. Installer Qualifications: Specialist subcontractor with at least 5 years of successful installation experience with projects utilizing data system similar to that required for this project. Subcontractor shall be subject to approval of Engineer.

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. The voice and data communication cabling shall consist of horizontal and backbone cables and connecting hardware to transport data (including LAN/WAN) and voice (telephone) system signals between related as shown on drawings. Numbers of outlets shall be as shown on drawings and documents. The Data Local Area Network (LAN) Sub-Contractor shall coordinate his work with telephone equipment Sub-Contractor(if any).

C. The Data Network will perform all switching and routing functions for voice, video and data services and applications. The network shall serve all IP based services such as VOIP, IP CCTV, IPTV, etc, as applicable.

D. The Core Switches will be located at the heart of the network and shall provide very fast switching, intelligent high performance platform for deploying numerous concurrent intelligent services without degrading the overall performance of the network. The core switches shall perform various functions using various service modules for wan interfaces, security firewalls…etc. Core Switches should support MPLS and act as P-Routers.

E. Connectivity between DC Switches and Core Switches should be based on 40G/ per BOQ/Risers.

F. Connectivity between Core Switches and Distribution Switches should be based on 40G/ per BOQ/Risers.

G. Access Switch: Access Switches will be located per per BOQ/Risers/Dwgs.

P. The maximum allowable horizontal cable length is 90 m. This maximum allowable length does not include an allowance for the length of 4.9 m to the workstation equipment. The maximum allowable length does not include an allowance for the length of 4.9 m in the horizontal cross connect.

Q. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

R. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

2.2 GENERAL:

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be of latest technology/version available at the time of installation, and has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and standards specified.

2.3 HORIZONTAL CABLING:

A. Horizontal Distribution Cable:

1. Horizontal distribution cable shall be Category 6.

2. The cable shall be a four, thermoplastic-insulated, individually twisted pairs of copper conductors; No.23 AWG, color-coded; enclosed in PVC jacket or a material.

3. Cable shall be designed to support the IEEE 802.3 1000Base.

4. All pairs must have impedance of 100 Ohms, with a tolerance of +/- 15

Ohms. In the construction of the cable cross-talk performance shall be maintained using a C3 (Central dielectric Cross-talk Cancellation) member set between the 4 pairs.

5. Insulators in standard Blue/White, Orange/White, Green/White, Brown/White colors must cover the conductors.

6. Cable shall be of latest technology/speed manufactured and available at the installation time.

7. Cable shall be used for horizontal run between data, voice (telephone), clock and security system outlets and floor communicable cabinet.

10. Meet the following electrical characteristics per consultant's recommendations (if any):

Max DC Resistance (@ 20°C) <8.5Ω /100m

Characteristic Impedance

(no impedance averaging allowed) 1-100 MHz: 100 ohms ± 15%

100 - 750MHz: 100 ohms ± 22%

Nominal Velocity of Propagation (NVP)

LSOH – 67%

11. Provide the following 100m, 4-connector topology performance (std ref. values in grey cells):

2.4 BACKBONE CABLING:

A. Data Backbone: This backbone will link the Switches located in the Floor Distributors (FD) to the

Data network server through the Building Distributor (BD).

1. Optical Fiber Cable: The cable shall be suitable for connector manufacturer termination processes (LC, SC or ST connectors). Fiber splicing method should be used for termination of Fiber Cables using fiber pigtails manufactured by the same vendor.

Construction: Tight buffered with water blocking Aramid/Glass yarn reinforcements or tape and shall be suitable for indoor or outdoor use making it ideal for short campus links without the use of transition joints. The cable strength member shall be glass yarn laid longitudinally between the fibers and the inside wall of the outer jacket. The cable shall be dielectric construction, i.e. with no metallic content. The cable shall be a dry construction i.e. with no gel content. The jacket material shall be waterproof LSZH with a minimum fire performance of IEC 332 part 3C.

2. Single Mode Fiber Optic Cable

a. The Cabling system must be designed and installed according to ISO 11801 OS1 for indoor use, and ISO 11801 OS2 for outdoor use, compliant and should also meet EN50173 2nd editions and TIA/EIA 568B3. The Cable shall have 6 or 12 or 24 cores, 9.2/125 µm universal distribution cable with improved performance.

b. Low Smoke Zero Halogen - LSZH Jacket that does not give off toxic fumes in case of fire and offer flame propagation retardant properties.

c. Shall contain a Rip Cord applied longitudinally under the cable jacket for easy cable jacket removal.

d. Shall contain a lightweight Central Strength member located in the middle of the fibre bundles.

e. Shall contain both colour-coded buffered fibres as well as colour- coded buffer tubes.

f. Cables shall have length markings in 2 ft. increments.

g. Fibre will be available in strand counts of 4, 6, 12, 24, 36, 48, 72, 96, 144 and 288.

h. Shall meet these minimum performance parameters per standards specified above.

3. Optical Fiber Patch Panel:

a. Optical fiber Patch Panels shall be mounted in 19" frames of the cabinets. The patch panels shall be equipped with a mechanism that ensures the retention and support of incoming cables. An Earth Key shall be provided within the patch panel to earth any metallic part of the cable. The patch panel shall be designed with a sliding mechanism enabling front side installation and maintenance work to be carried out without having to remove the entire panel.

b. The patch panel shall provide facilities to recess the front connector plate deeper than the front of the 19" rails of the cabinet. This will provide sufficient bend radius for the patch cords once connected to the panel. This shall also prevent damage to the patch cords when the cabinet doors are closed.

c. Direct Termination of the connectors on to the fibers as well as splicing of pigtails shall be possible. The Patch Panel shall provide management for 1m of fiber per link after breaking the fibers out from the cable. The Patch Panel shall support the connector type specified for this installation. For multimode fiber links, these can be LC, SC and ST. The panel-mounted couplers shall be protected on the front presentation side of the patch Panel for safety purposes.

4. Optical Fiber Patch Cords

a. The Fiber adapters will be connected to the active equipment by means of duplex patch cords 2LC-2LC, 2 SC-2 SC or 2 ST-2ST as per client site standard.

b. The patch cords consist of 50/125 microns fibers and a LSHF-FR jacket. The SC or ST connectors shall comply with the International standard IEC 74-13. The patch cords should be available in lengths of 2 and 5 meters.

c. To avoid mix of patch cords built around different types of fiber, cords produced with LASERoptimized fiber will be used for both OM1 and OM2 optical fiber cables. When using OM3 optical fiber cables, patch cords produced with the same OM3 fiber have to be installed.

d. Fiber cables shall interface and connect to fiber interface unit at both ends as part of the fiber contractor work.

2.5 CABINETS:

A. The metal cabinets shall have a footprint of 800x1000 mm. In the frames 19” components can be mounted by means of the standard cage nuts. The front door consists of a metal framework with hinges and a central perforated panel. The side panels and the panel in the back have to be equipped with a hinge on the left or the right in order to facilitate the access to the equipment. A 42 U cabinet is preferred providing enough space for active equipment.

B. For an orderly cord storage and easy to manage installation, the following accessories shall be used:

- Closed 1 or 2 U patch guides between the patch panels;
- Lateral cable rings installed at both sides of the frames. The patch rings can be removed very easily by rotation and have to be located on the front rails of the 19" frames in the cabinets.

The cabinets should be supplied with:

- Provide power strip with 8 * 240VAC BS 1363 electrical sockets, No ON/OFF switch, 3-meter power cord and commando socket (male) at the end. Female commando outlet to be provided by the electrical contractor.
- Provide seismic kit, casters, leveling feet, and bolt down stabilization bracket for each cabinet.
- Provide Horizontal/Vertical Cable Management. 1 RU of cable management per 24 port patch panel and 1 RU above and below per 48 port patch panel.

C. Earthing has to be achieved .The cabinet and frame assembly when installed will also serve as equi-potential plane so that damaging external EMI currents can be drained off. To this end, the inter-cabinet connections shall also be made off by extending the earth connection from cabinet to cabinet in a suite of cabinets. The suite of cabinets shall be connected to the grounding network of the building.

D. The Earth key of the cabinet must be connected to the protective earth. The dimension of the earth conductor is 6mm². If no or only a poor protective earth system is present in the building, a separate earthing to the main earth terminal of the building is required. The dimensions of the conductor should then be 16mm².

3.1 INSTALLATION:

A. The entire system shall be installed by specialist subcontractor approved by the Engineer.

B. Installation shall be in accordance with the approved drawings and manufacturer's written instructions.

C. System components and appurtenances shall be installed in accordance with ISO/IEC 11801, manufacturer's written instructions and as shown on drg. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables.

D. Horizontal Distribution Cable: The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 300 mm shall be maintained when such placement cannot be avoided. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

E. Riser and Backbone Cable: Vertical cable support intervals shall be per manufacturer's recommendations. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced.

F. Data Outlets: As a minimum each jack shall be labeled as to its function and a unique number to identify cable link. Minimum of 6 inches of slack cable loosely coiled into the data outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

G. Unshielded Twisted Pair Patch Panels: Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 percent spares. Cable guides shall be provided above, below and between each panel.

H. Fiber Optic Patch Panels: Patch Panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant plus 10 percent spares. A slack loop of fiber shall be provided within each panel. Loop shall be

900 mm in length. The outer jacket of each cable entering a patch panel shall be

secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.2 ELECTRICAL SAFETY:

A. Separation of telecommunication circuits from the building electrical system and electrical equipment shall conform to the latest publications of Articles 800-3 (a) and 820-13 of National Electric Code (NEC) / per consultant's recommendations.

B. An earth or ground shall be provided and extended to the termination box and connected to each station protector. The earth or ground shall be installed and bonded in accordance with Article 250, 800 and 820 of National Electric Code (NEC)/ per consultant's recommendations.

3.3 TESTING (per consultant's recommendation):

A. General: After installation of entire system and prior to acceptance of work, manufacturer's standard tests shall be conducted in the presence of the Engineer to show proper operation of each equipment and the system entirely. The manufacturer of the cabling system shall provide copper (Data)

and optical fiber testing procedures that clearly describes the tools and settings to be used to ensure correct measurements of the system. The result of testing shall meet or exceed the requirements of ISO/IEC 11801, latest edition and ISO/IEC TR 24750.

B. Testing of Class E: 100 % of the installed horizontal links shall be tested. The testing procedure has to comply with the standard ISO/IEC 11801: 2002 for Class E, according to the procedure for "Channel or Permanent Link". The measurements shall be done using Level III testing equipment. Channel testing shall be preferred. Channels shall be tested to support 10 G 500 MHz

The complete test results of all the installed links or channels shall be collected in a certification file.

C. Vertical Fiber Testing: The procedure shall comply with the ISO/IEC 14763-3 standard. The ISO/IEC 14763 standard specifies the implementation and operation of customer premises cabling. The part 3 of this ISO document (14763-

3) Details test procedures for optical fiber cabling designed in accordance with ISO/IEC 11801:2002 and installed according to the recommendations of ISO/IEC 14763-2 (Planning and installation of customer premises cabling).

For Multimode fibers, the test procedure is based on the use of the "one-jumper method" specified by Method 2 of IEC 61280-4-1. This procedure is used for testing links for which the connector loss is a significant portion of the total link attenuation. This is the case for LAN premises links.

For Single mode fibers, the test procedure to be applied is the same and is based on the use of the "one jumper method" specified by Method 1a of IEC 61280-4-2.

Fiber-optic Tests applied to links and exclude equipment and work area cord.

OF Attenuation testing is used to verify the initial performance of the installed link. All 100 % of the installed OF links have to be tested and must pass the acceptance criteria.

The attenuation of the link is measured using the insertion loss method. This method uses an optical source and an optical power meter to compare the difference between two optical power levels.

When testing multimode optical fiber links with a Light Source and a Power Meter, this measurement kit has to be capable of operating at …

- 850nm and 1300nm for multimode fibers (OM1, OM2 & OM3)
- 1310nm and 1550nm for single mode fibers (OS1)

The test scenario with a Light Source and a Power Meter shall be one of the following for each link:

- Single direction @ 850nm and @ 1300nm for multimode fibers
- Single direction @ 1310nm and @ 1550nm for single mode fibers

The use of certification tool is recommended. Those tools are capable of producing a report logging the time of the test the link identification under test, the link length, the attenuation at the window tested and the acceptable link attenuation. The report shall also identify in which direction the testing was implemented.

17.9.0 CCTV System

1.0 IP BASED CCTV SYSTEM

1.1 SCOPE OF WORK

The scope of the work includes the installation, testing and commissioning the complete CCTV system as described herein and as shown on the plans. The system shall include NVRs, PTZ cameras, Dome Cameras, Box type cameras, PTZ controller, LCD screens, wiring, termination, electrical boxes, and all other necessary material for a complete operating system.

1.1.1 FIXED DOME / BOX TYPE IP COLOUR DAY/NIGHT CAMERA

The fixed camera should have the following features:

- Directly IP based without requirement of encoder.
- Day / Night camera. Should switch automatically to monochrome mode (black and white) at night.
- Imaging Device 1/3 inch complementary metal oxide semiconductor (CMOS) or charge Coupled Device (CCD) with wide dynamic range (WDR)
- Image Control with Automatic white balance (AWB), automatic back light compensation (BLC), automatic gain control (AGC)
- Iris setting should be auto/manual with definitions for sharpness, image quality and also time stamp and camera ID.
- Minimum Illumination should be:

  Color mode: F1.4 @ 0.1 lux (.01 fc)
  Black and white mode: F1.4 @ 0.04 lux (0.004 fc)

- Vari-focal CS mount lens 3.5mm to 50mm required
- Supported Video Compression should be H.264 and Motion JPEG (MJPEG)
- 704 x 576 @ 25 fps PAL (minimum required)
  1920 x1080 @ 25 fps PAL (maximum required)
- Should support dual Video Streaming with both streams originating independently from the camera
- Should support multicasting
- Should support Power over Ethernet (PoE) 802.3af
- Should provide at least two digital inputs and two digital outputs for hardwire integration.
- Camera should provide 802.1X authentication
- Camera should support at least 128 bit encryption using hardware-based Advanced Encryption Standard (AES)

- Multiple user access levels with password protection.

1.1.2 PAN/TILT/ZOOM DAY/NIGHT INDOOR/OUTDOOR COLOUR DOME CAMERA

The PTZ Camera should have the following features:

- The camera should be IP based.
- The camera should be true outdoor model suitable for use in Pakistan.
- It shall be a discreet camera dome system consisting of a dome drive with a variable speed/high speed pan/tilt drive unit with continuous 360° rotation.
- Imaging device should be 1/3 inch CCD and support both color and monochrome black and white. With 540 TVL horizontal resolution.
- Should provide 27x optical zoom and 12x digital zoom (minimum) with auto focus feature
- The camera should provide high-quality MPEG-4, MJPEG or H.264 compressed images.
- The camera should provide images @ 4CIF i.e. with a resolution of 704x576 pixels in PAL mode.
- The supported frame rate should be 30ips or 25ips in PAL mode.
- The camera should support two simultaneous streams
- Should support Day/Night mode and should switch automatically to monochrome mode at night with below 1 lux sensing at variable shutter speeds.
- Should provide super quick, 400° per-second pan and 200° per-second tilt speeds with 256 pre-set positions. Each pre-set position should support the programmable camera settings such including selectable auto focus modes, iris level, Low Light limit, and backlight compensation for each preset.
- Should support wide dynamic range (128x) appropriate for high contrasting environments
- Should support Automatic focus, automatic Iris control, gain control horizontal and vertical aperture control.
- Should be installed in a High-impact, weather-resistant dome enclosure
- Camera must provide at least 7 Inputs and 2 outputs that can be programmed individually. Inputs should be able to trigger an alarm condition. Outputs should be able to drive an external device.
- Should support intelligent privacy masking by providing 8, four-sided user-defined shapes, each side with different lengths; window blanking setting to turn off at user-defined zoom ratio; window blanking set to opaque gray or translucent smear; blank all video above user-defined tilt angle; blank all video below user-defined tilt angle .
- Should support at least 8 user-defined programmable patterns including pan/tilt/zoom and preset functions, and pattern programming through control keyboard or through dome system on-screen menu

- Should support a web interface utility for 5 simultaneous users when using MJPEG/MPEG-4 in uni-cast mode. When configured in multicast mode (MPEG-4), the camera should support an unlimited number of users.
- Should support On-screen display for time, date and location. The position of the display and text should be user definable.

- Should support On-screen display of compass heading and user-definable compass setup so as to indicate direction that the camera is looking in.

- Should support multi level password protection.

- Should support Secure Sockets Layer (SSL) 128 bit encryption

1.1.3 VIDEO MANAGEMENT AND RECORDING SYSTEM

The Video Surveillance Management platform should be optimized for applications to view, store, and manage real-time and recorded video in a networked environment. The system should use an open suite of URL-based programmatic interfaces to communicate with applications. The system shall provide a highly scalable and reliable platform to enable customized, network-based surveillance applications. The Video Surveillance Management platform shall include but not limited to the minimum of the following features/functions/specifications:

- The system shall display any combination of live and recorded camera feeds on multiple workstations simultaneously using an IP network.

- The system shall provide low latency video with high quality images and support H.264, MPEG-4, and Motion-JPEG compression schemes simultaneously.

- The system shall provide replication of individual video feeds at different frame rates for multiple users and other system processes.

- The system shall support simultaneous video feeds across multiple locations for centralized and decentralized storage, display, and distribution of video without limitation, but shall minimize load on video servers by streaming only the active video channels.

- The system shall be capable of streaming and recording video at different bit rates and variable frame rates up to full motion 25 fps (PAL) video on all camera feeds and shall support QCIF, CIF, VGA (640x480 pixels), D1 (720x576pixels) and 4CIF (704x576 pixels) camera resolution.
- The system shall provide the ability to remotely configure the cameras and shall allow configuration data to be imported from a spreadsheet.

- The system shall allow instant replay of video and will permit pausing of live video, forward and backward review of recorded video, and return to live viewing.

- The system shall manage storage of real-time video at any specified frame rate, duration, and physical location on the network.

- The system shall provide flexible archiving capability in terms of frame rate, duration, and location and shall utilize dynamic file allocation to ensure that the full duration of the selected video stream will be recorded, regardless of lighting condition, motion, or scene detail.

- System shall support access to the archived video, to seek to any point in the archive, to set the pre and post time, and to loop that segment of the archive.

- The system shall cater for redundant multi-site video storage. Meaning that the video feeds coming from the sites must be stored on primary and backup storage.

- The system shall provide a Management Console that shows the status of CPU, Memory, Disk Usage, and traffic analysis.
- The System shall support H.264 Compression Protocol and 128 bit encryption. The system shall provide diagnostic tools that support Simple Network Management Protocol (SNMP).

- The system shall provide for integration with other software applications through an open and published Application Programming Interface (API). Such applications shall include, but not be limited to, access control, video analytics, and other alarms and sensor inputs.

- The system shall be capable of running on a single physical server or distributed across the network, scaling to handle thousands of cameras and users.

- The system shall provide for or have the capability of interoperating with the functional modules providing the capability for multiple web-based display consoles to configure, manage, display, and control video throughout the IP network; multiple options to store video and audio; virtual matrix switching; client PC viewing; and, remote encoding and storage.

- The system shall be capable of simultaneously supporting 3rd party IP based cameras from a variety of different vendors.

The system shall provide the following administrator functionalities:

- Secure login
- Server, encoder, and camera administration
- Scheduled and event-based video recording
- User and role management
- Fine-grained activity reports and system audit
- Ability to push pre-defined views to any number of digital monitors with Virtual Matrix Ability to schedule to operator shifts, event filters, temporary views.

The operator workstations running as part of the Video Management System shall provide the following operator functionalities:

- Secure login
- Flexible video displays
- PTZ controls including presets and advanced camera options (e.g. focus, white balance, iris)
- Digital zoom and instant replay
- Create instant recordings, “Record Now”
- Client-side video enhancements (adjusting brightness, color, transparency, etc.)
- Instantly swap between live and archive video of the same camera feed
- Archive review and clipping
- Event notifications
- Ability to search archived video based on motion within a predefined window within the video frame
- Synchronize playback of multiple archives

Supported file format types shall include or as per BOQ**:**

- WMV - A standard file format for downloading and playing audio/video data or to stream data on a PC.
- AVI - A standard file format for storing audio/video data on a PC.MP2
- Clip (BWM) - A segment of video extracted from an existing stream-able archive.

- Digitally Signed Clip (BWX) - A segment of video extracted from an existing stream-able archive and signed with a digital signature to verify content has not been tampered with.

Operator Workstation:

- The minimum configuration of the Operator workstation PCs and the Video Wall PCs shall be or as per BOQ:

    - workstation based on the new Intel® X38 Express performance chipset and the latest workstation-class dual core Intel processors:

    - Intel's Core™ 2 Duo (2.83 GHz, 4 MB L2 Cache) or better
    - DDR-2 800 MHz ECC

- Should include the following Components or as per BOQ:

    - 160 GB SATA 3 GB/s NCQ 7200, 1st HDD
    - Intel Core 2 Duo E6850 3.0 4 MB/1333 CPU
    - 2 GB (2x1 GB) DDR2-800 ECC Memory
    - 768 MB PCIe Graphics
    - Microsoft Windows XP Pro 32-bit OS

    - Graphic card: NVIDIA®, GeForce® FX 5700 Ultra, FX 5900 Ultra or FX 5950 Ultra, Matrox Parhelia™, ATI RADEON® 8500,9500,9800

- The Operator workstation PC and the Video Wall PC will be separate and the two applications will not be combined on the same PC.

The minimum configuration of the Management and Recording servers shall be:

- Rack mounted, high end server - Multi processor based on a latest Intel processor.
- Minimum 2 GB of RAM
- Network adapter 1000 Mbps Ethernet
- Standard sound card is optional and recommended.
- Minimum 750GB storage capacity for installation.
- Redundant Power Supply.

1.1.4 STORAGE REQUIREMENTS

The video storage system shall have following features:

- Recording of all the camera streams must be stored for the period of 30days on DAS, NAS or SAN.
- The storage media must be SATA drives or Fiber Channel drivers or Flash Drives.
- Minimum storage requirement is 64TB raw (The supplier to confirm the storage requirement as per number of cameras, pixel resolutions, video compression and number of recording days)
- The storage servers must have redundant power supply and meet high availability standards
- The storage should be RAID 5 configured for disaster recovery.
- Each recording unit/server should allow for internal storage up to 32 TB per recording unit so as to allow expansion if later required

CCTV Color LCD Monitor

- The Video Color LCD Monitor shall be high performance with high resolution.

- Its image signal input / output port terminal allow bridge connection.
- The Video monitor shall have operating controls & shall be mounted below or on side-front of its screen.
- It should have 450v lines Resolution and variable control Knobs to control contrast, V hold HHold & brightness.
- Push buttons switch to control power On / Off and separate LED pilot light.
- The video monitor screen size shall be 21 inches flat & square tube shall produce clear distortion less viewing all the way out to the edge and corners of the screen.
- It shall consist of S- video input / output connectors separated output. Input signal shall be 1.0V p-p and impedance 75 ohms.
- The power source shall be AC 198-264 auto and power consumption shall be not more than 36 W.
- It shall consist of Automatic Voltage selector (AVS) to level voltage fluctuation instantly and automatically.

1.1.5 INTEGRATION (OPTIONAL)

CCTV system shall be integrated with Fire alarm system, Emergency Voice Evacuation system, Access control system and Building Management system for sequential operations and status monitoring.

25.7 CLEANING OF LINES

The lines shall be cleared of silt and other clogged material in the pipeline as directed by the Engineer-in-Charge.

25.8 PAVEMENT RESTORATION

The paved surfaces which are cut shall be restored to the original condition according to drawings and as approved by the Engineer-in-Charge.

25.9 MEASUREMENT AND PAYMENT

25.9.1 COMPOSITE RATE

The measurement and payment for the items of the work of Sewerage 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.

25.9.2 LABOUR RATE

The measurement and payment for the items of the work of Sewerage 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.

23.1.6.3 LAYING OF SEWER PIPES

Sewer pipes shall be laid as per Clause 25.3 of Section 25 – Sewerage. The following conditions shall be taken care of particularly.

i) Each length of pipe between manholes shall be in straight line and true to the alignment, position, gradient and levels.

ii) Sewer laying shall proceed in all uphill direction, laying spigot end into already laid bell end. Reverse laying shall not be allowed and any such work so carried shall be rejected.

iii) Each length of sewer pipe shall be checked for cracks and defects before placing in the line. Each pipe shall be placed carefully to the requisite line and grade and jointed perfectly with connecting pipes.

iv) Pipes shall be cut only where directed by the Engineer-in-Charge in order to complete a length between manholes. All pipes shall be cut neatly and at right angles to the axis of the pipe and the cut of the pipe' shall be smooth and truly circular.

v) The top of bedding material shall be shaped to fit the pipe barrel, with pits left for the bells. When laying is not in progress, the open end shall be closed with a tapered wooden plug to keep out foreign matter.

23.1.13 LAYING OF PIPES IN TRENCHES

23.1.13.1 EXCAVATION OF TRENCHES AND REFILLING

The trenches shall be set out to suit alignment of the pipe lines. The trenches shall be carefully trimmed on sides and bottom so that pipe lines when laid shall rest on the firm bed throughout the length. Shallow joint holes shall be left for the joints, where necessary. Where pipe line is to be laid in plains the depth of cover, i.e. the normal distance from ground level to the top of the pipe be kept at about 800 mm and shall not be less than 750 mm except due to special reasons where the Engineer-in-Charge directs in writing to the contrary.

Backfilling of trenches shall be carried out in accordance with the provisions of Sub-Section 3.8.4(ii).

23.1.13.2 FLANGES

Flanged joints shall be provided at intervals of not more than 150 m or as directed by the Engineer-in-Charge. Each flanged joint shall be made by inserting an accurately cut disc of tough multiply rubber insertion about 3 mm thick of approved quality between the flanges. The bolt holes in the rubber insert as well as in the flanges shall be drilled to template. The bolts and nuts for all flanged joints shall conform to British Standard 10 and shall be of mild steel, hexagonal, round and diagonal. The bolts shall be pulled up gradually and evenly by the use of standard spanners of the approved make, so as to ensure a perfect joint.

23.1.13.3 BENDS, TEES AND OTHER SPECIALS

Bends, tees, reducers and other specials shall be provided and jointed at points as shown on the drawings or as directed by the Engineer-in-Charge. All changes in direction shall be effected by means of bends wherever practicable and the use of elbows shall be restricted only to cases where there is no room for bends. In such cases only round elbows will be allowed.

23.1.14 PIPES ANCHORED TO WALLS OR CEILINGS

Suitable and substantial hangers or fixings shall be provided for all horizontal and vertical lines of approved types and special vibration eliminating and flexible hangers shall be provided for all pipe work affected by moving machinery or expansion and contraction including building expansion joints. Hot and cold horizontal piping shall be supported in accordance with the schedule given as under:

Pipe dia in mm	Maximum spacing of Fixings in meters		Rod size for Hangers dia in mm
	In Vertical run	In Horizontal run	
G.I and Flexible			
15 – 25	3.0	2.5	10
31 – 50	3.6	3.0	10
62 – 75	4.5	3.6	13
100 – 150	4.5	4.0	13
Cast Iron			
All sizes	3.0	1.5	13

One fixing shall be provided for each fitting.

iii) Hanger shall be supported from approved concrete inserts in concrete slabs for all pipes 50 mm and above. Insert shall be as approved by the Engineer-in-Charge and shall have space for nuts of all size. All inserts shall have a reinforcing rod of specified diameter to be installed through slot provided for this purpose, and the Contractor shall be responsible for its being in place when concrete is poured.

If any pipe has to be hung where no inserts have been provided, the Contractor shall drill holes from below through concrete slabs and provide rods and hangers attached to not less than two approved type expansion shield each one capable of taking full maximum load. The rods and complete hangers shall be of adequate size to support the load, which they carry.

iv) Approved roller supports, floor stands, wall brackets, masonry, etc. for all lines running above the floors, and which can be properly supported by the walls shall be provided. Pipe lines near walls may also be hung by hangers, carried from approved wall bracket at a higher level than the pipe.

v) Pipes shall not be hung from the pipes of other trades or other pipes except for small water branches in toilet where no other practical means support can be found, in which case specific approval for the installation shall be obtained from the Engineer- in-Charge. Hangers shall not be fastened by means of vertical expansion bolts. Hanger shall be of heavy construction suitable for the size of pipe to be supported. All materials, except roller shall be a malleable iron or steel. Rollers shall be cast iron. Hanger shall be swivel split ring, wrought pipe clamp, or adjustable type or as approved.

vi) Special cares shall be taken in the placing of hangers at the top, bottom and in offsets of hot water risers so as to allow for expansion of the vertical piping. Vertical risers shall be securely supported from the building construction by means of pipe clamps at every floor.

vii) For cast iron hub and spigot pipe and fittings hangers shall be provided on not more than 1.5 meters centers or a minimum of one hanger for each length of pipe. Where excessive number of fittings are installed between hangers, the Contractor shall provide additional hangers or reinforcing as required to the satisfaction of the Engineer-in-Charge. Fittings shall be securely anchored to the building construction at changes of direction to eliminate all horizontal movement. The Contractor shall furnish and install steel channels and angles for piping support. These supports will be required where there is not roof slab or where the building structure is not directly usable for pipe support.

23.1.15 PIPE SLEEVES

Pipe line laid through any wall, floor, ceiling or roof may be arranged to pass through proper hot dipped galvanized sleeve pipes of ample diameter embedded therein to enable the pipe lines to pass easily and freely. The length of every such sleeve pipe shall be of the full width or thickness of the wall and in the case of roof, ceiling or floor, shall be at least 40 mm longer than the thickness thereof and shall project to that extent above the upper surface thereof unless the Engineer-in-Charge orders to the contrary. Inside diameter of sleeves shall be at least 25 mm greater than the outside diameter of pipe passing through it. Space between pipe and sleeve shall be lead caulked and made water tight wherever required.

23.1.16 HOT WATER SYSTEM

All Hot Water supply piping shall be insulated as specified herein. Prior to insulation the pipes shall be thoroughly cleaned of all rust, scales and other containments by wire brushing, sand blasting etc and by using aromatic solvents complying with ASTM D-3734 to remove oil, grease etc. Subsequent to the cleaning operation the pipe, shall be coated with two coats of approved, temperature resistant, anti-corrosion paint. Insulation shall be applied to the painted pipe only after hydraulic testing as specified and shall be of a thickness shown as under:-

Nominal pipe dia mm	Insulation thickness (mm)
15 – 20	20
25 – 40	25
50 – 100	32

The insulation, covering and jacket canvas shall be suitably fixed and an approved temperature resistant adhesive shall be used. The circumferential and longitudinal joints for the kraft covering and canvas jacket shall be lapped at least 40 mm.

Further reinforcement shall be provided by the use of 20 mm wide soft aluminum bands, generally spaced at 450 mm and on either sides of elbows, tees, valves and other piping specialties. All butt joints shall be sealed with self -adhesive type of approved quality adhesive tape.

All valves, fittings and other specials shall be insulated with plain glass fibre wool blanket of thickness equal to the adjoining pipe insulation and shall be covered by kraft paper and canvas jacketing as specified earlier. Two coats moisture proof approved paint shall also be applied. The adjoining insulation near these fittings shall be trimmed into suitable sections to 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 and workman like manner and must reflect recommended practice.

23.1.17 EMBEDDED PIPELINES

Chassis shall be left in concrete or masonry walls where pipe lines are to be embedded. The cavity shall be deep enough so that after installation of pipes sufficient space is available for cover. Pipes shall be laid before plastering walls or laying of concrete floors so that no joint or cover is visible. Hot and cold lines shall be laid in separate chassis or cavities and wherever specified shall be painted with two coats of bitumen and wrapped in hessian cloth or polythene sheet.

23.1.18 INSTALLATION OF GAS PIPES

All pipes from gas regulator to the consumption point shall be laid as G.I pipes for water supply. Two coats of hot bitumen shall be given all around to the entire length of pipe and hessian cloth wrapped around it. There shall be no pressure on the joints to obviate the possibility of leakage later on.

23.1.19 PAINTING OF EXPOSED PIPES

All exposed pipes for cold, hot and mixed water and gas supply shall be painted if required in different colours as specified. One coat of red oxide primer and two coats of synthetic paint shall- be given to all M.S hangers, brackets and pipes.

23.1.20 DISMANTLING OF GI PIPES SYSTEM

Whenever dismantling of GI pipe system is required all the joints shall be carefully opened and the components such as pipes, sockets, specials, valves & fittings and holder bats etc. shall be carefully removed, cleaned, all the usable materials shall be sorted out and stacked properly for subsequent use.

23.1.21 INSTALLATION OF FIXTURES

23.1.21.1 TAPS, STOP COCKS AND VALVES

All taps, stop cocks and valves shall be eased and grease before fixing. The washers and gland packing shall be equally suitable for hot & cold water.

23.1.21.2 CHAMBERS FOR STOP COCKS AND VALVES

Chambers for stop cocks and valves shall be of brick mortar and plaster as specified and shown on drawings. The work shall be carried with applicable provisions of Section 11, Brickwork & Section 5, Plain and Reinforced Concrete.

23.1.21.3 GAS ROOM HEATERS & GAS LAMPS

The gas room heaters & gas lamps shall be of type and make as specified and shall be provided and installed as approved by the Engineer-in-Charge.

23.4 PAYMENT

23.4.1 COMPOSITE RATE

The measurement and payment for the items of the work of Road and Road Structures 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.

23.4.2 LABOUR RATE

The measurement and payment for the items of the work of Road and Road Structures 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.

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21 ROAD AND ROAD STRUCTURES

21.1 CONSTRUCTION OF ROADS

21.1.1 EARTHWORK

21.1.1.1 General

The earthworks for Construction of Roads shall generally conform to the provisions of Section 3, Earthwork subject to the further provisions stated hereunder. AASHTO (American Associations State Highways Officials) Specifications shall apply for construction of roads unless otherwise specified.

21.1.2 CLEARING & GRUBBING

The clearing & grubbing required for construction of roads shall be carried out in accordance with applicable provisions of Clause 3.12.3 under Section 3 – Earthwork.

After the clearing and grubbing operation, all the depressions and cavities etc. shall be filled back with suitable material at. the Contractor's cost to the average level of the undisturbed original ground.

Rendering of the soil in the area, as unsuitable due to the Contractor's operation by way of littering and/or mixing of the cleared and grubbed material or any other reason, shall be to the Contractor's cost and shall be stripped and reinstated with acceptably suitable material without any payment.

Cleared and grubbed material shall not be left in or under embankments or other constructed facility. All removed materials shall be disposed of at locations outside the right-ofway and not visible from the roadway.

Disposal of removed materials at public and private sites away from the right of way shall be done at the Contractor’s sole expense, in accordance with all laws and regulations, after an agreement with the property owner or public agency has been fully executed. The Engineer shall be given fifteen (15) days prior notice and a written release from the property owner or public agency on whose property the materials are to be placed. Clearing and grubbing shall be waived off where the fill height is two (02) meters or more and at the discretion of the Engineer

21.1.3 MEASUREMENT

Length and breadth shall be measured correct to a cm, along the surface. Area shall be worked out in sqm correct to two places of decimal.

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

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 formation

21.1.4 STRIPPING

21.1.4.1 General

This work shall consist of removing, transporting and depositing top soil in stock piles or spreading where indicated on the drawings or as directed by the Engineer-in-Charge.

21.1.4.2 Construction Requirement

The areas from which stripping of top soil is required shall be as indicated on the drawings or as directed by the Engineer-in-Charge. The Contractor shall remove top soil from these areas to depth as directed by the Engineer-in-Charge. Stripping of top soil in any case shall be not less than 4 inches (10 cm) in depth. The removed top soil shall be transported, deposited in stock piles at locations designated by the Engineer-in-Charge and/or spread where indicated on the drawings or as directed by the Engineer-in-Charge. Stripped material at stock pile shall not be used by the Contractor.

The top soil shall be placed separately from other excavated materials and be completely removed to the required depth from the area prior to the beginning of regular excavation or embankment work in that area. No payment will be made for top soil removed from places other than that directed by the Engineer-in-Charge.

21.1.5 COMPACTION OF NATURAL GROUND

21.1.5.1 General

The work shall consist of the compaction of the natural ground/original ground, the cleared and grubbed surface (i.e. the surface after cleaning and grubbing), stripped surface after stripping and the excavated surface after excavation, prior to commencement of the embankment construction in accordance with these specifications as shown on the Drawings or as directed by the Engineer-inCharge. The compaction shall be carried out through a written order by the Engineer-in-Charge.

21.1.5.2 Construction Requirements

The natural ground/cleared and grubbed surface/ stripped surface/ excavated surface shall be broken up, ploughed, scarified; all sods and vegetation matter removed and compacted to a depth of 200 mm and to the specified density as given below

For Height of Embankment below sub grade level	%age of maximum dry density as determine by AASHTO T-180
0 to 300 mm (0 to 30 cm)	95
300 to 750 mm (30 to 75 cm)	93
Over 750 mm (75 cm)	90
Below the foundation of structure	95

21.1.5.3 Measurement

Length and breadth shall be measured correct to a cm, along the surface. Area shall be worked out in sqm correct to two places of decimal.

21.1.6 ROADWAY & BORROW EXCAVATION FOR EMBANKMENT

21.1.6.1 Roadway Excavation

Roadway excavation shall comprise all excavation that is not classified as structural excavation carried out within the limits of roadway including permanent drainage ditches and side slope cuts. The classification of the excavation shall conform to the provisions of Clause 3.2 under Section 3 of Earthwork.

21.1.7 BORROW EXCAVATION

21.1.7.1 General

Borrow excavation shall be taken for construction of embankments and backfills where necessary and shall comply with the provisions of Clause 3.11.3, Section 3 – Earthwork.

21.1.8 CONSTRUCTION REQUIREMENT

All material removed from excavation shall be used in the formation of embankment, sub-grade, shoulders and at such other places as directed, unless it is declared unsuitable and ordered to waste by the Engineer-in-Charge. No excavated material shall be wasted without written permission from the Engineer-in-Charge, and when such material is to be wasted it shall be so placed that it will present a neat appearance and not be an injury to abutting property. The material shall be declared unsuitable if the soaked CBR (96 hours) is less than five (5) percent or it falls under A-6 or A-7 of AASHTO soil classification.

During construction of the roadway, the road shall be maintained in such a condition that it will be well drained at all times. All slopes, except in solid rock or other material shall be trimmed precisely as per cross-sections and care must be exercised that no material shall be loosened beyond the required slopes. In blasting rock slopes, a reasonably uniform face shall be left, regardless of whether or not the excavation is carried beyond the specified side slope. All breakage and sides shall be removed by the Contractor and disposed of as directed by the Engineer-in-Charge.

Rock, shale and other unsuitable road bed material encountered in cuts shall be excavated to require width and depth indicated on the plans or as otherwise directed. Any over- breakage below the depth shown on the plans will not be paid for. Backfill of the over-cut shall be of approved earth material and shall have the same density requirements as specified on the plans and shall be at the expense of Contractor.

Borrow-pits shall be located so that the nearest edge of the pit is at, least thirty (30) meters from the roadway toe of slope unless otherwise directed by the Engineer-in-Charge. Permission to use any borrow material including its suitability, shall be obtained in writing from the Engineer-in-Charge at-least fifteen days in advance of the proposed date of taking borrow materials.

In no case shall borrow material be obtained from downstream of any hydraulic structure. However the borrow-pit may be established at five hundred (500) meters upstream of the hydraulic structure. The side slopes of the pits or channels shall be constructed as shown on the plans or directed by the Engineer-in-Charge. In no case the side slopes of borrow pit be steeper than a slope; 1:5 (V:H). Upon abandonment of borrow pit or quarry area the Contractor shall at his own expense, clean and trim the borrow-pit or quarry area, the right of way, and adjoining properties which were occupied during execution of work, all to the satisfaction of the Engineer-in-Charge.

Where between two successive cross-sections of the road, the proportions of rock boulders, in sizes larger than a one quarter (1/4) of a cubic meter, to earth is more than 50%, the excavation will be considered wholly as rock.

Rock material above ground level such as stones, boulders, piles of stone, and dry stones walling whose individual sizes are greater than one quarter of a cubic meter shall be removed and disposed of if directed by the Engineer-in-Charge. When the Contractor is directed to excavate unsuitable material below the surface of original ground in fill areas other than required for cleaning and grubbing, the depth to which these unsuitable materials are to be removed will be determined by the Engineer-in-Charge. The Contractor shall schedule his work in such a way that authorized cross-sections can be taken before and after the material has been removed.

The excavation in rock shall be carried out strictly in conformity with provisions of Sub-Section 3.8 of Section 3 – Earthwork.

21.1.9 MEASUREMENT

The filling shall be measured and quantity of earth work computed from cross sections of filling or the embankment. No deduction shall be made for voids. For further details refer Section-3.

21.1.10 EMBANKMENT CONSTRUCTION

21.1.10.1 General

The work shall consist of formation of embankment, including preparation of area for placing and compaction of embankment material in layers and in holes, pits and other depressions within the road-way area in accordance with the specifications and in conformity with the lines, grades, thickness and typical cross-section shown on the plans or established by the Engineer-in-Charge. The work shall also include the compaction, trimming and shaping of the side slopes as shown on the plans and removal of any excess fill as directed by the Engineer prior to placement of top soil on slopes of the embankment where required

21.1.10.2 Material Requirements

Material for embankment shall consist of suitable material excavated from road way excavation or structural excavation or borrow. Borrow material will be used only when material obtained from roadway or structural excavation is not suitable or is deficient for embankment formation and shall include all lead and lift.

Wet excavated material which will be suitable when dry and if approved by the Engineer-in-Charge shall first be allowed to dry before being placed in the embankment

The material under this item shall conform to the following specification.

a) Contractor shall use AASHTO Class A-1, A-2, A-3, A-4, A-5, soil as specified in AASHTO M-145 or other material approved by the Engineer-in-Charge.

b) C.B.R. of the material shall not be less than five (5) percent, determined in accordance with AASHTO T-193. CBR value shall be obtained at a density corresponding to the degree of compaction required for the corresponding layer.

c) Swell value of the material for embankment formation shall not exceed 0.3 percent. In case sandy material be used for embankment formation, it shall be properly confined with a material approved by the Engineer-in-Charge and shall not be used on slopes of embankment.

d) In areas subject to flood and prolonged inundation of the embankment, such as at bridge sites, the material used in embankment unless rock, shall be AASHTO Class A-1 or A-2, soils. Other soils may be used only with the written consent of Engineer-in-Charge.

e) For the purpose of embankment and sub-grade construction, the following shall be considered as unsuitable materials:

- Material from soil AASHTO classification group A-6 and A-7.
- Material from swamps, marshes and bogs.
- Peat, logs, stumps and perishable materials.
- Organic soils.
- Material having a C.B.R value less than 7% determined according to AASHTO T-193, for the embankment depth of 30 cm below sub-grade.
- f) The moisture content of the soil at the time of compaction shall be optimum to achieve the compaction up to the specified density. The maximum dry density and optimum moisture content shall be determined from moisture density test (AASHTO T-180 Method 0) performed on different type of soil to be used in the construction of the work. Optimum moisture content and the moisture range required for the soil to achieve the desired compaction shall be approved by the Engineer-in-Charge.
- The soil shall be compacted at optimum moisture content with +1 % to -2 % tolerances, commensurate with the soil type, unless otherwise directed by the Engineer. When compaction is determined by "Relative Density Test" the tolerance for moisture content shall be finalized during the compaction trial and approved by the Engineer-in-Charge.

21.1.10.3 Construction Requirements

a) Formation of Embankment with Common Material

If suitable material is not available in the Project area, the Contractor may opt, without any additional cost to the Employer, to blend granular material with locally available A6/A7 soils to achieve a uniform blend that meets the material requirements stated above. Such widely divergent materials may be mixed, sampled and tested outside the embankment limits and the mixture may be used as a proposed source of borrow material as outlined in Section 21.1.8. However, the Contractor will submit his method statement to the Engineer and get it approved before proceeding with the work. Approval of this method statement by the Engineer shall not relieve the Contractor of his responsibility to use the suitable material in the Works. Material for embankment, obtained and approved as provided above, shall be placed in horizontal layers of uniform thickness and in conformity with the lines, grades, sections and dimensions shown on the Drawings or as required by the Engineer. The layers of loose material other than rock shall be not more than 20 cm. thick, unless otherwise allowed by the Engineer after a trial section is prepared and approved for each material source and/or borrow area.

Depth in centimetres below sub-grade level	Percent of Maximum Dry Density as Determined by
0 to 30	AASHTO T95 -180
30 to 75	93
Over 75	90

In place density determinations of the compacted layers shall be made in accordance with AASHTO T-191 or other approved methods. For all soils, with the exception of rock fill materials, containing more than 10% oversize particles retained on 19 mm(¾ inch) sieve, the in place density thus obtained shall be adjusted to account for such oversize particles as or directed by the Engineer-in-Charge. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and accepted by the Engineer-in-Charge.

Material for embankment at points inaccessible to normal compacting equipment shall be placed in horizontal layers of loose material not more than 15centimetres thick and compacted to the densities specified above by the use of mechanical tempers or other appropriate equipment. The compaction of the embankment shall be carried out at the designated moisture content consistent with the available compacting equipment. Embankment material that does not contain sufficient moisture shall be given additional moisture by means of approved sprinklers and mixing to obtain the required compaction. Material containing more than the optimum moisture may not, without written approval of the Engineer-in-Charge, be incorporated in the embankment until it has sufficiently dried out. The drying of wet material may be expedited by the scarifier disking or other approved methods.

When materials of widely divergent characteristics, such as clay and chalk or sand, drawn from different sources, are to be used in the embankment they shall be deposited in alternate layers of the same material over the full width of the embankment to depths approved by the Engineer-inCharge. Rock, clay or other material shall be broken up, and no accumulation of lumps or boulders in the embankment will be permitted. No surplus material shall be permitted to be left at the toe of embankment or at the top of cut sections. Side slopes shall be neatly trimmed to the lines and slopes shown on the drawings or as directed by the Engineer, and the finished work shall be left in a neat and acceptable condition. The slopes of the design road cross-section shall be trimmed and compacted to the densities as specified above for different zones.

Relative Density Test

For cohesion-less free-draining soils for which impact compaction will not produce a well-defined moisture density relationship curve and the maximum density, the Test for the Relative density of Cohesion-less soils ASTM D-4253/4254 shall be used to determine the relative density.

Relative density is defined as the state of compactness of a soil with respect to the loosest and densest state at which it can be placed by the laboratory procedures described in the ASTM D4253/4254. The field Density and actual Moisture Content of the compacted embankment shall be determined by field tests according to AASHTO T 191.

b) Formation of Embankment on Steep Slopes

Where an embankment is to be constructed against an existing slope of 1 vertical to 5 horizontal or steeper, hill sides, existing shoulders or where new fill is to be placed and compacted against existing pavement or where embankment is to be built along one half the width at a time, the existing slope shall be benched. The horizontal dimension of benches shall be greater than half the width of the compacting equipment in use except where this would result in a vertical dimension at the back of the bench of more than 60cms in which case the horizontal dimension may be reduced. The compaction of benches shall be as per section 21.1.8 of the General Specifications.

No measurement shall be made of the volume of material cut from the existing slope, recompacted at the same place or reused elsewhere for benching purpose. Filling against the slope will be calculated on the volume of fill placed against the original slope. Existing slope in the context of this clause includes a partially constructed embankment but does not include the side of trench excavation.

c) Formation of Embankment on Existing Roads

Before fill is placed and compacted on an existing roadway, the existing embankment and/or pavement may be levelled by cutting, rolling or scarifying by approved mechanical means to a level to be determined by the Engineer-in-Charge. The earth, old asphalt or other material arising as a result of this operation will be declared either suitable or unsuitable for use in the embankment by the Engineer-in-Charge. The payment for incorporation of such item shall be decided by the Engineer-in-Charge.

d) Formation of Embankment in Water Logged Areas

Where embankments are constructed across marshlands, tidal flats, or wet ground which is soft (such as .SPT < 5) and compressible and will not support the weight and forces of hauling and compacting equipment, the lower part of the embankment may be constructed by dumping successive loads in a uniformly distributed layer (bridging lift) of a thickness necessary to support equipment hauling but not more than 50 cm, and the placing and compacting of subsequent layers. Such supporting layers shall not be subjected to compaction requirements specified in clause 21.1.8.3. The remainder of the embankment shall be constructed in layers as specified. The material of working platform shall be as per clause 21.1.8.2.

It should also be checked that selected grading is such that intrusion into the working platform material of sub-grade or natural ground surface material is not allowed.

For this condition to be met it will be required that the ratio as below shall be checked and followed:

$$\frac{D15-(Granular\ Fill\ Material)}{D85-(Natural\ Ground\ Material)}<5$$

D15 & D85 mean the particle diameters corresponding to 15% and 85% respectively, passing (by weight) in a grain size analysis.

The thickness of the working table as prescribed above shall be approximately 0.5 meter unless directed otherwise by the Engineer-in-Charge, and the width shall be that of the embankment. The placement and compaction of the working table shall be carried out by use of light equipment, as directed by the Engineer-in-Charge.
No density requirements are specified for the working platform, however, subsequent layers above it shall be compacted to the densities specified in 21.1.8.3.

When the roadway profile is so low that the construction of the lower part of the embankment using a "bridging lift" will not permit the placement and compaction of fifty (50 cm) centimeters of acceptable embankment material, Contractor shall prepare a proposal to raise profile of the embankment and submit it to the Engineer-in-Charge for his approval.

Boulders and rock fragments larger than twenty (20 cm) centimetres in maximum dimension shall not be placed in the embankment any closer than twenty (20) centimeters from top of the embankment.

Embankment settlement period for critical section, where height is greater than 5.0 meter, is approximately three (3) months. Embankment therefore, shall remain in place for the required settlement period before placing the 30 cm thick subgrade layer, excavating for abutments, wing walls or retaining wall foundations or installing foundation piles at each location.

The embankment settlement test specified herein shall be in addition to the test section in sub section 108.3.9.
The sub-grade/embankment above the working platform shall be compacted as specified in sub-section 108.2 for the applicable zones of compaction.

e) Formation of Embankment with Rock Material

Embankment formed of material consisting predominantly of rock fragment of such size that the material cannot be placed in layers of the thickness prescribed without crushing, pulverizing or further breaking down the pieces, such material may be placed in layers not exceeding in thickness than the approximate average size of the rocks except that no layer shall exceed 80 cm. (eighty centimetres) of loose measurement and compacted by a vibratory roller with the minimum mass as shown in the following table.

Mass per metre width of Vibrating roll (Kg/M)	Depth of fill layer (mm)	Number of passes of the Roller on each layer
2300-2900	400	5
2900-3600	500	5
2600-4300	600	5
4300-500	700	5
>5000	800	5

The material shall be carefully placed in layers, so that all larger stones will be well distributed and voids completely filled with smaller stones, clean small spells, shale, earth, sand, gravel, to form a solid mass. After placing rock material surface shall be covered with a layer of fine material having thickness less than twenty (20) centimeters. Such fine material shall be reserved from roadway excavation by the Contractor. Should such material be available but not reserved, Contractor will supply and place borrow material for forming smooth grade without extra payment.

Each layer shall be bladed or levelled with motor grader. bulldozer or similar equipment capable of shifting and forming the layer into a neat and orderly condition. No rock larger than eight (8) centimeters in any dimension shall be placed in the top fifteen (15) centimeters of embankment unless otherwise allowed by the Engineer-in-Charge.

Material for each layer should be consolidated with heavy weight vibratory roller until settlement as checked between two consecutive passes of roller is less than one (1) percent of the layer thickness. In evaluation of settlement, survey points should be established and rolling continued until difference of levels as checked after two consecutive passes is less than one (1) percent of the total layer thickness. More over initial rolling of overlaid fine material shall be done without watering to ensure their intrusion in voids of rock layer beneath. Watering shall be done when voids are properly filled.

Embankments, which are formed of material that contain rock but also contain sufficient compactable material other than rock or other hard material to make rolling feasible, shall be placed and compacted in the manner prescribed above and to the point when settlement is within above mentioned requirement. Compaction test will be made whenever the Engineer-in-Charge determines they are feasible and necessary. Each layer must be approved by the Engineer before the next layer is placed.

When rock to be incorporated in fill is composed largely of weak or friable material, the rock shall be reduced to a maximum size not exceeding fifty (50) percent of the thickness of the layer being placed.

f) General Requirements

To avoid interference with the construction of bridge abutments and wing walls, the Contractor shall at points determined by the Engineer-in-Charge, suspend work on embankment and/or in cuts forming the approaches to any such structure until such time as the construction of the later is sufficiently advanced to permit the completion of the approaches without the risk of interference or damage to the bridge works. The cost of such suspension of work shall be included in the contract unit prices for embankment. In carrying embankments up to bridges, culverts or pipe drainage, care shall be taken by the Contractor to have the embankments brought equally on both sides of any such structure. The contractor shall make special arrangements to ensure proper compaction in restricted spaces and around structures without any extra compensation for this work.

When as a result of settlement, an embankment requires the addition of material up to 30 cm in thickness to bring it up to the required grade level, the top of the embankment shall be thoroughly scarified before the additional material is placed, without extra payment to the Contractor for the scarification.

The Contractor shall be responsible for the stability of all embankments and shall replace any portions that in the opinion of the Engineer-in-Charge have been damaged or displaced due to carelessness or neglect on the part of the Contractor. Embankment materials which may be lost or displaced as a result of natural causes such as storms, cloudburst or as result of unavoidable movement or settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow. No additional compensation will be allowed for the replacement except that the quantity of material required will be paid for at the contract price for the type of material used.

During construction, the roadway shall be kept in shape and drained out at all times. When unsuitable material has been placed in the embankment by the Contractor, he shall remove it without extra payment.

Embankment filling shall be brought up and compacted over the full width of the embankment of the carriageways in one operation in layers parallel with the sub-grade level. At no time shall any

part of the embankment width under one carriageway be left more than one-layer lower than any other part of the embankment width.

Shoulder construction shall be brought up simultaneously with the pavement construction. In order to prevent water penetration into the pavement layers during construction, shoulder and median construction shall be brought up simultaneously with the pavement construction whenever the transverse slope of the sub-grade slopes downwards towards the pavement or sub-grade.

Embankment side slopes shall be neatly trimmed to the dense lines and slopes shown on the drawings or as directed by the Engineer-in-Charge and the finished work shall be left in a neat and acceptable condition.

The fill behind abutments and wing walls of all bridges, pipe slab and box culverts shall be deposited in well-compacted, horizontal layers not exceeding twenty (20) cm in thickness to the density 100 percent of max. dry density as per AASHTO T180(D).

g) Formation of Embankment with A-3 Material

The construction of embankments with A-3 material shall be accomplished as shown on the plans, specified in Particular Specifications and Special Provisions and as directed by the Engineer-in-Charge. Construction of embankment with A-3 material shall be carried out in a series of operations as follows:

Edge berms shall first be constructed along both sides of the staked embankment, except where the embankment is to be constructed against hillsides or existing embankment, using Class A-1, A-2 or A-2-4 soils from roadway excavation or borrow or any other source which resist erosion by wind and water and are approved by the Engineer. However, if Engineer so approved A-4 material having PI value 4-8 from borrow excavation can be used for confinement. Edge berms shall be constructed with an external side slope as shown on the plans or specified in the Particular Specifications and Special Provisions, but not steeper than one (1) vertical to three (3) horizontal. Edge berms shall be constructed not more than forty (40) centimetres in height and not less than 2.0 meters wide at the top. The materials shall be placed and spread in layers as specified in these Specifications , material shall be excavated, hauled, deposited and spread within the edge berms to the full height of the edge berms using any means other than hydraulic sluicing.

h) Formation of Embankment on Existing Structures

When an embankment surface is to be constructed over an area previously occupied by a building basement, cellar, irrigation canal, well, any previous excavation, or other such construction that will not permit the use of normal compaction equipment, the embankment construction shall conform to the backfilling requirements specified in Structural Backfilling in these Specifications, until the normal compaction equipment can be used. The material shall be compacted to the density specified for the adjacent embankments.

i) Trial Section

Before starting the filling of the embankment, the Contractor shall construct trial sections of minimum 200 meters and maximum of 500 meters or as directed by the Engineer with each soil type/source proposed to be used as fill material. The soils used in the trials shall be the same as those intended to be used for the formation of embankment and the compacting equipment shall be the same that the Contractor will use for the main work.

The construction of embankment with any type of soil/material source shall be subject to written approval of the Engineer after the trial section made for that particular type of soil/material source.

The objective of these trials shall be to determine the optimum moisture content and the relationship between the number of passes of compacting equipment and density obtained for the soil types under trial and for the verification of the soil type itself. No separate payment will be made for this work, The Engineer-in-Charge may order additional compaction test sections when deems necessary

21.1.11 SUB-GRADE PREPARATION

21.1.11.1 General

The sub-grade preparation shall include that part of the work on which the sub-base is placed or in the absence of sub-base acts as the base of the pavement structure. It shall extend to the full width of the road bed including the shoulders and lay-byes as indicated on the drawings or as specified herein.

21.1.11.2 Construction Requirements

a) Prior Works

Before commencing the work all structures such as culverts, drains, ditches (including fully compacted backfill over them) outlets for drainage, head walls/wing walls of culverts and any other minor structure which will be below thirty (30) centimetres of existing sub-grade level or all the structure which will be below (30cm) of newly placed sub-grade level, shall be in such operative conditions as to ensure prompt and effective drainage and to avoid damage to sub-grade by surface water.

No work of sub-grade preparation will be started before the prior work herein described has been approved by the Engineer-in-Charge.

b) Compaction Requirement

All materials down to a depth of 30 cm below the sub-grade level in earth cut or embankment shall be compacted to at least 95 percent of the maximum dry density as determined according to AASHTO T-180 Method 'B' or 'D' whichever is applicable or corresponding relative density as per ASTM D-4254-83.

c) Sub-grade Preparation in Earth Cut

In case bottom of subgrade level is within thirty (30) cm of the natural ground, the top ~ fifteen (15) cm material shall be removed and stockpiled at a nearby location. The exposed surface shall then be scarified, broken up, adjusted to optimum moisture content and compacted to minimum density of ninety five (95) percent of the maximum dry density as determined by AASHTO T-180 Method D. Second layer of sub-grade shall then be prepared by incorporating the above mentioned stockpiled material to ensure that the depth of sub-grade layer is thirty (30) cm.

In case, the bottom of sub-grade is below the natural ground by more than thirty (30) cm, the material above the top of sub-grade shall be removed and subsequent layer of thirty (30) cm shall be prepared in two layers as per the method describe above.

In case, unsuitable material is encountered at the sub-grade level within the depth of Thirty (30) cm, the same shall be removed and replaced by the approved material. The Contractor shall be paid for

removal of unsuitable material for replacement by approved material. Subgrade of thirty (30) cm shall in any case be prepared and compacted in two layers of fifteen (15) cm each.

d) Sub-grade Preparation in Rock Cut.

Excavation in solid rock shall extend to at least fifteen (15) centimetres below the sub-grade level. Rock shall be undercut neatly to required elevation and sections shown on the plans or as directed by the Engineer-in-Charge. Transverse and longitudinal profile checked by template shall be accurate to the specification, Cuts below sub-grade level shall be backfilled with selected sub-base material and compacted to at minimum ninety eight (98) percent of the maximum dry density as determined by AASHTO T-189, method 'D' at Contractor's own cost.

No rock shall be higher than two (2) centimetres above the undercut section elevation. The undercut material shall be placed in embankment or disposed off at the direction of Engineer-inCharge.

e) Sub-grade in Embankment

When the sub-grade is formed in embankment, its width shall be the full width of top of embankment and material placed in the upper part of embankment down to a depth of thirty (30) centimetres below sub-grade level shall meet compaction requirement of Section (a). Soils having a minimum value of C.B.R of seven (7) percent and swell value of not more than 0.3 percent shall be used. The C.B.R less than 7% may be used in case, the design allows for it. Unsuitable material if encountered within the formation layer as per laboratory specified test, shall be removed, disposed of and replaced by suitable one as per direction of the Engineer-in-Charge for which no payment will be admissible to the Contractor. Rollers of approved size and type, accepted by the Engineerin-Charge, shall be used for compaction. Water shall be added to obtain optimum moisture content, if necessary.

f) Sub-grade Level in Existing Roads

Where indicated on the drawings or directed by the Engineer-in-Charge that the existing road surface is to be used as the sub-grade, the correct elevation on which the base or sub-base is to be laid shall be obtained, where necessary, either by means of levelling course or by scarification. The levelling course shall be constructed to the requirements of the Engineer-in-Charge and paid for under the appropriate pay item involved. Scarification shall include disposal of any surplus material in the adjacent embankment or elsewhere as may be ordered by the Engineer-in-Charge. When the width of the new road is greater than that of the existing roads, surface shall be prepared as herein provided and the part that falls outside the existing road surface shall be prepared according to Sections (c), (d) and (e) above or Section (g) below as the case may be.

g) Sub-grade Extension

When the width of the existing pavement, either to be scarified or not, is insufficient to contain the sub-base or base to be placed upon it, the Engineer-in-Charge may order to strengthen and place the sub-base or base on one or both sides of the existing pavement. This work shall consist of the removal and disposal of any unsuitable material and its replacements with suitable material to such width and depth as required by the Engineer-in-Charge.

The excavated material shall, if declared suitable for use elsewhere in the embankment by the Engineer-in-Charge be so used. If declared unsuitable it shall be disposed off.

h) Protection of Completed Sub-grade

Any part of the sub-grade that has been completed shall be protected and well drained. Any damage resulting from carelessness of the Contractor shall be repaired as directed by the Engineer-in-Charge without additional payment.

The Contractor shall be responsible for all the consequences of traffic being admitted to the subgrade. He shall repair any ruts or ridges occasioned by his own traffic or that of others by reshaping and compacting with rollers of the size and type necessary for such repairs. He shall limit the amount of

sub-grade preparation to an area easily maintained with the equipment available. Subgrade preparation and sub-base or base placing shall be arranged to follow each other closely. The sub-grade, when prepared too soon in relation to the placing of the sub-base, is liable to deteriorate, and in such case the Contractor shall, without additional payment, repair, reroll, or recompact the sub-grade as may be necessary to restore it to the state specified herein.

(i) Templates and Straightedges, Tolerance Limits

The Contractor shall provide for the use of the Engineer-in-Charge, satisfactory templates and straight edges in sufficient numbers to check the accuracy of the work, as provided in these specifications and no subsequent work shall be permitted until the sub-grade levels and shape have been checked and approved by the Engineer-in-Charge. Tolerance limits shall be as follows: Thickness + 20 mm, level + 0 & - 40 mm; 3 M straightedge 30 mm cross fall + 0.5 mm. Longitudinal grade in 30M + 0.1%.

(j) Finishing Tolerances and Requirements

Quality Assurance measuring or testing shall involve verification that the sub-grade is constructed, timely finished and trimmed in a neat, workmanlike manner to the lines, grades and typical cross sections shown on the Plans or staked by the Engineer-in-Charge within the required tolerances.

21.1.11.3 Granular Sub-Base Course

General

The work under these specifications shall consist of furnishing, spreading in one or more layers and compacting granular sub-base according to the specifications and drawings and/or as directed by the Engineer-in-Charge.

21.1.11.4 Material Requirements

Granular sub-base material shall consist of natural or processed aggregates such as gravel, sand or stone fragment and shall be clean and free from dirt, organic matter and other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable sub-base.

The material shall comply to the following grading and quality requirements.

The sub-base material shall have a gradation curve within the limits for grading A, Band C given below. However grading A may be allowed by the Engineer-in-Charge in special circumstances.

Grading Requirements for Sub-base Material			
Sieve designation Standard / Alternate	Mass Percent Passing Grading		
(mm.) / inches	A	B	C
60.0(2 ½ inches)	100	-	-
50.0(2 inches)	90-100	100	-
25.0(1 inch)	50-80	55-85	100
9.5(3/8 inch)	-	40-70	50-85
4.75 (No. 4)	35-70	30-60	35-65
2.0 (No. 10)	-	20-50	25-50
0.425 (No. 40)	-	10-30	15-30
0.075 (No. 200)	5-15	5-15	5-15

(a) The Coefficient of Uniformity D60/D10 shall be not less than 3, where D60 and D10 are the particle diameters corresponding to 60% and 10%, respectively, passing (by weight) in a grain size analysis curve.

b) The Material shall have a CBR value of at least 50%, determined according to AASHTO T-193, The CBR value shall be obtained at a density corresponding to Ninety eight (98) percent of the maximum dry density determined according to AASHTO T-180 Method-D.

c) The coarse aggregate material retained on sieve No.4 shall have a percentage of wear by the Los Angeles Abrasion (AASHTO T-96) of not more than fifty (50) percent.

d) In order to avoid intrusion of silty and clayey material from the sub-grade in the sub-base, the ratio D15 (Sub-base)/D85 (Sub-grade) should be less than 5.
Where D85 & D15 are the particle diameters corresponding to eighty-five (85)% and fifteen(15)%, respectively, passing (by weight) in a grain size analysis, curve.

e) The fraction passing the 0.075mm (No. 200) sieve shall not be greater that two third of the fraction passing the 0.425mm (No. 40) sieve. The fraction passing the 0.425mm sieve shall have a liquid limit of not greater than 25 and a plasticity index of 6 or less.

f) If oversize is encountered, screening of material at source shall be done invariably and no handpicking shall be allowed. However handpicking may be allowed by the Engineer-in-Charge if oversize quantity is less then 5% of the total mass.

g) Sand equivalent for all classes shall be 25min.

21.1.11.5 Schedule of Material Sampling and Testing

Sampling & testing of the materials shall be done as per the following schedule:

- Gradation (AASHTO T-27); 3 samples from the source or one per thousand cubic meters.
- Plasticity index (AASHTO T-89 & T-90); 3 samples from the source plus as desired on the basis of visual inspection.
- CBR (AASHTO T-193); 3 samples from the source plus according to variation in gradation.
- Abrasion (AASHTO T-96); 3 samples from the source or one per 500 cum. - Max density (AASHTO T-180); one per 1,000 Cu. m.

21.1.11.6 Construction Requirements

a) Spreading

Granular sub-base material shall be deposited on the roadbed or shoulders in a quantity which will provide the required compacted thickness without resorting to spotting, picking up or otherwise shifting the sub-base material.

Granular sub-base material shall be spread on approved sub-grade layer as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentration of coarse or fine materials.

The aggregates shall be spread and compacted in one or more layers of thickness not exceeding 15 cm, and not less than 7.5 cm. All layers shall be spread and compacted in a similar manner. Granular sub-base material shall be spread in uniform layers conforming to their transverse and longitudinal requirements. Hauling or placement of material will not be allowed during such weather or such road conditions which may cause cutting or rutting of sub-grade or contamination of sub base material.

b) Compaction Trial

Prior to commencement of granular sub-base operation, Contractor shall construct a trial length, not to exceed, five hundred (500) meters and not less than two hundred (200) meters with the same approved sub-base material as will be used during construction to determine the adequacy of the Contractor's equipment, loose depth measurement necessary to result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.

In case the required results are not attained then the Contractor with the approval of the Engineerin-Charge shall change the equipment and/or the procedure to achieve the required results.

c) Compaction

The moisture content of sub-base material shall be adjusted prior to compaction by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the specified compaction.

The sub-base material shall be compacted by means of approved vibrating rollers or steel wheel rollers (rubber tyred rollers may be used as a supplement), progressing gradually from the outside towards the centre, except on super-elevated curves, where the rolling shall begin at the low side and progress to the high side. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain smooth surface free from ruts or ridges and having proper section and crown. Rolling shall continue until entire thickness of each layer is thoroughly and uniformity compacted to specified density.

Any area inaccessible to rolling equipment shall be compacted by means of mechanical tampers, where the thickness in loose layer shall not be more than 10 cm.

If the layer of sub-base material or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water, and re-compact the material before next layer of the pavement structure is constructed.

Immediately prior to the placing of first layer of sub-base course the sub-grade (both under the travel way and the shoulders) shall conform to the required level and shape. Prior to placing the succeeding layer of the material, the top surface of previous layer shall be sufficiently moist to ensure bond between the two layers. The edges or edge slopes shall be bladed or otherwise dressed to conform to the lines and dimensions on the plans.

No material for construction of the sub-base shall be placed until the sub-grade has been approved by the Engineer-in-Charge.

d) Compaction Requirements

The relative compaction of each layer of the compacted sub-base shall not be less than ninety eight (98) percent of the maximum dry density determined according to AASHTO T-180 Method-D. The field density shall be determined according to AASHTO T-191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained on 19mm sieve) as directed by the Engineer-in-Charge. Also adjustment of any material retained on 4.75 mm sieve, AASHTO Method T-224 shall be used.

It shall be ensured that same size of sample is placed in oven for moisture determination in case of laboratory density (proctor) and field density. Moisture content for calculation of field density and proctor shall be observed on material passing 4.75 mm sieve. At least 4 density tests shall be carried out for each layer of 400 meters length.

e) Tolerances

The sub-base shall be compacted to the desired level and cross slopes as shown on the drawings. The allowable tolerance shall be +10mm or -20mm for the total thickness of the sub-base and + 0 mm or -25 mm for final level of the sub-base.

21.1.11.7 Measurement

The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre intervals or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

The quantity of subbase to be paid for shall be measured by the theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed granular subbase course. No allowance will be given for materials placed outside the theoretical limits as shown on the cross-sections.

21.1.12 AGGREGATE BASE-COURSE

21.1.12.1 General

This item shall consist of furnishing, spreading and compacting one (1) or more layers of aggregate base on a prepared sub-grade, sub-base, or existing road surface, in accordance with the specifications and the drawings and or as directed by the Engineer-in-Charge.

21.1.12.2 Material Requirements

a) Aggregates

Material for aggregate base course shall consist of crushed hard durable gravel, rock or stone fragments. It shall be clean and free from organic matters, lumps of clay and other deleterious substances. The material shall be of such a nature that it can be compacted readily under watering and rolling to form a firm, stable base for both flexible and rigid pavements.

The aggregate base shall comply to the following grading and quality requirements.

i) The gradation curve of the material shall be smooth and within the envelope limits' for Grading (A or B) given below:

Sieve designation Standard/ Alternate mm / (inches)	Mass Percent Passing Grading	
	A	B
50.0 (2 inches)	10	100
25.0 (1 inch)	7	75-95
9.5 (3/8 inch)	30-65	40-75
4.75 (No. 4)	25-55	30-60
2.0 (No. 10)	15-40	20-50
0.425 (No. 40)	8-20	12-25
0.075 (No. 200)	2-8	5-10

The material shall be well graded such that the coefficient of Uniformity D60/D10 shall be greater than four(4).

ii) Crushed Aggregate (material retained on sieve No.4) shall consist of material of which at least ninety (90) percent by weight shall be crushed particles, having a minimum of two (2) fractured faces.

iii) The Coarse aggregate shall have a wear by the Los Angeles Abrasion test (AASHTO T-96) of not more than forty (40); if overlaid by T.S.T and forty five (45) if overlaid by Asphaltic concrete.

iv) The material shall have a loss of less than twelve (12) percent when subjected to five cycles of the Sodium Sulphate Soundness test according to AASHTO T-104.

v) The sand equivalent determined according to AASHTO T-176 shall not be less than 45 and the material shall have Liquid Limit of not more than twenty five (25) and plasticity Index of not more than (6) as determined by AASHTO T-89 and T-90.

vi) The material passing the 19 mm sieve shall have a CBR value of a minimum eighty (80) percent, tested according to the AASHTO T-193. The CBR value shall be obtained at the maximum dry density determined according to AASHTO T-180, Method D.

vii) Laminated material shall not be allowed.

21.1.12.3 Filler Material

If filler, in addition to that naturally present in the aggregate base material is necessary for meeting the grading requirement or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the crushing plant or in a pug mill unless otherwise approved. The material for such purpose shall be obtained from sources approved by the Engineer-in-Charge. The material shall be free from organic matter, dirt, shale, clay and clay lumps or other deleterious matter and shall conform to the following requirements.

AASHTO Sieve	Percent Passing
3/8 inch	100
4	85-100
100	10-30
Plasticity Index (AASHTO – T-90)	6 Maximum
Sand Equivalent (AASHTO T-176)	30 Maximum

21.1.12.4 Schedule of Material Sampling & Testing

Sampling and testing of the material shall be done as per the following schedule:

- Gradation (AASHTO T.27); 3 per source plus 1 for each 1000 cum.
- Plasticity index (AASHTO T-89 & T-90); 3 per source plus as desired on the basis of visual inspection.
- CBR (AASHTO T-193); 3 per source plus as required on variation of aggregates.
- Abrasion (AASHTO T-96); 3 per source plus 1 for each 5000 cum.
- Sodium sulphate (AASHTO T-104); 3 per source plus 1 for each 5000 cum.
- Fractured faces; 3 per source plus as per visual inspection.
- Moisture density (AASHTO T-180); 1 for each 1000 cum.

21.1.12.5 Construction Requirements

a) Preparation of Surface for Aggregate Base Course

In case crushed aggregate base is to be laid over prepared sub base course, the sub base course shall not have loose material or moisture in excess to optimum moisture content.

b) Spreading

Aggregate base material shall be deposited on the roadbed in a quantity which will provide the required compacted thickness without resorting to spotting, picking up or otherwise shifting the base material. Aggregate base material shall be spread on approved sub-base layer as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentration of coarse or fine materials.

The aggregates shall be spread and compacted in one or more layers of thickness not exceeding 15 cm, and not less than 7.5 cm. All layers shall be spread and compacted in a similar manner. Aggregate base material shall be spread in layers conforming to the transverse and longitudinal requirements. Hauling or placement of material will not be allowed during such weather or such road conditions which may cause cutting or rutting of sub-grade or contamination of base material. Moisture content determination shall conform in all respects to requirements specified in 21.1.10.4(d).

c) Trial Section

Prior to commencement of aggregate base course operations, a trial section of two hundred (200) meters minimum, but not to exceed five hundred (500) meters shall be prepared by the Contractor using same material and equipment as will be used at site to determine the adequacy of equipment, loose depth measurement necessary to result in the specified compacted layer depths, field moisture content, and relationship between the number of compaction passes and the resulting density of material.

d) Compaction

The moisture content of base material shall be adjusted prior to compaction by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the specified compaction. The base material shall be compacted by means of approved vibrating rollers or steel wheel rollers (rubber tyre rollers may be used as a supplement) progressing gradually from the outside towards the centre, except on super-elevated curves, where the rolling shall begin at the low side and progress to the high side. Each succeeding pass shall overlap the previous pass by at least one third of the roller

width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain surface free from ruts or ridges and having proper section and crown. Rolling shall continue until entire thickness of each layer is thoroughly and uniformity compacted to specified density. Any area inaccessible to rolling equipment shall be compacted by means of mechanical tampers, where the thickness in loose layer shall not be more than 10 cm.

If the layer of base material, or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water, and re-compact the material before next layer of the pavement structure is constructed. Immediately prior to the placing of first layer of base course the sub-base top (both under the travel way and the shoulders) shall conform to the required level and shape. Prior to placing the succeeding layers of the material the top surface of the previous layer shall be sufficiently moist to ensure bond between the two layers. The edges or edge slopes shall be bladed or otherwise dressed to conform to the lines and dimensions on the plans.

No material for construction of the base course shall be placed until the sub-base has been approved by the Engineer-in-Charge.

e) Compaction Requirements

The relative compaction of each layer of the compacted base shall not be less than 100 percent to the maximum dry density determined according to AASHTO T-191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained or 19 mm sieve) as directed by the Engineer-in-Charge. Also for adjustment of any material retained on 4.75 mm sieve, AASHTO Method T-224 shall be used. Moisture content for calculation of field density shall be observed on material passing 4.75 mm sieve. At least density tests shall be carried out on each layer of 400 meters.

f) Maintaining Base Course

Completed base course shall be maintained in an acceptable condition at all times until prime coat is applied. When base course is to carry traffic for an indefinite length of time before receiving surfacing, the Contractor shall maintain the surface until final acceptance by wetting, balding, rolling and addition of lines as may be required to keep the base tightly bound and leave a slight excess of material over the entire surface which must be removed and the surface finish restored before application of prime coat.

g) Tolerances

The completed base course shall be tested for required thickness and smoothness before acceptance. Any area having waves, irregularities in excess of one (1) cm in three (3) M or two (2) cm in fifteen (15) M shall be corrected by scarifying the surface, adding approved material, reshaping, re-compacting and finishing as specified. Skin patching of an area without scarifying the surface to permit proper bonding of added material shall not be permitted. The allowable tolerances shall be +5mm or -10mm for the total thickness of the base course and + 5mm or 10mm in the final level of the base course.

21.1.12.6 Brick Ballast Sub-base or Base-Course

a) Where specified the brick ballast of size 1 ½" to 2" (3.75mm – 50mm) made out of first class bricks complying with the requirements of Section 11 – Brickwork shall be used as sub-base & base material for construction of roads.

b) The brick ballast shall be placed in layer of 6" for thickness as specified. The preparation of subgrade shall meet the provisions of Section 21.1.9 or as specified. Brick bats shall be raked off the stack with rakes to clear of mud and dust if any. The brick ballast shall be spread evenly over the prepared surface to the required depth with a finishing material to avoid segregation. Brick ballast shall be carefully laid and packed, bigger size being placed at the bottom to 3" depth unless specified otherwise, after the area shall be grouted with fine sand.

c) The brick ballast shall be consolidated by dry rolling with 3 ton or light weight power roller and or as directed by the Engineer-in-Charge.

21.1.12.7 Measurement

The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre intervals or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

The quantity of Brick Ballast Sub-base or Base-Course to be paid for shall be measured by the theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed Brick Ballast Sub-base or Base-Course. No allowance will be given for materials placed outside the theoretical limits as shown on the crosssections.

21.1.13 WATER BOUND MACADAM BASE-COURSE

21.1.13.1 General

This work shall consist of furnishing and placing one or more courses of clean crushed stone base mechanically interlocked by rolling, and voids thereof filled with screening with the assistance of water, laid on a prepared sub-grade, sub base, or existing pavement in conformity with the lines, grades and. cross-sections shown on the drawings.

21.1.13.2 Material Requirements

a) **Coarse Aggregates**

Coarse aggregates either crushed or broken stone shall conform to the quality requirements as specified hereunder except that no CBR testing is required. The gradation curve of the coarse aggregates shall be within the envelop limits as follows:

US Standard Sieve Sizes	Percent Passing by weig ıt		
	ClassA	ClassB	ClassC
102mm (4”)	100	_	_
89 mm (3-1/2”)	90-100	_	_
76 mm (3”)	_	100	_
63.5 mm (2-1/2”)	25-60	90-100	100
50 mm (2”)	_	25-75	90-100
37.5 mm (1-1/2”)	0-15	0-15	35-70
25 mm (1”)	_	_	0-15
19 mm (3/4”)	0-5	0-5	_
12.5 mm (1/2”)	_	_	0-5

Los Angeles Abrasion Value shall not exceed 45% and Flakiness Index shall not exceed 15%; coefficient of uniformity shall be greater than four (4); 90% of the particles shall have at least 2 faces crushed; soundness test shall not produce loss more than 12% and CBR value of material passing 19 sieve shall not be less than 80%.

b) **Fine Aggregates**

Fine aggregates (filler material or screenings or murum) shall consist of natural sand or crushed stone screenings free from clay lumps, dirt and other objectionable material. The fine aggregate shall be of the following gradation:

US Standard Sieve Sizes	Percent Passing by weight
9.5mm (3/8 inch)	100
4.35mm (No. 4)	85-100
0.15mm (No. 100)	10-30

The material passing No. 40 sieve shall have Liquid Limit of not more than 25 & Plasticity Index of not more than 6.When more than one layer is required to complete the Macadam course to the thickness shown on the drawings, each layer shall be constructed as prescribed before.

21.1.13.3 Physical Requirements

The additional physical requirements of coarse aggregates for water bound macadam will satisfy the following limits:-

a. Los Angeles Abrasion Value Max 45%
b. Flakiness Index Max 15%
c. The loss when subject to five cycles of the Sodium Sulphate Soundness test. (AASHTO T-104) shall be less than twelve (12).

21.1.13.4 Binding Material

Binding material to prevent ravelling of water bound macadam shall consist of fine grained material passing 100 percent through sieve # 40 and possessing Plasticity Index (P.I) value of four to nine (4-9) when the Water Bound Macadam (WBM) is to be used as a surfacing course, and up to 6 when WBM is being adopted as sub-base/base course with bituminous surfacing. If lime stone formations are available nearby, lime stones dust or as directed by the Engineer, may be used fully employed for this purpose.

21.1.13.5 Construction Requirements

a) Equipment

Any combination of machines or equipment that will produce the results meeting these specifications may be used with the approval of the Engineer-in-Charge. These include mechanical spreaders, water sprinklers and rollers/compactors.

b) Structure Preparation

Preparation of surface for water bound macadam shall be carried out in the same manner as for aggregate base course Sub-Section 21.1.11.5(a).

Where the existing road surface is black topped, 50 mm x 50 mm furrows shall be cut in the existing surface at one (1) meter intervals at forty five (45) degree to the centre line of the carriageway before proceeding with the laying of coarse aggregates.

Before starting with WBM Construction, necessary arrangements shall be made for the lateral confinement of aggregates. One method is to construct side shoulders in advance to a thickness corresponding to the compacted layer of the WBM course. After shoulders are ready, there inside edges may be trimmed vertical and the included area cleaned of all spilled material thereby setting the stage for spread of coarse aggregates. The practice of constructing WBM in a trench section excavated in the finished formation must be avoided.

c) Spreading and Compaction

Crushed stone shall be deposited and spread on the prepared surface to the proper depth so that the compacted layer will not exceed two and a half (2.5) times the thickness of maximum aggregate size. Each layer shall be inspected thoroughly before rolling to detect high or low spots. Crushed stones shall be added or shifted to provide a true surface. The course aggregate layer, after being laid to proper thickness, shall be lightly rolled sufficient only to establish the required grade and level of the stones.

Spreading of the coarse aggregates shall be followed by rolling with a smooth wheel roller weighing at least 10 tons. Rolling shall begin at the lower edge of the shoulders to lock the stones firmly at the edge then progress gradually towards the centre line. Rolling shall continue until the aggregate is well keyed and does not creep ahead of the roller.

In no case, shall coarse aggregates be stored in heaps directly on the area where these are to be laid nor shall the hauling over a partly completed base be permitted, however dumpers shall be allowed at the construction area where the material will be spread quickly after dumping.

Following the initial rolling, dry screenings shall be applied uniformly over the surface. Dry rolling shall be continued while screenings are being applied. The surface shall be swept with mechanical or hand brooms to aid spreading of the screenings.

When the interstices in the coarse aggregate are filled with screening, the surface shall be sprinkled with water until it is saturated. The rolling, sprinkling and application of additional screenings shall continue until a grout is formed that fills all the voids and forms a wave of grout in front of the roller. When more than one layer is required to complete the Macadam base course to the thickness shown on the drawings, each layer shall be constructed as before prescribed.

d) Construction Control Testing

Tests for compliance with the requirements of materials will be as deemed necessary and to the satisfaction of the Engineer-in-Charge.

e) Maintenance

The completed base course shall be maintained in an acceptable condition until the necessary subsequent treatment is applied.

21.1.13.6 Measurement

The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre intervals or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

21.1.14 CRUSHED STONE SOLING

21.1.14.1 Stones

The stones shall be clean, hard stones, free from decay and weathering. They shall be in block and hammer dressed on all sides. The sizes of the stones unless otherwise specified shall be approximately 22.5 cm. in depth and not less than 15 cm. in any other direction.

21.1.14.2 Preparation of Surface

The stones shall be placed on sub-grade prepared as specified under Sub-section 21.1.9. The sides and bottom of sub-grade shall be brought to the required slope and gradient and shall be compacted to a firm and even surface.

21.1.14.3 Laying of Stone

The depth of stone laid shall be of 22.5 cm. depth unless specified otherwise. Profiles shall be put up by means of pegs and strings or by placing stones, at intervals of not more than 15 meters. The stones shall then be laid closely in position in between the profile and firmly embedded with joints staggered and with exposed faces true to line, gradient and in uniform slope throughout.

Cross bands of approximately 22.5 cm. width through bond stones equal to the full depth shall be provided at an interval of approximately 3 metres centre to centre both longitudinally and transversely. The interstices between adjacent stones shall be packed with stones, spawls & chips of proper size, well driven in with crow bars to ensure tight packing and complete filling of all interstices. Such filling shall be carried simultaneously with the placing in position of the large stones and shall in no case be

permitted to fall behind. Final wedging shall be done with the largest sized chip practicable, each chip being well driven home with a hammer so that no chip is possible of being picked up or removed by hand.

21.1.14.4 Measurement

The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre intervals or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

21.1.15 BRICK SOLING

21.1.15.1 General

The brick soling of road shall consist of laying a course of burnt brick over prepared sub-grade and filling the interstices with sand.

21.1.15.2 Materials

a) Bricks

The bricks shall conform to the provisions of Section 11 – brickwork as specified. They shall be well burnt, rather slightly over-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 homogenous 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 and shall show no signs of efflorescence on drying. Compressive strength shall not be less than 2000 pounds per square inch or 140.62 Kgs./ Sq. cm.

b) Sand

Sand shall be used for filling joints between the bricks. It shall conform to Specification 11.7.2(ii) – Cement Mortar – Brickworks.

c) Water

Water for mortar shall conform to specification 11.7.2(ii) Cement Mortar – Brickwork.

21.1.15.3 Construction Requirements

a) **Preparation of Sub-grade**

The sub-grade shall be constructed in accordance with clause 21.1.9 of this Section.
The sub-grade shall have a camber of 1:60 except at curves where requisite super-elevation shall be given.

b) **The Construction Procedure**

The centre line of the proposed road shall be marked on the sub-grade and necessary level pegs shall be fixed every 25 feet along the sides of the road. Bricks shall be laid on edge 4.5 inches thick. A 3 inches wide and 9 inches deep brick on end edging shall be laid on both sides of the brick on edge soling. A string course of 9 inch brick on edge shall be laid on both sides of the trench as well as in the centre parallel to the centre line of the roads. The bricks shall be laid diagonally towards the centre line of the road between the string courses and to correct levels. Bricks shall be laid by the masons with close fine joints and shall be set properly with wooden mallets. All joints shall be evenly spaced and laid diagonally to the centre line of the road. The direction of the diagonals shall be changed every 25 feet and each section shall be broken by a cross string course 9 inches wide bricks on edge. After the bricks have been laid and approved by the Engineer-incharge, the joints shall be carefully filled with clean sand.

21.1.15.4 Measurement

The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre intervals or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

21.1.16 CRACK – RELIEF LAYER

21.1.16.1 General

The work shall consist of constructing a layer of graded crushed aggregate or asphaltic opengraded plant mix on a prepared soil-cement base course in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the Drawings.

21.1.16.2 Material Requirements

a) Aggregates

Material for graded crushed aggregates shall in all respects conform with the requirements specified under 21.1.11 with the following exceptions and supplementary requirements:

i. The portion of the aggregate retained on the 9.5 mm. (3/8 inch) sieve shall not contain more than 10 percent by weight of flat and/or elongated particles (ratio of maximum to minimum dimension = 2.5:1).

ii. Crushed aggregates shall consist of particles with not less than Ninety (90) percent of the portion retained on the 4.75 mm. (No.4) sieve having at least two fractured faces.

Aggregates for the asphaltic open-graded plant mix shall conform to the requirements of 21.1.12 with the following exceptions:

Fine aggregates and mineral filler will be required. Sand equivalent and plasticity requirements are not applicable.

b) Asphaltic Material

Asphaltic binder shall be asphalt cement, 60-70 penetration grade, meeting the requirements of AASHTO M-20.

c) Asphaltic Open-Graded Mixture

The composition of the asphaltic open-graded crack-relief layer shall meet the following criteria:

AGGREGATE GRADING REQUIREMENTS		
Sieve Designation		Percent Passing
mm	inch	by Weight
50 37.5 19 4.75 0.15	2 1-1/2 ¾ No. 4 No.100	100 75-90 50-70 8-20 0-5
Asphalt Cement content of total Mix		2-3% by weight
Mixing Time		30 seconds (maximum)
Mix Design		Within Master Range Gradation

The exact percentage of asphalt cement content shall be such that at least Ninety five (95) percent coating of aggregates will be achieved when tested in accordance with AASHTO T– 195.

21.1.16.3 Construction Requirements

Prior to construction of the crack-relief layer (CRL) the completed base course shall be duly accepted by the Engineer-in-Charge.

21.1.16.4 Graded Crushed Aggregate

Construction of this layer shall conform in all respects to the requirements specified under Item 21.1.11.

A Asphaltic Open-Graded CRL

Construction of this layer shall conform in all respects to the requirements specified under Item 21.1.23 except as provided below:

a) Compaction shall be accomplished by ten (10) Ton steel Wheeled tandem rollers. A maximum of three complete coverage, or as otherwise directed by the Engineer-in-Charge shall be sufficient. No density test will be required, however the compaction shall be achieved in the same manner as displayed in the total test and to satisfaction of the Engineer-in-Charge.

b) The consistency and temperature of the mix shall be such controlled that it does not squeeze out or move under the pressure of compacting roller. For this purpose, trial reaches shall be prepared by the contractor to fix the above parameters.

In order to ensure the stability of CRL before the placement of any subsequent layer or opening of a layer to traffic, a priming time of 4 days in hot weather will be allowed. This time may be reduced to two days where the lower temperature allows.

c) All traffic shall be kept off this layer until a subsequent layer has been placed on it. Any damage caused by traffic moving directly on the crack-relief layer shall be the responsibility of the Contractor and all necessary repair work thereto shall be at the Contractor's expense.

21.1.17 GEOTEXTILES

21.1.17.1 General

The work covered by this section shall consist in furnishing all material, labour, equipment and placing of Geo-textiles on prepared surfaces complete in accordance with the specifications for the work items involved, in thickness and to the dimensions shown on the typical cross-section of applicable drawings or as directed by the Engineer-in-Charge.

21.1.17.2 Geotextile Functions

Where indicated on the drawings or directed by the Engineer-in-Charge, Geotextile will be placed to perform one or more of the following functions.

- On road foundation for the purpose of separation between road fill material and soft underlying soils in order to eliminate the need for removal of poor subsoil material and quick and effective drainage of soil-fill interface.

- For subgrade stabilization and increasing soil shear strength by providing bonding mechanism of the Geotextile-soil system.

- As a filter for all drainage systems where a danger of clogging by fine particle of adjacent soil is possible. The Geotextile will retain the particles from passing whilst allowing the seepage water to pass through.

- As a filter element for all bodies of water where the soil can be eroded by current, wave action or changing water levels.

- For permanent protection of synthetic sealing systems (Geo-membrane) against mechanical damage during installation and after completion of construction.

21.1.17.3 Material Requirements

1. **Composition and Environmental Behaviour**

The raw material of Geotextile shall be Ultra Violet stabilized polypropylene. The fibres shall consist of continuous filaments of approximately 40 micron diameter and mechanically bonded by needling. The Geotextile material shall be resistant to acid and alkaline media in the pH range 2 to 13, resistant to lime, cement and concrete, resistant to all naturally occurring bacteria and fungi. A prolonged outside exposure of several months shall have no effect on the properties of Geotextile.

2. **Mechanical and Hydraulic Properties**

- To ensure free drainage, the geotextile shall have high water permeability.

- Geotextile shall offer high retention capability for almost all types of soils.
- The geotextile shall have optimum stress-strain behaviour even with low unit weight for high resistance against installation damage.

21.1.16.4 Construction Requirements

a. Preparation

The surface shall be fairly levelled before placement of Geotextile. It is to be ensured that there are no protruding stones which may damage the geotextile fabric.

b. Geotextile Placement

The Geotextile shall be rolled out directly on top of the prepared surface in a manner as recommended by the manufacturer. It shall be over lapped at the edges as shown on the drawings or as recommended by the manufacturer.

c. Placement of Fill

The first layer of fill material shall be applied by overhead placement. Traffic on the geotextile itself shall be avoided. Necessary precautions shall be observed to ensure that geotextile shall not be damaged during placement.

d. Spreading

Spreading of fill material shall be done with suitable equipment and procedure ensuring that geotextile must not be damaged by high axle load stresses of spreading equipment travelling on sharp fill over the geotextile.

e. Compacting

The compacting method (Static/ Dynamic) shall be suited to sub-grade/ fill material. f.

Jointing of Geotextile Panels

A tension joint shall be achieved by overlapping, welding or sewing as shown on drawings or approved by the Engineer-in-Charge.

g. Overlapping

Overlapping width shall not be less 30 cm on even surface and 50 cm on uneven surface. In order to avoid displacing the geotextile during backfill over end panel joints, the connecting panel must be placed underneath the end of the previously rolled out geotextile.

h. Welding

Welding width shall not be less than 10 cm. A wide pattern gas torch shall be used at a low temperature and about 20 cm from the geotextile. The welded geotextile section shall be continuously pressed down by walking on it during placement.

i. Sewing

The stitching method shall be single thread, double thread or butterfly type suitable to geotextile thread type and strength. The thread shall be sufficiently tightened and stitch density shall be three to six stitches per inch.

21.1.17.4 Geotextile Function for Repaving

This section deals geotextiles placed between old pavement and new asphalt overlay, along with suitable tack coat of bitumen. Where indicated on drawings or directed by the Engineer-in-Charge, geotextile will be placed to perform one or more of the following functions:

- To ensure proper adhesion between old pavement and new asphalt overlay & thus reducing the overall flexural tensile stresses and increasing life of road surface.
- As a cut off layer for the prevention of propagation of cracks in the pavement.
- As water barrier, even under high pressure to stop reflective cracking in the pavements.

1. Construction Requirements
   - Removal of dirt, dust and vegetation from wearing surface and cracks.
   - Filling potholes and larger cracks (>5mm) with hot mix or an adequate filler.
   - Removal of sharp or craggy edges on surface.
   - On badly damaged roads, a level course of approximately 1.5 cm shall be laid to avoid the labour intensive and time consuming operation of crack filling.

2. Applying the tack coat

Depending on the condition of the old surface, a calculated amount of tack coat approximately 1.1 kg/m^2 active binder is to be sprayed evenly on the prepared surface before laying geotextile, making sure that:-

- The bitumen is applied beyond the width of the geotextile by about 5 cm on either side.
- The spraying temperature for pure bitumen is kept between 150ºC and 170ºC to achieve a coating as even as possible.
- When using bitumen emulsion, the coating amount is adjusted to contain the required average amount of bitumen.
- The coating is only applied to areas where the paving felt is to be laid.
- No additional pre-spray agent is applied on top of the paving felt.
- Where only sections for the road are covered with the paving felts, their surfaces must be gritted.

3. Laying Geotextile

Geotextile shall be laid by hand or machine taking into account that:

- When using pure bitumen as tack coat, Geotextile may be laid immediately after coating.
- When using bitumen emulsion, Geotextile shall not be laid until the emulsion has cured. Wrinkles shall be avoided.
- Edges lengthways and across will be overlapped by 5-10 cm, an additional pure bitumen binder of 0.9 kg/m^2 shall be applied on the overlapping seams.
- Transverse overlapping is to be carried out with reference to the direction in which the asphalt finisher will proceed i.e. under the previous one so that the felt does not shift out of place when the asphalt concrete is applied.
- When one half of the road is made (leaving the other open to traffic), at least 25 cm of the lengthways felt edge shall remain uncovered to allow overlapping when laying the other half of the road.
- During short time stoppages of construction work, the road under construction shall be opened only to slow traffic without detriment to Geotextile.
- Rain water on the Geotextile surface shall be allowed to evaporate before applying a top layer.

4. Applying the Asphalt Concrete Surface

The asphalt concrete surfacing shall be applied immediately after laying Geotextile preferably by crawler type finisher, taking the following points into consideration.

- The material mix shall have a temperature between 145ºC and 165ºC.
- To avoid types of the finisher or truck sticking to the felt (which can happen in hot climates or where too much tack coat has been applied), some of the mix can be spread manually in the pathway of the vehicles.

21.1.17.5 Geotextile testing

Geotextile testing shall be in accordance with the following standard test method.

Properties	Standard
Weight	ASTM D-3776
Thickness	ISO 9863
CBR Puncture Resistance Test	BS 6906/4
Strip Tensile test	ASTM D-4595
Grab Tensile Test	ASTM D-1682
Tear strength test	ASTM D-1682
Penetration resistance test (drop test)	NT Build 243
Vertical permeability	BS 6906/3
Pore size	E DIN 60500/6

Based on the required functions and the type of stresses, the contractor shall propose the type of geotextile. The contractor shall furnish technical literature and manufacturer's certificates of guarantee for the type of geotextile material for approval of Engineer –in-charge prior to delivering the material to the site. The certificate shall note compliance to the specifications and shall state the result of the test performed on the material, as required by the specifications.

21.1.17.6 Measurement

The length & breadth of the area of Geotextile of specified thickness has been provided shall be measured correct to a centimeter and the area shall be calculated in square metres correct to two decimal places.

21.1.18 INTERLOCKING CONCRETE PAVING BLOCKS

21.1.18.1 General

The work shall consist of precast concrete paving blocks intended for the construction of low speed roads, parking areas, lay byes, industrial and other paved surfaces subjected to all categories of static and vehicular loading and pedestrian traffic. Paving blocks covered by these Specifications 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 and placed in conformity with the lines, grades, thicknesses and typical cross-section shown on the drawings or as directed by the Engineer-in-Charge.

21.1.18.2 Material Requirements

For execution of this item provisions made in BS 6717 shall be applicable. Detailed requirement of materials and construction shall be as under:

1. **Binders and Binder Constituents**

Paving blocks shall be made using one or more of the following binders or binder constituents complying with the requirements of the relevant standards:

Section	Description	Section	Standard
21.2	Ordinary Portland Cement	21.3	BS 12
21.4	Portland Blast-furnace Cement	21.5	BS 146: Part 2
21.6	Portland Pulverized Fuel ash Cement	21.7	BS 6588
21.8	Pulverized fuel ash	21.9	BS 3892:
21.10	Ground granulated blast-furnace slag	21.11	BS 6699 Part 1

Where pulverized fuel ash is used, the proportions and properties of the combination with Portland cement shall comply with as BS 6588. Where ground granulated blast furnace slag is used, the proportions and properties of the combination with Portland Cement shall comply with BS 146: Part 2.

Aggregates

Paving blocks shall be made using one or more of the following aggregates complying with the relevant standards:

Section	Description	Standard
	Aggregates	**BS : 882 : 1983 Natural**
21.2	(Crushed or Uncrushed)	21.4 (except grading requirement in clause 5)
		BS 1047 : 1083
21.5	Air Cooled blast-furnace slag	21.6 (except grading requirement in 4.8) **Pulverized**
	Fuel Ash	
21.7	Ground granulated blast-furnace slag	21.8 BS 3892 : Part-1 or Part-2 BS 6699

a) Acid Soluble Material (Fine Aggregate)

When tested as described in BS 812 : Part 119, the fine aggregate (material passing a 4.75 mm sieve complying with BS 410) shall contain no more than 25% by mass of acid soluble material either in the fraction retained on or in the fraction passing, a 600µm sieve. b) Water

The water shall be of drinking quality or in accordance with the provisions in Sub-Section 5.3.1.6 under Plain & Reinforced Concrete.

c) Admixtures and Pigments

Proprietary accelerating, retarding and water reducing agents shall comply with Sub-Section 5.3.1.7 under Plain & Reinforced Concrete. Pigments shall comply with BS 1014. Calcium chloride shall comply with BS 3587.

d) Finishes

The finish should be agreed between the manufacturer and the Engineer-in-Charge. Concrete described as “natural colour” shall contain no pigment.

In composite paving blocks the surface layer shall be formed as an integral part of the block and shall be not less than 5 mm thick.

e) Binder Content

The cement content of the compacted concrete shall be not less than 380 kg/m^3. For equivalent durability, paving blocks made with binder constituents other than ordinary Portland cement shall have higher binder content than paving blocks made in a similar way using only Portland Cement. The

Engineer-in-Charge will decide the additional binder content. The compressive strength test will be the only guide to the amount of additional binder needed.

21.1.18.3 Sizes and Tolerances

1. Sizes

Paving blocks shall have a work size thickness of not less than 60 mm Type-R blocks shall be rectangular with a work side of 200 mm and a work side width of 100 mm Type-S blocks shall be of any shape fitting within a 295 mm square coordinating space and shall have a work size width not less than 80mm.

The preferred thicknesses are 60 mm, 65 mm, 80 mm & 100 mm.

A chamfer around the wearing surface not exceeding 7mm in width or depth shall be permitted. All arises shall be of uniform shape.

2. Tolerances

The maximum dimensional deviations from the stated work sizes for paving blocks shall be as follows:

Length	± 2mm
Width	± 2mm
Thickness	± 3mm

Where a paving block includes profiled sides, the profile shall not deviate from the manufacturer's specification by more than 2mm.

21.1.18.4 Compressive Strength

The average compressive strength of paving blocks shall be not less than 49 N/mm^2 (7000 psi) and the crushing strength of any individual block shall be not less than 40 N/mm^2 (6000 psi).

21.1.18.5 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|(2) 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 way carried out in accordance with this Part of BS 6717.
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.

21.1.18.6 Marking

The following particulates 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, trade mark or other means of identification of the manufacturer.
b) The number and date of this British Standard, i.e. BS 6717: Part 1 : 1986*; or latest revision.

21.1.18.7 Construction Requirements

1. Laying the Paving Blocks

The total area to be covered with paving block shall be prepared by:

a) Compaction of sub-grade
b) Laying of sub-base in a thickness specified
c) Laying of crushed aggregate base or lean concrete in thickness as per typical section.

2. Tolerance

Tolerance of these layers shall be as per applicable requirement of each item of this specifications.

3. The total area will thereby be divided with nylon strings into sectors of not more than 1.5 square meters. This shall be done to control the alignment of paving blocks and to avoid multiplication of deviation in sizes of paving blocks.
   Payment for each of the above item shall be made under the relative item of work.

21.1.18.8 Measurement

The length & breadth of the area of interlocking Paver Blocks of specified thickness has been provided shall be measured correct to a centimeter and the area shall be calculated in square metres correct to two decimal places.

21.1.19 ASPHALTIC MATERIALS

21.1.17.1 Asphalt Cement

Asphalt Cement shall be an oil asphalt, or a mixture of refined liquid asphalt and refined solid asphalt, prepared from crude asphaltic petroleum. It shall be free from admixture with any residues obtained by the artificial distillation of coal, coal tar, or paraffin and shall be homogeneous and free from water. No emulsification shall occur when a 30 gram sample is boiled for 2 hours with 250 cubic centimetres of distilled water in a 500 cubic centimetres Erlenmeyer flask equipped with a reflex condenser.

Asphalt Cement shall be classified by penetration and when tested in accordance with the standard methods of tests of the AASHTO, the grades of asphalts shall conform to .the requirements set forth in Table 21(a) and 21(b). The grade of asphalt to be used shall be in accordance with these specifications or the Special Provisions or as directed by the Engineer-inCharge.

21.1.17.2 Environmental Factors

In area where highly frost susceptible soils and severe low temperature conditions are encountered, it may be necessary to remove and replace soils susceptible to frost heave or take other precautions prior to pavement construction. In extremely hot climates, asphalt mixes should be designed to resist rutting and maintain stiffness at high temperatures.

Because asphalt mixtures are influenced by temperature, it is recommended that different asphalt grades be used where different temperature conditions prevail. Table below gives recommended asphalt grades for various temperature conditions.

SELECTING ASPHALT GRADE

Temperature Condition	Asphalt Grade +
Cold, mean annual air temperature< 7 °C(45°F)	AC-10, AR-4000, 80 / 100 pen.
Warm, mean annual air temperature between 7°C (45°F) & 24°C (75°F)	AC-20, AR-8000, 60 / 70 pen.
Hot, mean annual air temperature> 24 °C (75°F) and	AC-40, AR-8000, 40 / 50 pen.

Both medium setting (MS) and slow setting (SS) emulsified asphalts are used in emulsified asphalt base mixes. They can be either of two types; cationic (ASTM D-2397 or AASHTO M-208) or anionic (ASTM D-977 or AASHTO M-140). Selecting one of the two shall depends on the type of aggregate used for better affinity.

The grade of emulsified asphalt is selected primarily on the basis of its ability to satisfactorily coat the aggregate. This is determined by coating and stability test (ASTM D-244, AASHTO T-59). Other

factors important in the selection are the water availability at the job site, anticipated weather at the time of construction, the mixing process to be used, and the curing rate.

21.1.17.3 Cut-Back Asphalt

Liquid asphalts (cut-back) shall consist of materials conforming to the following classifications. When tested in accordance with the standard methods of tests of the AASHTO, the grades of liquid asphalt shall conform to the requirements specified in the Tables 21(c) and 21(d). Medium curing products designated by letters MC, shall consist of asphalt cement fluxed or blended with a kerosene solvent. Rapid curing products designated by the letters RC, shall consist of asphalt cement with a penetration of approximately 80 to 100, fluxed or blended with a naphtha solvent.

21.1.17.4 Emulsified Asphalt

Asphaltic emulsions shall be composed of a bituminous base uniformly emulsified with water and an emulsifying or stabilizing agent. They shall be classified according to use as Rapid Setting (RS) or Slow Setting (SS), and shall conform to the requirements specified in Table 21(e).

The bituminous base used in manufacturing RS-1 type emulsion shall be asphalt cement, Grade 120-150 or Grade 200-300, as designated by the Engineer-in-Charge.

The bituminous base used in manufacturing SS-1 type emulsion shall be paving asphalt, Grade 6070 or Grade 120-150, as designated by the Engineer-in-Charge.

TABLE 21(a)
APPLICATION TEMPERATURE RANGE 'C'

Description	Spray	Mix
Asphalt Cement (All grades)	160 (max)	As required to achieve viscosity of 75-150 secs. Saybolt-Furol or as required to achieve a Kinematic Viscosity of 150-300 centistokes.
Cut-back or Emulsified Asphalts		
MC-70, RC-70	27-65	27-65
MC-250	38-93	38-93
RC-250	38-79	27-65
MC-800	85-127	71-99
RC-800	71-107	57-85
SS-1, SS-1H	24-55	-
RS-1	24-55	-
RS-2	44-70	-

TABLE 21 (b)
REQUIREMENTS FOR ASPHALT CEMENT (AASHTO M-20)

Description	Penetration Grade							
	40-50		60-70		80-100		120-150	
	Min	Max	Min	Max	Min	Max	Min	Max
Penetration at 77°F (25°C) 100g 5sec.	40	50	60	70	85	100	120	150
Flash point, Cleveland Open Cup, 0°F (0°C)	150 (232)	- -	450 (232)	- -	450 (232)	- -	425 (218)	- -
Ductility at 77°F (25°C) 5 cm per min. cm.	99	-	99	-	99	-	99	-
Solubility in trichloroethylene percent	99	-	99	-	99	-	99	-
Thin-film oven test, 1/8 inch (3.2mm), 325°F, (163°C), 5 Hrs. Loss on heating, percent	-	0.8	-	0.8	-	1.0	-	1.3
Penetration of residue, percent of original	58	-	54	-	50	-	46	-
Ductility of residue at 77°F (25°C), 5 cm. per min. cm.	-	-	50	-	75	-	100	-

TABLE 21 (c)
REQUIREMENTS FOR MEDIUM-CURING TYPE ASPHALT (AASHTO M-82)

Description	MC-70		MC-250		MC-800	
	Min	Max	Min	Max	Min	Max
Water percent	-	0.2	-	0.2	-	0.2
Flash point (tag. open cup) C	38	-	66	-	66	-
Kinematic Viscosity at 60°C (140°F) (See Note 1) Centistokes	70	140	250	500	800	1600
Distillation test: Distillate, percentage by volume of total distillate to 360°C 680°F)						
to 225°C (437°F)	0	20	0	10	-	-
Description	MC-70		MC-250		MC-800	
	Min	Max	Min	Max	Min	Max
to 260°C (500°F)	20	60	15	55	0	35
to 315°C (600°F)	65	90	60	87	45	80
Residue from distillation to 360°C (680°F) volume percentage of Sample by difference	55	-	67	-	75	-

Tests on residue from distillation: Penetration, 100 g., 5 sec., at	120	250	120	250	120	250
25ºC (77ºF)						
Ductility, 5 cm/min.cm.(see note 2)	100	-	100	-	100	-
Solubility in Trichloroethylene percent	99	-	99	0	99	-

Note-1: As an alternative, Saybolt Furol Viscosities may be specified as follows:
Grade MC-70 Furol viscosity at 50□C (122□F) – 60 to 120 sec.
Grade MC-250 Furol viscosity at 60□C (140□F) – 125 to 250 sec.
Grade MC-800 Furol viscosity at 82.2□C (180□F) – 100 to 200 sec.

Note-2: If penetration of residue is more than 200 and its ductility at 25□C (77□F) is less than 100 cm, the material will be acceptable if its ductility at 15.5□C (60□F) is more than 100 cm.

TABLE 21 (d)
REQUIREMENTS FOR RAPID-CURING TYPE ASPHALT (AASHTO M-81)

	RC-70		RC-250		RC-800	
	Min	Max	Min	Max	Min	Max
Water percent Flash point (tag. open cup) ºC	- -	0.2 -	- 27	0.2 -	- 27	0.2 -
Kinematic Viscosity at 60ºC (140ºF)(See Note 1) centistokes	70	140	250	500	800	1600
Distillation test: Distillate, percentage by volume of total distillate to 360ºC (680ºF)						
to 190ºC (374ºF)	10	-	-	-	-	-
to 225ºC (437ºF)	50	-	35	-	15	-
to 260ºC (500ºF)	70	-	60	-	45	-
to 315ºC (600ºF)	85	-	80	-	75	-
Residue from distillation to 360ºC(680ºF) volume percentage of Sample by difference	55	-	65	-	75	-
Tests on residue from distillation: Penetration, 100 g. 5 sec. at25ºC (77ºF)	80	120	80	120	80	120
Ductility, 5 cm/min. cm. of 25ºC (77ºC) cm.	100	100	-	100	-	-
Solubility in Trichloroethylene percent	99	-	99	-	99	-

Note-1: As an alternative, Saybolt Furol Viscosities may be specified as follows:
Grade MC-70 Furol viscosity at 50□C (122□F) – 60 to 120 sec.
Grade MC-250 Furol viscosity at 60□C (140□F) – 125 to 250 sec. Grade
MC-800 Furol viscosity at 82.2ºC (180□F) – 100 to 200 sec **TABLE 21 (e)**

REQUIREMENTS FOR EMULSIFIED ASPHALT (AASHTO M-140)

TYPE.....	Rapid – Setting				Slow - Setting			
GRADE.....	RS – 1		RS – 2		SS – 1		SS -1h	
	Min	Mix	Min	Mix	Min	Max	Min	Max
TEST OF EMULSIONS								
Viscosity, saybolt furol at 77°F (50°C), sec.	10	100	-	-	20	100	20	100
Viscosity, saybolt furol at 122°F (50°C), sec.	-	-	75	400	-		-	-
Settlement 5 days, percent(a)	-	5	-	5	-	5	-	5
Storage stability test, one day(b)	-	1	-	1	-	1	-	1
De-mulsibility C 35 ml 0.02 NCaCL2 percent	60	-	60	-	-	-	-	-
Cement mixing test, percent	-	-	-	-	-	2.0	-	2.0
Sieve test, percent	-	0.1	-	0.1	-	0.1	-	0.1
Residue by distillation, percent	55	-	63	-	57	-	57	-
Test on residue from distillation test penetration 77°F (25°C) 100g. 5 sec.	100	200	100	200	100	200	40	90
Ductility, 77°F (25°C), 5 cm/mim.cm.	40	-	40	-	40	-	40	-
Solubility in Trichloroethylene percent	97.5	-	97.5	-	97.5	-	97.5	-
Suggested Uses	Surface treatment & penetration macadam tack coat		Surface treatment & penetration macadam.		Plant or road mixture with graded and fine aggregates a substantial quantity of which passes a No.8 (2.3 mm) sieve & a portion of which may pass No. 200 (0.75 mm) sieve: slurry seal treatment.			

NOTES:

a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days' time; or the Engineer-in-Charge may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.
b) The 24-hours (1 day) storage stability test may be used instead of the 5-day settlement test.
c) The de-mulsibility test shall be made within 30-days from date of shipment.

21.1.18 BITUMINOUS SURFACE TREATMENT

21.1.18.1 General

This work shall consist of furnishing and application of three courses of asphaltic material of the specified type and grade with one, two or three covers of aggregates in accordance with these specifications to the width shown on the Drawings or as directed by the Engineer-in-Charge.

21.1.18.2 Material Requirements

a) Aggregate

Aggregate shall consist of clean, dry, hard, tough, angular, sound crushed stone, or crushed gravel of uniform quality, free from dust, clay, and other deleterious materials and from excess of flat or laminated pieces. All aggregate materials shall have a percentage of wear by the Los Angeles Abrasion test (AASHTO T-96) of not more than 40 percent. When subjected to 5 cycles of sodium sulphate soundness testing as determined by AASHTO T-104, it shall have a weight loss not greater than 10 percent. The moisture content in the aggregate applied directly to the surface of the bituminous material shall not exceed 3 percent by weight plus one half ½ the water absorption of the aggregate at the time of delivery to the project.

The portion of aggregate retained on the 9.5mm (3/8 inch) sieve shall not contain more than 15 percent of particles by weight so flat or elongated, or both, that the ratio between the maximum and the minimum dimensions exceeds 2.5:1.Flakiness index tested under BS-812(1990) Part 105 shall be 25(max) for nominal size18mm and 12mm and 30(max) for nominal 9 mm. size The percentage composition by weight of aggregate shall conform to the following gradations:

US Standard Sieve	Percentage Passing by Weight			
	Size No.1(18mm)	Size No.2(12mm)	Size No.3(9mm)	Size No.4(6mm)
1" (25.00 mm)	100	--	--	–
¾" (19.00 mm)	90 – 100	100	--	–
½" (12.50 mm)	20 – 55	90 – 100	100	–
3/8" (09.50 mm)	0 – 15	40-70	85-100	100
No. 4 (04.75 mm)	0 – 5	0 – 15	10-30	85 – 100
No. 8 (02.38 mm)	--	0 – 5	0 – 10	10 – 40
No. 16 (01.18 mm)	--	0	0-5	0 – 10
No. 200 (0.075 mm)	--	--	---	–

b) Asphaltic Material

The asphaltic material shall conform to the requirements of AASHTO M-20, M-81, M-82 and M140. The type shall be the following or as instructed by the Engineer-in-Charge. Triple surface treatment: AC 85-100, RC-70, RS-1 or RS-2.

21.1.18.3 Construction Requirements

Surface treatment shall be applied when the weather is warm and dry, and the road surface is clean and dry. Spraying shall not be done unless the road temperature has been above 20 degree centigrade for at least one hour prior to the commencement of spraying operations, and the temperature shall not be less than 20 degree centigrade during spraying. Prior to applying the asphaltic material, dirt and other objectionable materials shall be removed from the surface. If so directed by the Engineer-in-Charge, the surface shall be cleaned by power brooming until all loose and foreign materials are removed.

a) **Equipment**

The liquid asphaltic material shall be sprayed by means of a pressure distributor of not less than 240 gallon capacity, mounted on pneumatic tyres of such width and number that the load produced on the road surface will not exceed 560 lb. per inch width of tyre. It shall be of recognized manufacture. The tank shall have a heating device able to heat a complete charge of asphaltic liquid upto 180 degree Centigrade. The heating device shall be such that overheating will not occur. The flames must not touch directly on the casting of the tank containing the asphaltic liquid. The Contractor will

be responsible for any fire or accident resulting from heating of bituminous materials. The liquid shall be circulated or stirred during the heating. The tank shall be so insulated that the drop in temperature when the tank is full and not being heated, will not allow temperature drop by more than 2°C/hour. A thermometer shall be fixed to the tank to enable continuous control of the temperature of the liquid. The thermometer shall be placed in such a way that the highest temperature in the tank is measured. The tank shall be furnished with a device that indicates the quantity. The pipes for filling the tank shall be furnished with an easily interchangeable filter. The distributor shall be such that the spray width of the asphaltic liquid can be varied in steps of maximum (4 inch) to a total width of 13 ft (4 m). The spraying bar shall have nozzles from which the liquid is sprayed in fan shaped pattern on the road surface with uniform distribution over the total spraying width.

The distributor shall have a pump driven by a separate motor for dosing the liquid or the speed of the pump shall be synchronized with the speed of the distributor. The pump shall be furnished with an indicator showing the performance in liters per minute. At the suction side, the pump shall have an easily exchangeable filter.

The distributor shall be furnished with a tachometer indicating the speed in meter per minute. The tachometer shall be visible from the driver's seat. The function of the distributor shall be so exact that the deviation from the prescribed quantity to be spread on 10 square feet does not exceed 10%. The distributor shall also be equipped with a device for hand spraying of the bituminous liquid.

b) **Application of Asphaltic Materials**

Asphalt cement, liquid asphalt and emulsified asphalt shall be applied by means of pressure distributor at the temperature specified for the type and grade of asphalt being used. The rates of application shall be within the range given in Table 21(f), however, the exact rate shall be determined by the Engineer-in-Charge.

The spreading of bituminous materials shall be at least 10 cm wider than the width covered by the aggregate from the spreading device. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected in an approved manner. Junctions of spreads shall be carefully made to assure a smooth riding surface. The length of spread of bituminous material shall not be more than that which trucks loaded with cover coat material can immediately cover. Under no circumstances shall operations speed in such manner that bituminous material will be allowed to chill, setup, dry , or otherwise impair retention of the cover coat.

The distributor when not spreading shall be so designed that the spray bar or mechanism will not drip bituminous material on the surface of the travelled way. Distribution of bituminous shall be so regulated and sufficient bituminous material left in the distributor at the end of each application, so that there will be a uniform distribution of bituminous material. In no case shall the distributor be allowed to expel air with bituminous material thereby causing uneven coverage. The angle of the spray nozzles and the height of spray bar shall be so adjusted and frequently checked that uniform distribution is ensured. The distribution shall cease immediately upon any clogging or interference of any nozzle and corrective measures shall be taken before distribution is resumed.

c) **Spreading of Aggregate**

Immediately after applying the asphaltic material, dry aggregate shall be uniformly and evenly distributed over the treated surface from an approved mechanical aggregate spreader. The truck carrying the aggregate shall move back-ward as it spreads the same so as to prevent the tyres of the truck and the mechanical aggregate spreader from driving directly on the newly sprayed asphalt. No portion of the binder shall remain uncovered for a period in excess of 20-minutes after spraying. Immediately after spreading of the aggregate, the treated surface shall be rolled with a self -propelled pneumatic-tyred roller having a minimum contact pressure of 40 psi (2.8 kg/sq.cm). A steel-wheeled roller weighing between 6 to 8 tons should be used as a second roller. Rolling shall continue until a smooth, thoroughly compacted surface is obtained. Procedures of starting, stopping or turning of equipment which results in displacement of cover material or damage to seal courses is prohibited.

Any place where binder shows on the surface shall be covered with additional aggregate and further rolled and broom-dragged until even surface results, and does not adhere to wheels of vehicles. Over lapping the application of cover material shall be avoided and all spillage shall be removed from surface.

The quantity of aggregate to be used shall be within the ranges specified in Table 21(f) however, the exact rate shall be determined by the Engineer-in-Charge.

TABLE 21 (f)

Bituminous Surface Treatment		Aggregate		Bituminous Material	
Type	Application	Size No.	Quantity KG/Sq.M	Quantity Litre/Sq.M	Type
SINGLE	Single	2	12.5	1.19	(a)
				1.63	(b)
DOUBLE	First	1	24	1.90	(a)
				2.14	(b)
	Second	3	12.5	1.19	(a)
				1.63	(b)
TRIPLE	First	1	24	1.90	(a)
				2.14	(b)
	Second	2	12.5	1.19	(a)
				1.63	(b)
	Third	3	6.5	0.68	(c)
SEAL COAT / PAD COAT WITH AGGREGATE		4	4	0.5	(c)

NOTE: Bituminous material types are (a) asphalt cement, (b) cut-back (c) asphalt cement or cut-back.

21.1.18.4 Maintenance of Traffic

Detouring of highway traffic for this work will not be provided for or permitted, except when authorized by, the Engineer-in-Charge. All construction operations shall be coordinated to result in the least practicable delay of traffic. One way traffic shall be maintained and traffic speeds restricted to fifteen (15) Km per hour. The contractor shall provide flagmen, warning signs barricades, and sufficient number of pilot cars to control traffic through the bituminous sealing operations when so directed by the Engineer-in-Charge. Pilot cars shall be used to lead the traffic through the areas of all distribution and sealing operations. Pilot cars shall be light "Pick-up"; trucks or other approved vehicles and shall be equipped with signs reading "PILOT CAR - DO NOT PASS" on both English and Urdu. Two (2) signs shall be mounted on the vehicles so as to be clearly visible from both directions.

One(1) flagman shall be stationed immediately ahead of the application of the bituminous material and one(1) flagman immediately behind the section being rolled. Suitable speed limit signs shall be displayed, and the signs shall be moved forward with the flagman as the work progresses. No separate payment shall be made for conformance to this paragraph all items being considered subsidiary to all of the items in the CSR items.

21.1.18.5 Working Period

All work shall be so .conducted that the work of applying asphalt and aggregate and of all rolling shall be completed during the time from sunrise to sunset and under favourable weather conditions determined by the Engineer-in-Charge.

21.1.18.6 Maintenance of completed work

When directed by the Engineer-in-Charge, the Contractor will be required to add bituminous material or aggregate or both to portion of the project. Furnishing additional bituminous material and furnishing, spreading, dragging and rolling of additional aggregate will 'not be paid for separately but will be considered as subsidiary work pertaining to the relevant item of "Bituminous Surface Treatment".

21.1.18.7 Opening to Traffic and after-care

There shall be no delay in opening a completed surface dressing to traffic at a controlled speed. Prior to opening to traffic any spillage of aggregates shall be removed and any binder drips or windblown contamination shall be dusted with crusher waste. After 2-3 days under traffic, excess stone will be removed by brushing.

21.1.18.8 Pad Coat

To ensure chipping retention when surface dressing a very hard surface, a pad cat consisting of application of an initial binder spray followed by 6mm. chipping will be applied. After stabilizing of pad coat under traffic, the appropriate surface dressing will be applied.

21.1.19.1 Measurement

The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal.

The thickness of surface treatment shall be the ruling criterion for payment.

21.1.19 BITUMINOUS PRIME COAT

21.1.19.1 General

This work shall consist of furnishing all plant, labour, equipment, material and performing all operations in applying a liquid asphalt prime coat on a previously prepared and untreated earth sub grade, water-bound base course, top of road way shoulders, (and as otherwise shown on the plans) in accordance with the specifications and in conformity with the lines shown on- the drawings.

21.1.19.2 Material Requirements

Asphaltic material shall be either cutback or emulsified asphalt, whichever is specified.

21.1.19.3 Construction Requirements

Prime coat shall be applied when the surface to be treated is dry; except that when emulsified asphalt is used, the surface may be reasonably moist. The application is prohibited when the weather is foggy or rainy, or when the atmospheric temperature is below 15ºC unless otherwise directed by the Engineer-in-Charge. Prior to the application of the prime coat, all loose materials shall be removed from the surface and the same shall be cleaned by means of approved mechanical sweepers or blowers and/or hand brooms, until it is as free from dust as is deemed practicable. No traffic shall be permitted on the surface after it has been prepared to receive the bituminous material. Prior to the application of prime coat on bridge decks and concrete pavements, the surfaces shall be cleaned of all loose material as described. All expansion joints shall be cleaned and filled with bituminous material as directed by the Engineer-in-Charge. Area to be primed will be classified as under:

i) The top of earth surface or water bound base courses from a point twenty (20) centimetres outside the edge of the pavement line to 20 cms outside the line on the opposite side of the roadway.
ii) The top of the shoulders from the inter-section of embankment slope and top of sub-grade to the edge of the pavement line.
iii) The bridge wearing surface from curb to curb and end to end of bridge wearing surface.
iv) Other surfaces as shown on the plans or instructed by the Engineer-in-Charge.

Primed surface shall be kept undisturbed for at least 24 hours so that the bituminous material travels beneath and leaves the top surface in non-tacky condition. No asphaltic operations shall start on a tacky condition.

21.1.19.4 Equipment

The tank shall have a heating device able to heat a complete charge of asphaltic liquid upto 180 degree Centigrade. The heating device shall be such that overheating will not occur. The flames must not touch directly on the casting of the tank containing the asphaltic liquid. The Contractor will be responsible for any fire or accident resulting from heating of bituminous materials. The liquid shall be circulated or stirred during the heating. The tank shall be so insulated that the drop in temperature when the tank is full and not being heated, will not allow temperature drop by more than 2^{o}C/hour. A thermometer shall be fixed to the tank to enable continuous control of the temperature of the liquid. The thermometer shall be placed in such a way that the highest temperature in the tank is measured. The tank shall be furnished with a device that indicates the quantity. The pipes for filling the tank shall be furnished with an easily interchangeable filter.

The liquid asphaltic material shall be sprayed by means of a pressure distributor of not less than 1000 litre capacity, mounted on pneumatic tyres of such width and number that the load produced on the road surface will not exceed hundred (100) kg. per cm width of tyre. It shall be of recognized manufacturer. The distributor shall be able to vary the spray width of the asphaltic liquid in steps of maximum 10 cm, to a total width to four (4) meters. The spraying bar shall have nozzles from which the liquid is sprayed fan shaped on the road surface equally distributed over the total spraying width. The distributor shall be equipped with a device for hand spraying of the bituminous liquid.

All equipment shall be subject to the approval of the Engineer-in-Charge. The distributor shall have a pump for spraying the liquid driven by a separate motor or the speed of the pump shall be synchronized with the speed of distributor. The pump shall be furnished with an indicator showing the performance in litres/min. At the suction side the pump shall have a filter easily exchangeable. The thermometer shall be fixed which indicates the temperature of the liquid immediately before it leaves the spraying bar.

The distributor shall be furnished with the Tachometer indicating the speed in meter/min. The Tachometer shall be visible from the driver seat.

Application of Asphaltic Material

Immediately before applying prime coat, the full area of surface to be treated shall be free from ruts, corrugations, loose materials and other irregularities.

Prime coat shall be applied on a dry surface, however the surface may be reasonably moist when emulsified asphalt is used. The application shall not be done when the weather is foggy or rainy, or when the atmospheric temperature is below fifteen (15) degree centigrade unless otherwise directed by the Engineer-in-Charge. Prior to the application of the prime coat the surface shall be cleaned by means of approved mechanical sweepers or blowers and/or hand brooms, until it is free from dust and loose material as far as practicable. No traffic shall be permitted on the surface after it has been prepared to receive the bituminous material. The bridge decks and concrete pavements surfaces shall also be cleaned of all loose materials. All expansion joints shall be cleaned and filled with bituminous material as directed by the Engineer-in-Charge. Areas to be primed shall be:

i) The top of earth surface or water bound base courses from a point twenty (20) centimetres outside the edge of the pavement either side of the roadway.
ii) The top of shoulders from the intersection of embankment slope and top of sub-grade to the edge of the pavement line.
iii) The bridge wearing surface from curb to curb and end to end of bridge wearing surface.
iv) Other surfaces as shown on the plans or instructed- by the Engineer-in-Charge.

The rate of application of asphaltic material (cut back/emulsified) shall be according to the following rates or as approved by the Engineer-in-Charge.

Sr. No.	Type of Surface	Liters/ Sq. M.	
		Minimum	Maximum
1.	Earth surface, shoulders Water Bound base courses	0.65	1.75
2.	Bridge, Wearing Surfaces, Concrete Pavement	0.15	0.4

The prime coat shall be left undisturbed for a period of at least 24 hours and shall not be opened to traffic until it has penetrated and cured sufficiently so that, it will not be picked up by the wheel of passing vehicles. The contractor shall maintain the prime coat until the next course is applied. Care shall be taken that the application of bituminous material is not in excess of the specified amounts any excess shall be blotted with sand or shall be similarly treated. All area inaccessible to the distributor shall be sprayed manually using the device for hand spraying from the distributor. The surface of structures and trees adjacent to the area being treated shall be protected in such a manner as to prevent their being spattered or marred.

Where no convenient detour is available for traffic, operations shall be confined to one half the roadway width at a time. The contractor shall provide proper traffic control so that vehicles may proceed without damage to the primed area. Work shall not be started on the portion previously covered until it has dried and is ready for traffic.

21.1.19.5 Measurement

Bituminous Prime coat, for both items shall be measured as finished work over the area specified to be covered, in square metres at the bitumen content specified in the item.

Weight of Bitumen per Sq.m shall be the bases for Payment.

21.1.20 SURFACE DRESSING ON OLD SURFACE WITH HOT BITUMEN (ONECOAT)

21.1.20.1 General

This treatment consists of cleaning old painted surface and applying a coat of hot bitumen on the prepared base, blinding with stone chippings and consolidation with road roller.

21.1.20.2 Materials

The aggregates & asphalt materials unless otherwise specified shall conform to the provisions of Clause 21.1.19.2.

21.1.20.3 Preparation

Repairs: Pot holes or patches and ruts in the surface course which is to be surface treated, shall be repaired by removal of all loose and defective material by cutting in rectangular patches and replacement with suitable material.

For the purpose of repairs the area of pot holes shall be taken upto 0.75 sqm and depth up to 5 cm. All pot holes, patches and ruts up to 2 cm deep shall be repaired and brought to level with premix and properly consolidated while those of depths greater than 2.5 cm shall be repaired with similar specifications as adopted originally.

Prior to the application of the surface dressing all dust, dirt, caked mud, animal dung, loose and foreign material etc. shall be removed 30 cm on either side, beyond the full width to be treated, by means of mechanical sweepers and blowers or with wire brushes, small picks, brooms etc. The material so removed shall be disposed off as directed by the Engineer-in-Charge.

For a water bound macadam surface, the interstices between the road metal shall be exposed up to a depth of about 10mm by means of wire brushes. The surface shall then be brushed with soft

brooms to remove all loose aggregate. Finally the traces of fine dust which get accumulated while brushing shall be thoroughly removed from the surface by blowing with gunny bags.
The prepared surface shall be closed to traffic and maintained fully clean till the binder is applied.

21.1.20.4 Construction Requirements

The construction for dressing shall be carried out complying with the provision of clause 21.1.19.3.

21.1.20.5 Measurement

Hot Bitumen Coat for both items shall be measured as finished work over the area specified to be covered, in square metres at the bitumen content specified in the item.

21.1.21 BITUMINOUS TACK COAT

21.1.21.1 General

The work covered by this section shall consist of furnishing all plant, labour and equipment for application of asphaltic material on a previously prepared asphaltic layer in addition to performing all operation in connection with the application of a bituminous tack coat, complete as shown on the typical cross-sections of applicable drawings.

21.1.21.2 Material Requirements

Asphaltic material shall be either emulsified asphalt, or cut back asphalt as specified.

21.1.21.3 Construction Requirements

a) **Equipment**

Equipment shall conform in all respect to the provision under Item 21.1.20.4 and shall be subject to the approval of the Engineer-in-Charge.

b) **Application of Asphaltic Material**

Immediately before applying the tack coat, all loose material, dirt or other objectionable material, shall be removed from the surface to be treated as directed by the Engineer-in-Charge. The tack coat shall be applied only when the surface is dry, however for emulsified asphalt, application may be made on a reasonable moist surface. Application of tack coat shall be avoided in case of foggy or rainy weather or at temperatures below 15^{o}C. Tack coat will not be applied until the surface has been inspected and approved by the Engineer-in-Charge.
Asphaltic material shall be applied at the specified temperature for the particular material being used. Rates of application of cut back or emulsified asphalt shall be within 0.2-0.7 litres per square meter. The exact rate shall be specified by the Engineer-in-Charge.
Care shall be taken that the application of asphaltic material is not in excess of the specified amount; any excess asphalt shall be blotted by sand or similar treatment. All areas inaccessible to the distributor shall be treated manually using the device for hand spraying from the distributor. The surfaces of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred.
Where no convenient detour is available for traffic, operations shall be confined to one-half the roadway width at a time. The Contractor shall provide proper traffic control so that vehicles may proceed without damage covered by previous application until the surface previously covered has dried and is ready for paving.
Traffic shall be kept off the tack coat at all times. The tack coat shall be sprayed only so far in advance of the surface course as will permit it to dry to a "tacky" condition. The Contractor shall maintain the tack coat until the next course has been placed. Any area that has become fouled, by traffic or otherwise, shall be cleaned by Contractor at his own cost before the next course is applied.

21.1.21.4 Measurement

Bituminous Prime coat, for both items shall be measured as finished work over the area specified to be covered, in square metres at the bitumen content specified in the item.

Weight of Bitumen per Sq.m shall be the bases for Payment.

21.1.22 ASPHALTIC CONCRETE ROAD MIX

21.1.22.1 General

This work shall consist of furnishing of aggregates and asphalt binder plant, labour, equipment and performing all operations in connection with the construction of asphaltic concrete road mix on a previously constructed and accepted sub-grade, sub-base or base course, and in accordance with this section of the Specification, the drawings and the directions of the Engineer-in-Charge.

21.1.22.2 Material Requirements

Unless otherwise specified or directed, the materials for asphalt concrete mix shall comply with the followings specifications:

a) Mineral Aggregates

Mineral aggregates for bituminous concrete shall consist of coarse aggregate, all conforming with the following requirements:

Course aggregate which is the material retained on No.4 sieve shall consist of crushed rock, crushed gravel or a mixture of crushed rock and crushed gravel. The aggregate shall not contain more than 8% by weight of flat and elongated particles. Ratio of maximum to minimum dimensions of particles shall not exceed 5:1. At least (90) percent by weight shall have two or more fractured faces.

Fine aggregate which is material passing No.4 sieve, shall consist of 100% crushed material from rock or boulder. No natural sand will be allowed in the mix.

When the combined grading of the coarse and fine aggregates is deficient in material passing No. 200 sieve, additional filler material shall be added. The filler material shall consist of finely divided rock dust, hydrated lime, hydraulic cement or other suitable mineral matter. At the time of use, it shall be sufficiently dry to flow freely and free from conglomerations. Filler Material shall conform to following gradations.

US Standard Sieve	Percent Passing by Weight
No. 30	100
No. 50	95-100
No. 200	70-100

The coarse and fine aggregates shall meet the following applicable requirements:

i) The percentage of wear by the Los Angeles Abrasion test (AASHTO T-96) shall not be more than forty percent (40%).

ii) The loss when subject to five cycles of the Sodium Sulphate Soundness test (AASHTO -T-104) shall be less than twelve (12) iii) The Sand Equivalent (AASHTO T-176) determined after all processing except for addition of asphalt cement shall not be less than forty five (45).

iv) Fine aggregates shall have a liquid limit not more than twenty five (25) and a plasticity index of not more than four(4) as determined by AASHTO T-89 & T-90

v) The portion of aggregate retained on the 9.5 mm (3/8 inch) sieve shall not contain more than 15 percent by weight of flat and/or elongated particles (ratio of maximum dimensions = 2.5:1)

b) Asphaltic Material

Asphalt binder to be mixed with the aggregate to produce asphalt concrete shall be asphalt cement having penetration grade 40-50, or 60-70 or 80-100 as approved by the Engineer-inCharge, Generally it will meet the requirements of AASHTO M-20.

c) Sampling and Testing Schedule of Materials

i) Coarse Aggregates:
- •Abrasion (AASHTO T-96); 3 per source plus 1 for 5000 cum.
- •Sodium sulphate soundness (AASHTO T-104); 3 per source plus 1 for 5000 cum.
- •Stripping (AASHTO T-182); 3 per source.
- •Fractured faces, flake & elongated particles; 3 per source plus as per visual observations. Specific gravity (AASHTO T-85); 2 per source for each size.

ii) Fine Aggregates:
- •Sand equivalent (AASHTO T- 176); or plasticity index (AASHTO T-89 and T-90); 3 per source.
- •Specific gravity (AASHTO T-84); 2 per source. iii) Asphalt:
- •Specific gravity (ASSHTO T-228); 2 per shipment.
- •Penetration (AASHTO T-49); 3 per week.

21.1.22.3 Asphalt Concrete Mixture

a) **Composition**

Unless otherwise specified, the composition of the asphaltic concrete paving mixtures for concrete mix shall conform to class shown in the following table:

Sieve Designation		Percent Passing by Weight
mm	inch	
25	1	100
19	3/4	90-100
9.5	3/8	56-80
4.75	No. 4	35-65
2.38	No. 8	23-49
0.30	No. 50	5-19
0.075	No. 200	2-8

Asphalt Content Weight Percent of total mix.	3.5 (minimum)
The asphalt concrete binder course mixture shall meet the following Marshal Test Criteria:	
Compaction, no. of blows each end of specimen	75
Stability (Minimum)	1000 kg.
Flow 0.25 mm (0.01 inch)	8-14
Percent air voids in mix.	4-8
Percent voids in mineral aggregate	According to article 5.3, MS-2, (Asphalt Institute USA) edition 1993
Loss of stability	25% (Max.)
Filler/Bitumen ratio	1-1.5 (applicable to hot climate (<40°C)

b) **Job-Mix Formula**

A Job-Mix Formula (JMF) for the asphaltic concrete to be used for the project shall be established jointly by the Engineer-in-Charge and the Contractor. Job-Mix Formula shall combine the mineral aggregates and asphalts in such proportion conforming to specification requirements.

The JMF shall be established according to the procedure prescribed by the Engineer-in-Charge. Each JMF shall indicate a single percentage of aggregate passing each required sieve size and a single percentage of bitumen to be added to the aggregate.

After the JMF is established samples of materials taken from the asphalt plant during operations shall conform the following ranges of tolerance.

Combined Aggregates

Sieve	Permissible variation Weight of total mix. Percent by weight
Retained No.4 and larger sieves No.8 No. 30 No. 200 Asphalt	±6.0 % ±4.0 % ±3.0 % ±2.0 % ±0.3 %

Asphalt Content
Weight percent of total mix. ± 0.3 %
In addition to meeting the above requirements, the JMF shall also satisfy other requirements as prescribed by the Engineer-in-Charge.
Should a change of sources of materials be made, a new Job Mix Formula shall be established before the new material is used. When unsatisfactory results or other unacceptable conditions make it necessary, a new Job Mix Formula will be required.

c) **Asphalt Additive**

Cellulose Fibers shall be used as an asphalt additive with the aim of eliminating bleeding tendencies at the rate of 0.2 to 0.25 percent by weight of the total mix. Additives shall be fed by a separate feeding system or manually into pug-mill for each batch. The weight of the additive shall be determined in accordance with the percentage specified in the job mix formula.

21.1.22.4 Construction Requirements

21.1.22.4.1 Equipment

a) **Bituminous Mixing Plant**

Plants used for the preparation of bituminous mixtures shall be either "Batching Plants" conforming to AASHTO M-156 or continuous mixing as approved by the Engineer-in-Charge and shall be of adequate capacity, coordinated and operated to produce a mixture within the limits of these specifications. Mixing plant shall meet the following general requirements. i) Sufficient Capacity:

Mixing plants shall be of sufficient capacity and coordinated to handle adequately the proposed bituminous construction. Plants shall have minimum 3 cold bins and 3-5 decks of hot sieves. ii) Plant Scale:

Scales shall be accurate to 0-5 percent of the maximum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change of position. In lieu of plant and truck scales the Contractor may provide an approved automatic printer system which will print the weights of the material delivered or any other weighing device found satisfactory by the Engineer-in-Charge, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load, or any other weigh system satisfactory to the Engineer-in-Charge.

iii) Scales shall be inspected and calibrated as often as the Engineer-in-Charge may deem necessary to assure their continued accuracy, the Contractor will have on hand not less than 10 fifty-pound weights for testing the scales,

iv) Equipment for preparation of Bituminous Material:

Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring and sampling storage tanks.

v) Feeder for Drier:

The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

vi) Drier:

The plant shall include a drier or drier which continuously agitate the aggregate during the drying process. For cold type bituminous mix, equipment for mechanical cooling of the dried aggregate the temperature prescribed for cold mixtures shall be mixer to operate at full capacity.

vii) Screens:

Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

viii) Bins:

The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and, adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for filler or hydrated lime when used and provided with overflow pipes of a size and at such location as to prevent backing up of material into other compartments of bins. Each compartment shall be provided with its individual outlet gates which shall cut off quickly and completely. Bins shall be equipped with adequate tell-tale devices to indicate the position of the aggregates in the bins at the lower quarter points.

ix) Bituminous Control Unit:

Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

x) Thermometric Equipment:

An armoured thermometer of adequate range in temperature reading shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit. The plant shall be equipped with either an approved dial-scale, mercury actuated thermometer, an electric pyrometer or other approved thermometric instruments so placed at the discharge chute of the drier as to register automatically or indicate the temperature of heated aggregate.

xi) The Engineer-in-charge may require replacement of any thermometer by an approved temperature recording apparatus for better regulation of the temperature of aggregates.

xii) Dust Collector:

The plant shall be well equipped with a dust collector constructed to waste or return uniformly to the hot elevator all or any part of the materiel collected as directed.

xiii) Truck Scales:

The bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractors expense. Such scales shall be inspected and calibrated as often as the Engineer-in-Charge deems necessary to assure their accuracy. The accuracy shall be in accordance with paragraph(ii).

xiv) Safety Requirements Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the Engineer-in-Charge to obtain sampling and mixture-temperature data. Hoist or pulley or pulley system shall be provided to raise scale calibration equipment, sampling equipment and other similar equipment from the ground to the mixer platform and to return. All gears, pulleys chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

b) **Hauling Equipment**

Dump trucks used for hauling bituminous mixtures shall have tight, clean smooth metal beds which have been thinly coated with an approved material (vegetable oil or soap solution). The mixture will be delivered on the road at a temperature not less than hundred and thirty (130) degree C. Drivers

of Dump trucks will ensure that while moving backwards the vehicles, paver in not pushed back producing a hump.

c) **Asphalt Pavers**

Asphalt pavers shall be self-contained, power propelled units provided with an automatically controlled activated screed or strike off assembly, heated if necessary, capable of spreading and finishing courses of asphalt plant mix material in lane widths applicable to the specified typical section and thickness shown on the plans.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The paver shall be equipped with automatic feed controls, properly adjusted to maintain a uniform depth of material ahead of the screed. The screed or strike off assembly shall be capable of producing a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

The pavers shall be equipped with automatic screed controls with sensors for either or both sides of pavers, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope. The sensor shall be so designed that, it will operate from a reference line or a ski-line arrangement.

The traverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent variation. Manual operation will be permitted in the construction of irregularly shaped and minor areas.

Whenever the breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually or by other methods in order to allow the contractor to use the asphalt already produced at the plant or in transit, provided this, method of operation will produce results otherwise meeting the specifications.

Reference line will be required for both outer edges of the travelled way for each main line roadway for vertical control. Horizontal control utilizing the reference line will be permitted. The grade and slope for intermediate lanes shall be controlled automatically from reference line or by mean of ski and a slope controlled device or a dual ski arrangement. When the finish of the grade prepared for paving is superior to established tolerance and when it is considered that further improvement of the line grade cross-section and smoothness can best be achieved without the use of reference line a ski-line arrangement may be substituted subject to the approval of Engineer-in-Charge. The use of reference line shall be reinstalled immediately whenever the contractor fails to maintain a superior pavement. The contractor shall furnish and install all pins, bracket, tension devices, wire and accessories for satisfactory operation of the automatic control of the equipment.

d) **Rollers**

Rollers shall be steel wheel, pneumatic tyre or vibratory or a combination thereof. The roller(s) shall be in good condition, capable of reversing without backlash and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregates will not be permitted.

21.1.22.4.2 Preparation of Aggregates

Before being led to the dryer, coarse and fine aggregates and filler if used for the asphaltic base courses shall be placed in separate stock piles or cold bins.

Each aggregate ingredient shall be heated and dried at temperature not to exceed hundred and sixty three (163) degrees centigrade, they shall be removed from the binds and returned to their respective stock.

Immediately after heating, the aggregates shall be screened to required size and stored in separate bins for batching and mixing with bituminous materials.

21.1.22.4.3 Asphalt Mix

Asphalt cement shall be heated within temperature range of hundred and thirty five (135) degrees to hundred and sixty three degrees (163) centigrade at the time of mixing.

Dried aggregates weighted and drawn to pugmill shall be combined with proportionate amount of asphalt cement according to the job mix formulas. Temperature of asphalt, except for temporary fluctuation, shall not be lower than 15 degrees centigrade below the temperature of the aggregates at the time the materials enter into the pugmill.

In no case shall the temperature of asphalt mix exceed hundred and sixty three (163) degree centigrade when discharged from the pugmill.

21.1.22.4.4 Testing of Asphalt Mix

At least three test shall be performed on daily production to check;

- Extraction (Percentage of bitumen)
- Gradation
- Bulk specific gravity
- Air Voids
- Void filled with bitumen

21.1.22.4.5 Preparation of Base of Existing Pavement Surface

Before spreading materials, the surface of base or existing pavement on which the mix is to be placed shall be conditioned by application of a prime or tack coat as specified.

After a prime coat is applied, it shall be left undisturbed not less than twenty four (24) hours. The contractor shall maintain the primed surface until the mix material has been placed. This maintenance shall include the spreading of sand or other approved material, if necessary to prevent adherence of the prime coat to the tyres of vehicles using the primed surface, and patching any breaks in the primed surface with additional bituminous material or any area of primed surface with additional bituminous material. Any area of primed surface that has become damaged shall be repaired before the mix is placed. It should be ensured that primed surface is not in tacky condition when premix is laid.

A tack coat shall be applied on existing surface. After the tack coat is applied, it shall be allowed to dry until it is in the proper condition of tackiness to receive the mix. The tack coat shall be applied only as far in advance of the placing of mix, as is necessary to obtain the proper condition of tackiness. Any breaks in the tack coat shall be repaired. When the surface of the existing pavement or old base is irregular, it shall be brought to uniform grade and cross-section by levelling course as directed. A thin coating of bituminous material shall be placed on contact surface of curbing, gutters, manholes, and other structures, prior to the bituminous mixture being placed against them.

21.1.22.4.6 Spreading and Finishing

The mixture shall be laid upon an approved surface, spread and struck off to the section and elevation established. Asphalt pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

Care shall be taken to ensure that material is properly compacted up to joint positions. If this is not done or results in undesired surface of a layer, the Engineer-in-Charge may instruct unacceptable material to be cut back before laying the adjacent material. Joints in superimposed layers of asphaltic material must be offset longitudinally by at least 2 m and transversely by at least 30 cms. Longitudinal joints in wearing course shall, after cutting back, be of good alignment and preferably coincident with the position of carriageway markings. Except where laying in echelon, joints in wearing course shall be cut back to a vertical face and tack coated. Kerb faces, ironwork and the like in contact with wearing course shall be tack coated prior to laying wearing course.

The outer edges of wearing course shall be cut back to a good alignment, parallel with the road alignment. This will require a small additional width of wearing course to be laid.

The Contractor should allow, within his bid rates, for this additional width and for all cutting back wearing course, which will not be measured for payment. Tack coating of vertical faces will not be measured for payment.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be dumped spread and screeded to give the required compacted thickness ensuring even distribution of course and fine material.

When production of the mixture can be maintained and when practical; pavers shall be used in parallel formation along the length of the road to place the wearing course in adjacent lanes and shoulders.

All mixtures shall be spread at a temperature of not less than hundred and thirty (130) degree C and all initial rolling or tamping shall be performed when the temperature of the mixture is such that the sum of the air temperature plus the temperature of the mixture is between 165 degree C and 190 degree C. The mixture shall not be placed on any wet surface or when weather conditions will otherwise prevent its proper handling or finishing.

21.1.22.4.7 Compaction

After spreading and strike off and as soon as the mix condition permits the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted. Rolling shall not be prolonged when cracks appear on the surface. Initial or breakdown rolling shall be done by means of either a tandem steel roller of three wheeled steel roller. Rolling shall begin as soon as the mixture will bear the roller without undue displacement. The number and weight of rollers shall be sufficient to obtain the required compacting while the mixture is still in workable condition. The sequence of rolling and the selection of roller types shall provide the specified pavement density. Initial rolling with a tandem steel roller or a three wheeled steel roller shall follow the paver as closely possible.

Unless otherwise directed, rolling shall begin at the lower side and proceed longitudinally, parallel to the road centreline, each trip overlapping one-half of the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane the longitudinal joint should be rolled first followed by the regular rolling procedure. On super elevated curves the rolling shall begin at the lower side and progress to the high side overlapping the longitudinal trips parallel to the centreline. Intermediate rolling with a pneumatic tyred roller shall be done behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In no case shall the temperature be less than hundred and twenty (120) degree Centigrade. For initial break down rolling while all other compacting operations shall be completed before the temperature drops down to hundred and ten (110) degree C.

Rollers shall move at a slow but uniform speed with the drive roll or wheels nearest the paver. Rolling shall be continued until all roller marks are eliminated and a minimum density of Ninety seven (97) percent of a laboratory compacted specimen made from asphaltic material which is obtained for daily density measuring test. Any displacement resulting while reversing the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers, wheels of rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted. Along forms, curbs, headers, walls and other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tempers, smoothing irons or with mechanical tampers. On depressed areas, tempers be used or cleated compression strips may be use under the roller to transmit compression to the depressed area. Any mixture that becomes loose and broken mixed with dirt, or is in any way defective in finish or density shall be removed and replaced with the surrounding area. Mix in any area showing excess of deficiency or bituminous material shall be removed and replaced. Sequence of laying and compaction of premix shall be so managed that a long time does not elapse between successive dump trucks which may cool down the un-compacted premix, between paver & compacted asphalt below 120^{o}C.

21.1.22.4.8 Frequency of Testing for Cores

Core shall be taken for each seven hundred fifty (750) square meters of base or fraction thereof in special cases. If the core so taken shall fail against the specified density, then two (2) additional cores shall be taken in the longitudinal alignment of the road at an interval of three (3) meters on either sides with respect to the failing core and shall be tested against field density. If these core pass, then the individual compaction of the core shall not be less than Ninety three (93) percent and average of these three cores, in no case be less than Ninety five (95) percent. If average of the cores further fails against compaction, then, retake the cores at a distance of fifteen (15) meters on either side and compaction shall be checked in the same fashion. In case of failure of the average of these five cores, the failed area shall be removed and subsequently be replaced by specified mix in an approved manner under the expense of Contractor.

21.1.22.4.9 Pavement Thickness and Tolerances

After completion of final rolling, the finished surface shall be tested for smoothness with three (3) meters straight edge by the Engineer-in-Charge at selected locations. The variation of surface from testing edge of straight edge between any two (2) contacts with the surface shall at no point exceed six (6) millimetres when placed either parallel or perpendicular to centreline of roadway. Any irregularities that exceed the specified tolerances or that retain water on the surface shall be corrected by removing the defective area and replacing with new base course without additional cost to the Employer. For determination of the average thickness, six (6) cores per Kilometre shall be taken or as directed by the Engineer-in-Charge.

When layer thickness of asphaltic base source is deficient by more five (5) mm from that specified in the drawings, the deficiency shall be removed with satisfactory base course material and or made up by additional asphalt concrete wearing coarse thickness without extra cost to the Employer. If such remedial action is authorized, revised thickness determinations shall be made by measurements of new cores taken after placing of "Asphaltic Wearing Course" material or as directed by the Engineer-in-Charge. If base course deficiencies are corrected in this manner, full payment for the "Asphaltic Base Course" will be made to the Contractor but no additional payment will be made for the increase in thickness of the "Asphaltic Wearing Course".

21.1.22.5 Weather Limitations

Hot asphaltic mixtures shall be placed only when the air temperature is four (4) degrees centigrade or above and no asphalt shall be laid under foggy or rainy weather or over moist surface.

21.1.22.6 Measurement

The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal.

The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

21.1.23 ASPHALT CONCRETE WEARING COURSE – PLANT MIX

21.1.23.1 General

The work shall consist of furnishing aggregates and asphalt binder plant, labour, equipment mixing, transporting, spreading, compacting the mixture in an approved manner on a primed or tacked, base, sub-base, sub-grade bridge deck or concrete pavement in accordance with these specifications and in conformity with the lines, grades and typical cross-sections shown in the drawings or as directed by the Engineer-in-Charge.

21.1.23.2 Material Requirements

The materials consisting of Mineral Aggregates, Asphalt Materials shall conform with provisions of Sub-section 21.1.22.2.

21.1.23.3 Asphalt Concrete Wearing Course Mixture

The composition of the asphaltic concrete paving mixture for wearing course shall conform to class A and/or Class B shown in the following table:

Asphalt Concrete Wearing Course Requirements

Mix Designation Compacted thickness	Class-A 50- 100 mm	Class-B 35- 60 mm
US Standard Sieve size Percent Passing by weight		
1" (25 mm)	100	-
¾" (19 mm)	90-100	100
½" (12.5 mm)	-	75-90
3/8" (9.5 mm)	56-70	60-80
No.4 (4.75 mm)	35-50	40-60
No.8 (2.38 mm)	23-35	20-40
No. 50 (0.300 mm)	5-12	5-15
No. 200 (0.075 mm)	2-8	3-8
*Asphalt Content weight Percent of total mix	3.5 (Min)	3.5 (Min)

The exact percentage of asphalt content shall be determined through JMF.

The asphalt concrete wearing course mixture shall meet the following Marshall Test Criteria:

Description	Standard
Compaction, number of blows each end of specimen	75
Stability	1000 Kg (Min)
Flow, 0.25 mm (0.01 inch)	8-14
Percent air voids in mix	5 - 8
Percent voids filled with bitumen	65 - 75
Loss of Stability	20% (Max)

21.1.23.4 Job-Mix Formula

The Job-Mix Formula (JMF) shall comply with the provisions of Sub-section 21.1.22.3(b).

21.1.23.5 Asphalt Additives

The same as for Sub-section 21.1.22.2(c).

21.1.23.6 Construction Requirements

Construction requirements for this job shall conform to the requirements as specified for Asphaltic Concrete Base Course Plant Mix under Sub-section 21.1.20.4.

a) **Preparation of Base Surface**

Before wearing coat, the surface of the previously and accepted base course on which the mix is to be placed shall be applied a tack coat, or as directed by the Engineer-in-Charge.

b) **Pavement Thickness and Tolerances**

The asphalt concrete wearing course shall be compacted to the desired level and cross slope as shown on the drawing or as directed by the Engineer-in-Charge.

The tolerance in compacted thickness of the wearing course shall be ± five percent (5%) from the desired thickness shown on the drawings. For determination of the average thickness, six cores per kilometre shall be taken. If the average thickness so determined in deficient by more than ± 5%, the Engineer-in-Charge shall decide whether to accept the deficit thickness or to direct reconstruction.

The surface of the wearing course shall be tested by the Engineer-in-Charge using a 3 meter straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts, longitudinal or transverse with the surface shall at no point exceed five millimetres. The cross fall (camber shall be within± 0.2% of that specified, and the level at any point shall be within ± 5.0 millimetres of the level shown on the drawings. All humps or depressions exceeding the specified tolerance shall be corrected by removing the defective work and replacing it with new material, by overlaying, or by other means satisfactory to the Engineer-in-Charge.

21.1.23.7 Sand Flushing

Where specified, sand flushing with a mix of sand and bitumen of the specified proportions shall be applied on top of asphalt concrete road. The material requirements the preparation of the mix and application on road surface shall comply with the provisions of wearing course application.

21.1.24.8 Measurement

The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal.

For item No.21.85, the consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal for item No. 21-85. The quantities for asphaltic leveling / base course will be measured by volume in cubic meters compacted in place. Measurement shall be based on the dimension as shown on plan or as otherwise directed or authorized by the Engineer. No measurement shall be made for unauthorized areas or for extra thickness.

The quantity of asphaltic material used is included in the asphalt concrete mixture and will not be measured separately. Quantities of liquid asphalt, wasted or remaining on hand after completion of the work, shall not be measured or paid for.

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay items listed below and shown in the bitt of Quantities, which prices and payment shall constitute full compensation for all the costs necessary for the proper completion of the work prescribed in this item. Asphalt additive or antistripping agent, if allowed and used to meet with JMF requirement shall not be paid directly, payment shall be deemed to be included in the respective pay items.

21.1.24 SHOULDER TREATMENT

21.1.24.1 General

a) The work shall consist of constructing shoulders of the types specified hereinafter in accordance with the specifications and in conformity to the lines, grades thickness and typical cross-section shown on the plans or established by the Engineer-in-Charge.

b) The shoulders consist of that portion of the completed road construction which lies above the elevation of the subgrade or sub-base and which extends from the edge of the wearing course to the point of inter-section with the embankment slopes on either side of the road centreline.

21.1.24.2 Material Requirements

a) Earth Shoulders

The material used for "Earth Shoulders" shall consist of suitable materials from roadway or structural excavation supplemented by additional suitable material from borrow excavation or as designated on the plans and shall be obtained from sources approved by the Engineer-in-Charge. b) Aggregate Shoulders

Material used for "Aggregate Shoulders" shall be of class designated on the plans and shall conform to all the requirements of 21.1.10 "Granular Sub-base" 21.1.11, "Aggregate Base Course" or 21.1.12 or "Water Bound Macadam Base".

c) Asphaltic Materials

Materials for surface treatment of shoulders shall be liquid asphalts, emulsified asphalts or asphalt cement as specified or shown on the drawings and in the Bill of Quantities. Asphaltic materials shall conform to all the requirements of 21.1.18 for the type specified.

21.1.24.3 Construction Requirements

a) General

All shoulders shall be formed and compacted as soon as practicable after the asphalt paving on the traffic lanes is completed, however in the case of cement concrete surfacing, shouldering operation shall not be initiated prior to Engineer-in-Charge's approval.

b) Shouldering and delineation

On Projects that carry traffic through construction, the contractor shall begin shouldering on the second day of the laying of the final roadway surfacing layer, unless weather conditions prevent this operation, in which case the shouldering shall begin as soon as the weather does permit. If the contractor fails to begin the shouldering within a reasonable time after the last layer has been laid, whether the project has a flow of traffic through construction or not, the Engineer-in-Charge may order the contractor to cease paving until the shoulder work has begun. The shouldering shall be a continuous operation from that time until completion, with the weather being the only delaying factor. The Contractor shall, on roads under traffic or as directed by the Engineer-in-Charge, delineate the edge or pavement as soon as the surfacing is begun and maintain the delineation until the shoulders are completed. The delineators shall be approved prior to use and shall be placed at the edge of the surfacing at approximately one hundred (100) meter intervals. The cost of this delineation will be considered subsidiary to other items in the Bill of Quantities and will not be paid for separately.

c) Earth Shoulders

Earth Shoulders shall be constructed in accordance with the applicable paragraphs under item 21.1.8.

d) Aggregate Shoulders

Aggregate shoulders shall be constructed in accordance with the requirements of item 21.1.10, 21.1.11 or 21.1.12.

e) Asphaltic Treatment of Shoulders

The asphaltic treatment of the prepared shoulders shall be either a bituminous surface treatment or seal coat or a layer of asphaltic concrete as shown on the plans or in the Bill of Quantities. Detailed construction procedures for the particular treatment specified are outlined under SubSections 21.1.19, 21.1.23 and 21.1.24.

21.1.25 BIT – MAC

21.1.25.1 General

This work shall consist of furnishing and mixing aggregates with asphalt binder at site in mobile mixing plant, spreading, compacting on an approved primed subgrade, sub base or base course, for potholes, repair, levelling course and wearing course in accordance with the specification and in

conformity with the lines, grade, thickness and typical cross-section shown on the Drawings or as directed by the Engineer-in-Charge including sealing of cold bituminous surface cracks with sand-bitumen slurry.

21.1.25.2 Material Requirements

A. Mineral Aggregate

Mineral aggregates for BIT-MAC Construction shall consist of coarse aggregates, fine aggregate and filler material, all conforming to the following specification requirements:-

a. Coarse aggregate which is the material retained on No.4 sieve and passing 1 " sieve, shall consist of crushed rock, crushed boulder, or crushed gravel. It shall be clean, hard, tough, sound, durable, free from decomposed stones, organic matter, shale, clay lumps or other deleterious substances. Rock or boulders, from which coarse aggregates shall be obtained, must be of uniform quality throughout the quarry location.
b. Fine aggregates which are the material passing No. 4 sieve shall consist of crushed sand.
c. When combined gradation of coarse and fine aggregates is deficient in material passing No. 200 sieve, mineral tiller shall be added. The filler material shall consist of finely divided rock dust from sound rock, hydrated lime or hydraulic cement. At the time of use it shall be sufficiently dry to flow freely, free from lumps.
d. Aggregate should be stored on hard clean surface so as to facilitate prompt inspection and control, Private property shall not be used for storage purposes without written consent of the owner or lessee and payment to him by contractor, if necessary. Material shall be stored in such a way as to prevent segregation and coning to ensure proper control of gradation. The equipment and methods used for stockpiling and removing aggregates shall be such that no degradation of aggregate will result and no appreciable amount of foreign material will be incorporated into the aggregate. When aggregates containing a wide range of sizes are to be incorporated, they must be stockpiled separately to prevent intermingling. Mineral Filler must be protected from moisture to eliminate caking and hardening.

B. Bituminous Binder

Asphaltic binder used shall conform to standard specification of petroleum asphalt having grades 60-70 or 80-100 penetration. Generally, it will meet the requirement of AASHTO M-20.

C. Design Characteristics

Optimum grading curves for different types of hot mix asphaltic design related to quantum of repair work and maximum size of aggregates, given in Table 21.1.26(a), must be carefully selected considering average thickness of patches.

Design sheet under Table 21.1.26(a) showing Dense Graded Mix used for levelling courses and potholes should use little asphalt content of such quantity to prevent bleeding through subsequent wearing course or surface treatment. Design sheet under Table No. 21.1.26(b) is suitable for open graded wearing course having rough surface texture with good skid resistance thus having minimum bleeding tendency.

21.1.25.3 Construction Requirements

a) **Mixing Requirement**

Asphalt cement shall be heated to a maximum temperature of 163 degrees centigrade at the time of mixing. Asphalt cement heated above 163 degrees centigrade shall be rejected. Temperature of asphalt shall be checked frequently. Each aggregate ingredient shall be heated to temperature 150-160 degrees centigrade for at least six (6) minutes before mixing of asphalt cement to ensure complete drying of aggregates. The range of heating of aggregates shall be strictly followed to ensure proper coating of aggregates. Fine aggregates shall be introduced into the dryer (mixer) first followed by the coarse aggregates to assure proper mixing. Quantity of aggregates fed to dryer (mixer) must be accurately controlled by suitable measuring device (Iron box) having predetermined volume of one(1) cubic foot or as instructed by Engineer-in-Charge.

Both bitumen and aggregates must be heated before they are combined in the mixer drum. Mixing temperature should be kept within the range of 140-170 degrees centigrade.

To achieve uniform mixing and proper coating, aggregates and asphalt cement must be thoroughly mixed for a minimum duration of ninety(90) seconds. Mixing time shall be prolonged to hundred (100) seconds if coating of aggregates is not proper. After one hundred and twenty (120) seconds if it is still not possible to get good coating, the aggregate drying time must be increased. b) Deep Patches/Pot Holes

The surfaces of base course thus prepared as mentioned under Sub-Section 21.1.11 shall be primed to receive Bit Mac in a thickness as per drawings or as directed by the Engineer-inCharge, Bit Mac shall be spread carefully to avoid segregation. Compaction shall be done with equipment suited to the size of job. A vibratory plate compactor is recommended for small patches. Whereas roller may be more practical for larger areas,straight edge or string line shall be used to check riding quality and the alignment of the patch.

c) Levelling Course

All local depressions corrugated surface, ripples across the pavement should be rectified before levelling course is placed. Clean the area free to remove dust or other loose material with mechanical broom or compressed air. Apply light tack coat, 0.2 to 0.7 litres per square meter of A.C 80/100 Penetration grade. After drying dense graded hot Bit-Mac shall be spread in layer not more than seven(7) centimetres in thickness. Spread shall be done carefully to prevent segregation and compact with steel wheeled and pneumatic tyred roller. For small pot holes hand tempers shall be allowed. Use string line to check the riding quality of the levelling course.

21.1.25.4 Wearing Surface

a) Mini Mixing Plant

Local made bitumen aggregate mixer equipment used for preparation of Bit Mac shall be in good working condition of sufficient capacity, capable of being operated to produce a uniform blend with the given ingredients

21.1.25.5 Measurement

The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal.

For item No.21.85, the consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal for item No. 21-85. The quantities for asphaltic leveling / base course will be measured by volume in cubic meters compacted in place. Measurement shall be based on the dimension as shown on plan or as otherwise directed or authorized by the Engineer. No measurement shall be made for unauthorized areas or for extra thickness.

The quantity of asphaltic material used is included in the asphalt concrete mixture and will not be measured separately. Quantities of liquid asphalt, wasted or remaining on hand after completion of the work, shall not be measured or paid for.

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay items listed below and shown in the bitt of Quantities, which prices and payment shall constitute full compensation for all the costs necessary for the proper completion of the work prescribed in this item. Asphalt additive or antistripping agent, if allowed and used to meet with JMF requirement shall not be paid directly, payment shall be deemed to be included in the respective pay items.

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Table 21.1.26 (a)

DESIGN SHEETS FOR DENSE GRADED HOT MIX. FOR LEVELING AND POTHOLES, RELATED TO THICKNESS WITH ASPHALT BINDER 60-70 OR 80-100 PENETRATION GRADE.

AGGREGATE IN MIX	FILLER	FINE AGG.	COARSE AGGREGATES					BITUMEN USED.	REMARKS
Sieve Size Inch (mm)	200 (0.075)	No. 8 (2.36)	No. 4 (4.75)	3/8" (9.5)	1/2" (12.5)	3/4" (19)	1" (25)	4% by Wt. of Mix.	Minimum Layer Thickness:-20 mm Aggr. max size : 9 mm Rate of Aggr. Appl. :-50 Kg/SM
Specification Range	4-12	43-56	55-75	90-100					
Allowed % Passing	9	48	65	100					
% by Weight	57%		43%						
Qty. by Proportion.	4		3						
Specification Range	3-11	30-45	46-60	72-87	87-100			4% by Wt of Mix.	Minimum Layer Thickness: 30mm Aggregate Size:- 12mm Rate of Aggr. Appl.:- 70Kg/SM.
Allowed % Passing	8	36	54	80	100				
% by Weight	46%		54%						
Qty. by Proportion.	3		4						
Specification Range	4-11	32-46	46-60	65-80	75-88	90-100		3.5% by Wt. of Mix.	Minimum Layer Thickness:- 50mm Aggr.size:- 20mm Down Rate of Aggr. Appl.: 115 Kg/SM.
Allowed % Passing	8	38	53	73	82	100			
% by Weight	46%		54%						
Qty. by Proportion.	3		4						
Specification Range	4-12	24-37	34-47	49-61	57-70	70-87	88-100	3.5% by Wt. of Mix.	Minimum Layer Thickness:-50mm Aggr. size:- 20mm Down Rate of Aggr. Appl.: 150 Kg/SM.
Allowed % Passing	8	30	40	54	62	76	100		
% by Weight	46%		54%						
Qty. by Proportion.	3		4						

b) Preparation of Aggregates

Aggregates shall be stored and handled as discussed under 21.1.24.2, Material Requirement. c) Hauling Equipment

Bit-Mac mixed material shall be delivered in tight, clean and smooth metal bed hand trolleys, or any method as convenient to the Contractor and approved by the Engineer-in-Charge.

d) Preparation of Base or Existing Pavement Surface

Surface of base or existing pavement upon which Bit-Mac mix is to be placed shall be cleaned by means of compressed air to remove dust or as approved by the Engineer-in-Charge.

Priming shall be done in a manner as described in Sub-Section 21.1.20. The rate of application of prime coat shall be 0.8 – 1.5 litres per square meter. Tack coat shall be done in a manner as described in 21.1.22. The rate of application of tack coat shall be 0.2 – 0.4 litres per square meter. When surface of existing pavement or old base is irregular, it shall be brought to uniform grade and cross-section by levelling course as described above. Sand bitumen slurry to seal the cracks in clod bituminous surface shall be injected by pressure pumps with nozzles filled at the end instead of spray pipe in conventional Harris trolley.

e) Spreading and Finishing

Bit-Mac mixture shall be placed on approved surface, struck off to required section manually with rakes or hand tools by experienced foreman, distributed over the entire width or partial width as required. All mixtures shall be spread at temperatures not less than one hundred and forty (140) degrees centigrade. Mixture shall not be placed on any wet surface or when the atmospheric temperature is below five (5) degree centigrade or when the weather is foggy or rainy. f) Compaction

Roller shall be steel wheel or pneumatic tyre roller. The roller(s) shall be in good working condition, capable of reversing without backlash, capable to be operated at speeds slow enough to avoid displacement of Bit Mac. The number and weight of rollers shall be sufficient to compact the mixture while it is still in workable condition to obtain compaction to the satisfaction of Engineer-in-Charge. The use of equipment which results in excessive crushing of aggregates shall not be permitted.

After spreading and strike off as soon as the mix condition permit the rolling to be performed without excessive shoving or tearing, the Bit Mac mixture shall be thoroughly and uniformly compacted. Rolling will not be prolonged to avoid appearance of cracks. Rolling will be done longitudinally, beginning at the lower side of the spread and proceeding towards the higher side, overlapping successive trips by at least one half (1/2) the width of rear wheels of roller.

To prevent adhesion of mixture to rollers, the wheels of rollers shall be kept properly moist with water, but avoiding excess water. Rolling shall be continued until all roller marks have been eliminated.

Along forms, curbs, headers, walls and other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers or mechanical tampers. Any mixture that has become cold enough, mixed with dirt or is defective in any way shall be replaced with fresh hot mixture and compacted to conform the requirement.

21.1.26 PORTLAND CEMENT CONCRETE PAVEMENT

21.1.26.1 General

The work specified in this section consists of the construction of Portland Cement Concrete pavement constructed in one course on a prepared sub-grade or base in accordance with these specifications and in conformity with the lines and cross-sections shown on the plan and shall include curves where specified. The concrete shall be composed of mixture of Portland Cement, fine aggregate, coarse aggregate and water with air-entertaining admixture where specified, conforming in general to the requirements contained in Section 5 – Plain & Reinforced Concrete. When reinforced cement concrete is called for in the contract document, the concrete shall be reinforced with steel bar or steel mesh in accordance with the details shown on drawings.

21.1.26.2 Materials

a) **Portland Cement**

The Portland cement shall conform to the requirement, for Portland cement contained in Section 5, Plain & Reinforced Concrete.

b) **Fine Aggregate**

Fine aggregate shall be natural sand or other approved inert material with similar characteristics, of clean, hard, strong durable, uncoated particles, free from lumps of clay, soft or flaky particles, loam, frost or organic matter, unless otherwise approved, the grading shall meet the following requirements:

Sieve Size	Percentage Passing by Weight
3/8 inch	100
No. 4	95 –100
No. 16	45 – 80
No. 60	10 – 30
No. 100	2 – 10
No. 200	0 – 4

c) **Coarse Aggregate**

The coarse aggregate used shall consist of crushed stone gravel or other approved inert material of similar characteristics having hard, strong, durable, uncoated pieces free from deleterious substances.

Unless otherwise approved coarse aggregate shall be separated into two grading classifications. Each classification shall be stored separately in such a manner as will prevent segregation or combining of the two classifications prior to proportioning. Grading of the two classifications shall be as follows:

Sieve Size	Percentage Passing by Weight
Number 1	
1 ½ inch	100
1 inch	95 –100
½ inch	25 – 60
No. 4	0 – 10
No. 8	0 – 5
Number 2	
2 ½ inch	100
2 inch	95 –100
1½ inch	35 – 70
1 inch	0 – 15
½ inch	6 – 5

These two classifications shall be proportioned by weight at the time of batching or mixing in the proper proportions by volume, to meet the following grading requirements when tested in accordance with AASHTO T-27.

Sieve Size	Percentage Passing by Weight
2 ½ inch	100
2 inch	95 –100
1 inch	35 – 70
1½ inch	10 – 30

No. 4	0 – 5

The percentage of wear of coarse aggregate at 500 revolutions, when tested in accordance with AASHTO T-96 shall not exceed 40%.

d) **Water**

Water for concrete shall conform to the requirements contained for "water" as per Section 5 – Plain & Reinforced Concrete.

e) **Air-entertaining Admixture**

The admixtures when designated to be used in the concrete shall conform to the requirement of AASHTO M-154.

f) **Expansion Joint Fillers**

i) **Soft Wood-board / Expansion Joint Filler:**

a) General Requirements:

The boards shall be of sound heart wood. Occasional small sound knots and medium surface cheeks will be permitted provided the board is free from any defects that will impair its usefulness for the purpose intended. The joint filler may be composed of more-than one length of board in the length of the joint, but no board of a length less than 6 feet long be used and the separate pieces shall be held securely to form a straight joint.

Board joint-materials shall be immersed in water for a period of not less than 24 hours before being installed in the pavement slab. The boards shall not be allowed to dry out, and shall be kept thoroughly wet until installed in the slab.

b) Weight per cubic foot:

The oven dry weight of the soft wood shall not exceed 25 pounds per cubic foot.

c) Dimension shall be as specified or shown on the drawings and tolerance of +1/16 inch thickness, + 1/8 inch depth and +1/4 inch length shall be permitted.

d) Compression:

The load required to compress the material in an oven-dry condition to 50 percent of its thickness for test shall not be more than 1,500 pounds per square inch.

e) Method of Testing:

The sampling and testing shall be in accordance with the standard method of AASHTO T-52.

ii) **Mixed Asphalt and Mineral Filler:**

a) General Requirements:

The mixtures of asphalt and mineral filler are also used for filling joint in the pavement. The filler shall be prepared by mixing approved asphalt with cement and sand as specified. It shall be uniform in appearance and consistency and shall not foam when heated to a temperature of 350ºF. b) Asphalt:

The asphalt used, in the preparation of the asphalt mineral filler mixture shall conform to the requirements of standard specifications for asphalt cement (prepared from petroleum) as specified under Clause 21.1.20.2(c).

c) Cement and Sand:

The cement and sand shall be as specified under Clause 21.1. 19.2(a) & (b) respectively.

iii) **Joint Sealer (Hot-poured Elastic Type):** a) General Requirements:

The joint sealer shall be as approved and a rubber asphalt compound resilient and adhesive in nature capable of effectively sealing joints in concrete against the infiltration of moisture and foreign material during the expansion and contraction cycles due to temperature changes. It shall not flow from the joint or be picked up by a vehicle tyres in summer high temperatures. Pour point shall be at least 20°F lower than the safe-heating temperature.

Penetration at 77°F, 100 grams, 5 seconds shall not exceed 90.

b) Bond:

The sealer shall be tested at 0°F for five complete cycles. The development of crack, separation or other opening at any point is above 1/4 inch deep, in the sealer or between the sealer and mortar block at any time during the testing procedure, shall constitute failure of the test specimen. The depth of the crack, separation or opening shall be measured perpendicular to the side of the sealer showing the defect.

c) Method of sampling and Testing:

The sampling of the material and the testing of physical requirements specified above shall be done in accordance with the AASHTO designated T-40 and T-187 respectively.

d) PVC Water Stop:

The PVC water stop shall comply with applicable provisions of Section 5 – Plain & Reinforced Concrete.

e) Polythene Sheeting:

Polythene sheeting for placing immediately below concrete slabs shall be 0.065 mm thick or having a minimum weight of fifty (50) grams per square meter (whichever is greater) made from polythene or other approved hydrocarbon thermoplastic resin (produced by the polymerization of ethylene under high pressure and density) and given an anti-static treatment to reduce dust attraction and reduce friction. The sheet shall have the minimum mechanical properties shown in table as follows:

PROPERTIES OF POLYTHENE SHEETING

Properties	Machine Direction	Transverse Direction
Tensile Strength Method ASTM D882-73	140	105
kElongation at Break %gf/Sq. M	150	500
Tear Strength (Elmendorf Method)	390	310
ASTM D 689-62 (1974) kg/cm^2		

f) Dowel Tie, Reinforcement Bars:

The bars shall be deformed bars of the size shown on the plans and shall conform to the requirements of steel Section 5 – Plain & Reinforced Concrete.

g) Bituminized Water Proof Paper:

The bituminized water proof paper shall comply with the provisions of clause 8.2.3.2 as approved by the Engineer-in-Charge.

21.1.26.3 Construction Details

a) Pavement Base:

The base upon which the concrete pavement is laid shall have been constructed or prepared as specified on drawings and directed by the Engineer-in-Charge.

The base shall be smooth compacted and true to the grades and cross-sections including the cushion of sand, polythene sheet, bituminized paper shown on the plans and shall be so maintained, as provided throughout the period of placing concrete pavement. The base under polythene sheet & bituminized paper shall be moistened immediately prior to placing concrete. To ensure the proper depth and section, a template to depth and section and resting on accurately set aside forms shall be moved over the surface immediately before placing concrete; and any irregularities shall be immediately corrected. High spots shall be planed down; and the Contractor shall have the option of either filling low spots to the proper elevation with approved material, which shall be watered, compacted and struck off to the required grade or of placing additional concrete. No measurement or payment will be made for such additional concrete.

For reinforced pavement, the reinforcing bars shall be placed as shown and on drawings complying with the provisions of Section 5 – Plain & Reinforced Concrete.

b) Forms

Forms shall be made of steel, of an approved section; with a base width of at least 8 inches and the depth shall be equal to the thickness of the pavement at-the edge. The forms shall be staked with stakes, and stakes shall be of length satisfactory to the Engineer-in-charge. Batch section of forms shall have a stake pocket at each end and at intervals of not more than 5 feet in between. The stake pockets shall have a device for locking the form to the steel stakes. Each section of forms shall be straight and free from bends and warps at all times. No section shall show a variation greater than 1/8 inch in 10 feet from a true plane surface on the top of the form; and the inside face shall not vary more than 1/4 inch from a plane surface.

Before placing forms, the underlying material shall be excavated to the required grade if necessary and shall be firm and compact. The forms have full bearing upon the foundation throughout their length and shall be placed with exactness to the required grade and alignment of the edge of the finished pavement. They shall be so supported during the entire operation of placing tamping and finishing the pavement so that they will not deviate vertically at any time more than 1/8 inch from the proper elevation.

Forms shall be set to the required lines and grades well ahead of placing concrete; preferably not less than 600 feet. Forms shall not be removed for at least 12 hours after the concrete has been placed. Forms shall be carefully removed in a manner as to avoid damage to the pavement. Under no circumstances will the use of pry bars between the forms and the pavement be permitted.

Forms shall be thoroughly cleaned and oiled each time they are used.

When pavement is placed adjoining old concrete pavement with finishing machine, any irregularities in the old pavement shall be ground down to a true, uniform surface of sufficient width to accommodate the wheels of the finishing equipment if necessary to obtain proper smoothness of the pavement.

c) Proportioning

Proportioning & mixing of concrete shall be by volume as specified and shall be carried out in accordance with the applicable provisions of Section 5 – Plain & Reinforced Concrete. The fresh concrete shall be tested according to the provisions of the same section.

No change in the source, character or grading of the materials shall be made without prior approval of the Engineer-in-charge.

d) Moisture content of Aggregate

The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the proportioning plant or site to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dry to meet the above requirement.

e) Handling of Materials

Materials shall at all-time be handled in such a manner as will preserve their integrity and prevent loss. The equipment and methods used for stockpiling aggregates and for moving the aggregates, from the stockpiles to the mixer shall be such in the opinion of the Engineer-in-charge that no degradation or segregation of the aggregate will result and that no foreign material will be incorporated into the aggregate.

Aggregates shall be transported from the proportioning plant in batch boxes, vehicle bodies or other containers of sufficient capacity and adequate construction to carry properly the entire volume required per batch and shall be delivered to the mixer with each batch separate and intact without loss.

Loose cement shall be transported to the mixer either in waterproof compartments carrying the full amount of cement required for the batch.

Where cement is placed in contact with damp aggregates the materials may be rejected unless mixed within one hour of such contact. Cement in original factory packages may be transported on top of the aggregates.

f) Consistency

The slump of the pavement concrete shall be from one to three inches, as determined by the Engineer-in-charge. The slump shall not vary more than one inch from batch to batch.

g) Placing Concrete

Concrete shall be placed on the prepared sub-grade moistened as directed prior to the placement of polythene sheet, bituminized paper as specified. The concrete shall be placed in such a manner as will require as little re-handling as possible and avoid segregation of materials.

If required by the Engineer-in-charge the forms shall be wetted immediately prior to the placing of concrete. All operations shall be in accordance with provisions of Section 5 – Plain & Reinforced Concrete.

i) Cold Weather Concreting

Except by specific written authorization from the Engineer-in-charge concreting operations shall not be continued when air temperature in the shade and away from artificial heat falls below 40°F, nor shall operations be resumed until as ascending air temperature in the shade and away from artificial heat reaches 35°F. Mixing and placing concrete in any day, shall continue not later than the period which allows sufficient time remaining to finish and protect the concrete already poured, before the air temperature drops to 35°F. Concrete shall not be placed on frozen ground.

When concreting is authorized during cold weather the aggregates may be heated by the use of steam coils or dry heat before being placed in the mixer. The aggregates shall be heated uniformly, but not hotter than150°F. The apparatus used shall preclude the possible occurrence of overheated areas which might injure the materials. Water may be heated, but shall not be hotter than 150°F. Unless otherwise authorized the temperature of the mixed concrete shall be not less than 60°F nor more than 90°F when it is placed. After placement of concrete, blanketing material shall be provided and shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete.

The Contractor shall be responsible for protection of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced without additional expense to the Employer.

j) Joint

i) **General Requirements:**

All joints shall be constructed as per to alignment and grade in accordance with the details shown on the drawings and as specified herein. The tie bars and joint assemblies, such stakes, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and levelled position.

ii) **Construction Joints**

At the end of each day's concreting or where an interruption in the work of more than 30 minutes occurs, a construction joint shall be placed as shown on the plans or as desired by the Engineer-Incharge. Construction joints shall be placed only at the location of a contraction joint or at the midpoint of the slab between two adjacent normally spaced transverse joints. Any excess concrete shall be disposed of as directed by the Engineer-in-charge. The spacing of subsequent transverse joints shall be measured from the transverse contraction joints last placed. All transverse joints except mid-point construction joints shall be continuous across the full width of the pavement.

iii) **Longitudinal joints**

Longitudinal joints shall be constructed in accordance with the details shown on the drawings. Where specified, steel tie bars of the dimensions shown and meeting the requirements as specified herein shall be placed across the longitudinal joint as shown on the plans. The tie bars shall be held in position, at the spacing shown perpendicular to the joint and at the correct distance from the surface of the slab by metal chains, pins or other supports. Instead of using supports, the tie bars may be floated in place by approved methods.

When the lanes are poured separately, the tie bars may be set temporarily along the form and then straightened into the correct position before the next lane of pavement is poured.

Where sawed longitudinal joints are required or permitted, the joint shall be sawed after the concrete has hardened, but before traffic of any kind is permitted on the pavement. The joint shall conform to the requirements specified herein under sawed joints.

Where curb and gutter is to be constructed adjacent to new concrete pavement, the curb and gutter shall be placed after the pavement, and the joints in the curb shall be opposite each transverse joint in the adjoining pavement.

iv) **Transverse Contraction Joints**

1. General Requirements:

Transverse contraction joints shall consist of formed control joints and sawed joints conforming to the requirements of the roadway standards and these specifications.

Unless otherwise specified on the plan or in the special provisions and except as otherwise provided herein, the first lane poured shall have formed control joints spaced at a maximum of 60 feet and the intermediate joints at 15 feet centre shall be sawed joints. Under certain conditions, if deemed advisable by the Engineer-in-charge he may order that formed control joint be used instead of sawed joints. In lanes adjacent to previously constructed lanes, all contraction joints shall be opposite to joints or cracks which have opened in the previously constructed slab and these joint shall be formed control joints.

2. Formed Control Joints:

The formed control joints shall be constructed by making a transverse groove in the pavement lane and installing therein steel strips as joint inserts spaced as shown on the roadway standards or on the plans. The joint inserts shall be maintained true to line and grade at an elevation not more than 1/4 inch below the pavement surface. The joint inserts shall consist of steel strips 2¼ inches wide and maximum of No. 12 gauge. Each strip shall be furnished in one piece. Splicing, except by welding, will not be permitted. Any strips damaged in installing or during the finishing of the pavement shall be replaced with undamaged strip.

The joints inserts shall be set following the first pass of the finishing equipment, and may be installed either by a machine or by hand methods as approved by the Engineer-in-charge. If manual methods are used, a groove shall be formed by means of a "T" iron cutter with a blade at least 1/4 inch greater in depth than the joint strip. The joint inserts shall then be placed in the groove by means of a metal installing device with a backup plate extending full depth of the strip on one side and 3/4 inch on the other side and it shall have a gauge resting on each side of form to control the depth to which the strip is set. Mortar shall be floated into the groove around the joint after the installing device is removed and before any finishing equipment passes over the joint.

When it is necessary to place joint inserts temporarily at a depth greater than 1/4 inch below the pavement surface in order to prevent damage to the inserts by finishing equipment, the inserts shall be raised to the required elevation immediately after the last pass of the mechanical float.

3. Sawed Joints:

Sawed joints shall be formed by cutting a groove in the pavement with multiple blade power concrete saw. The grooves for construction joints shall be cut 2 inches deep and the width shall not exceed 3/16 inch.

Preferably all joints shall be sawed before uncontrolled shrinkage cracking takes place, usually four to twenty-four hours after placing, but sawing shall not be done until the concrete has hardened to the extent that tearing and ravelling is not excessive. The exact time for all sawing shall be determined by the Engineer-in-charge. In case it is found impossible to saw all joints before uncontrolled cracking takes place, the transverse contraction joints 30 feet or more apart shall be sawed before uncontrolled cracking takes place and the intermediate joints sawed immediately thereafter.

Any procedure for sawing joints that result in premature and uncontrolled cracking shall be revised immediately by adjusting the sequence of sawing the joints, by adjusting the time interval involved between the placing of concrete and the sawing of the joints, or by placing formed control joints. In addition to the multiple blade power saw, the Contractor shall keep a stand-by concrete saw on the project at all times while concrete operations are in progress. This saw may be a single blade saw.

4. Transverse expansion joints:

Transverse, expansion joints shall be constructed at the end of bridges and culverts at grade and at all obstructions that extend into or through the pavement, as shown on the roadway standards or on the plans and as specified herein. .

Transverse expansion joints shall be formed by a preformed or redwood joint filler conforming to the requirements specified herein under “Expansion Joint Filler" and as shown on the roadway standards or on the plans. The joint filler shall be held in position by protective means.

k) **Spreading, Finishing and Floating**

a) **General Requirement**

Except as otherwise specified, the striking off, compacting and floating of concrete shall be done by mechanical methods. Where the Engineer-in-charge determines that it is impracticable to use mechanical methods, manual methods of spreading, finishing and floating may be used on pavement lanes of widths less than 10 feet.

b) **Mechanical Methods**

1. Spreading and Finishing:

The concrete shall be spread uniformly between the forms immediately after it is placed by means of an approved spreading machine. The spreader shall be followed by an approved finishing machine equipped with two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Internal vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine or to the finishing machine. Vibrators shall not rest on new pavements or side forms or contact any tie bars and power to the vibrators shall be such that when the motion of the machine is stopped, vibration will cease. The rate of vibration shall be not less than 3,500 vibrations per minute.

The concrete shall be spread full width before being struck off by the finishing machine. The concrete shall be struck off and compacted so that the surface will conform to the finished grade and cross-section shown on the plans and at the same time leave sufficient material for the floating operation. The spreading and finishing machine shall move over the pavement as many times and at such intervals as may be required by the Engineer-in-charge to ensure thorough compaction.

2. Floating:

Except as otherwise specified, after the pavement has been struck off and compacted, it shall be finished with an approved longitudinal float.

The Contractor may use a longitudinal float composed of one or more cutting and smoothing floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels riding on and constantly in contact with the forms.

The Contractor may use a longitudinal float which works with a sawing motion, while held in a floating position parallel to the road centre-line and passing gradually from one side of the pavement to the other. Movements ahead along the centre-line of the road shall be in successive advances of not more than 1/2 the length of the float.

Instead of using either type of longitudinal float, a single machine which will affect satisfactory compaction, finishing and floating may be used. This machine may be towed by a spreading machine. This combination finishing-floating machine shall be equipped with screeds and vibrators as hereinafter specified for spreading and finishing machines. Floating shall be accomplished by means of a non-oscillating float held in a suspended position from the frame.

If any spreading finishing and floating equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or satisfactory equipment substituted or added at the direction of the Engineer-in-Charge.

c) **Manual Methods**

1. Striking-off and compaction:

When striking-off and compacting by manual methods are permitted, the concrete shall be approximately levelled and then struck-off to such an elevation that when properly compacted, the surface will conform to the required grade and cross-section. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither end is raised from the side forms during the process. While striking-off, a slight excess of concrete shall be kept in front of the cutting edge at all times.

Prior to tamping, the concrete along the forms shall be thoroughly spaded or vibrated. The entire area of pavement shall be tamped or vibrated in a manner that will ensure maximum compaction. The concrete shall be brought to the required grade and shape by the use of a tamper consisting of a heavy plank whose length exceeds the width of the pavement by one foot, or by the use of a mechanical vibrating unit spanning the full width of the spread. The tamper shall be constructed with proper trussed rods to stiffen it and prevent sag and shall be shod with a heavy strip of metal for finish as required. The tamper shall be moved with a combined tamping and longitudinal motion, raising it from side form and dropping it so that the concrete will be thoroughly compacted and rammed into place. A small surplus of concrete shall be kept in front of the tamper or vibrating unit and tamping or vibrating shall continue until the true cross-section is obtained and the mortar flushes slightly to the surface.

On grades in excess of 5 percent where manual methods are permitted, a little strike board shall follow from 25 feet to 50 feet back of the heavy strike board, and shall be used in the same way, so as to remove waves caused by the flow of concrete.

Where hand tamping is permitted, not less than two strike boards or tampers shall be used for production in excess of 350 cubic feet per hour. After the concrete has been compacted, it shall be smoothed with a wooden float where necessary in the opinion of the Engineer-in-charge.

2. Longitudinal Floating:

Manual floats shall be at least 12 feet in length, not less than six inches in width and shall be properly stiffened to prevent bending or warping. In using the float, it shall be held parallel to the centre-line of the pavement at all times and shall be moved laterally across the pavement from one side or edge to the other until all high areas are cut down and floated in to level, leaving a surface that is smooth and true to grade. Both transverse passage of the longitudinal manual float shall lap the half of the preceding passage.

3. First Straight Edge Testing:

Immediately following the final floating, entire area of the pavement shall be tested with a 10 feet straight edge. Any depressions found shall be immediately filled with fresh concrete which shall be struck off, compacted and finished. High areas shall be worked down and refinished. The straight edge testing and re-floating shall continue until the pavement has the required surface contour.

4. Burlap (Coarse Canvas) Dragging:

After the first straight edge testing and when most of the water shell has disappeared from the surface and just before the concrete becomes non-plastic, the surface shall be dragged with a strip of burlap (coarse canvas) three feet to 10 feet wide and having a length four feet more than the width of the slab. The burlap shall be dragged along the surface of the pavement in a longitudinal direction. Burlap shall be clean and kept free from coatings of hardened concrete. It shall be moist at the time of use.

5. Second Straight Edge Testing:

After the concrete has hardened sufficiently to permit walking on it, the surface of the pavement shall again be tested with a 10-feet straight edge. Any portion of the pavement which shows a variation from the testing edge of more than 1/8 inch shall be corrected by cutting, or shall be removed and replaced at the expense of the Contractor.

21.1.26.4 Opening Pavement to Traffic

Pavement shall remain closed to traffic until tests show the concrete to have a minimum modulus of rupture when tested in accordance with ASTM C-293 of not less than 600 pounds per square inch but in no case shall the pavement be opened to traffic in less than 14 days after concrete is placed.

21.1.26.4 Measurement

Refer Section 5

21.1.27 BOUNDARY PILLARS

21.1.27.1 General

The boundary pillars shall be of either precast RCC or hard stone of sound and durable quality. These shall be in blocks of size 6 inches x 6 inches x 30 inches (15x15x75 cm) unless directed otherwise by the Engineer-in-Charge. A tolerance of 12.5 mm shall be permitted in the specified size. In the case of boundary stones of hard stone, the upper 30 cm shall be chisel dressed on all the four sides and on the top.

21.1.27.2 Precast Concrete Pillars

The precast concrete boundary pillars shall be cast in cement concrete 1**:**2**:**4 (1 cement **:** 2 coarse sand **:** 4 graded stone aggregate 20mm nominal size), where specified reinforced with 10mm diameter tor steel bars or as directed. The precast concrete pillars shall be finished smooth with 1**:**3 cement mortars.

The lower half portion of the boundary pillars or as shown and drawings shall be encased on all sides by at least 15 cm of 1**:**4**:**8 foundation concrete (1 cement **:** 4 fine sand **:** 8 graded stone aggregates of 40 mm nominal size). The work shall be carried out according to the applicable provisions of Section 5 – Plain & Reinforced Concrete.

21.1.27.3 Hard Stone Boundary Pillars

The hard stone boundary pillars shall be as stated under Clause 21.1.28.1 above. The stone boundary pillars shall be installed as specified for concrete pillars under Clause 21.1.28.2 above.

21.1.27.4 Engraving / Letters

The boundary pillars shall be engraved/written letters for each pillar as specified.

21.1.27.5 Measurement

Boundary Pillar shall be enumerated.

21.1.28 KILLOMETER STONES

21.1.28.1 General

The kilometers stones shall be either precast concrete or of hard durable stone in shape and sizes as specified.

21.1.28.2 Precast Concrete Stones

The precast stones shall be cast in-situ 1:2:4 concrete complying with the provisions of Section 5 – Plain & Reinforced Concrete. To obtain smooth finish, 1:3 cement sand mortar shall be applied.

The excavation for foundation as specified for installation shall comply with the provision of Section 3 – Earthwork. The pillar shall be fixed in 1:4:8 concrete of the specified size and backfilled. The letters as specified shall be engraved or painted.

21.1.28.3 Hard Stone Kilometer

The hard stone kilometer shall comply the provisions for boundary stone under Clause 21.28.1 and shall comply with provision of Clause 21.28.3 for installation. The letters shall be engraved or painted as specified.

21.1.28.4 Measurement

Kilometer stones shall be enumerated.

21.1.29 CONCRETE KERBS, GUTTERS AND CHANNELS

21.1.29.1 General

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-inCharge. 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

21.1.29.2 Material Requirements

The quality of concrete for cast in place concrete kerb, gutters and channels shall be as indicated on the Drawings and shall conform to the requirements of Section 5- Plain & Reinforced Concrete. Precast concrete kerbing units shall consist of 1:3:6 concrete conforming to the Section 5 – Plain & Reinforced Concrete 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.

Form to hold the concrete shall be built and set in place as described under Sub-Section 5 – 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 Section 5.4 – “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 (3) minutes after preparation.

The Bonding compound when used shall conform to AASHTO M-200.

21.1.29.3 Construction Requirements

i) **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-inCharge. Where directed by the Engineer-in-Charge, 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 straightedge 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 sheet template referred to above, on the approval of the Engineer in-Charge. 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 of 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 location 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 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 construction 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 crosssection , 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 land 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 be not permitted on the face of a kerb or kerb and gutter and all rejected kerb or gutter shall be removed and replaced without additional cost. All surface 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 5.3.7 Curing approved by the Engineer-in-Charge. h) Backfilling

After removal of the forms and sufficient curing 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.

ii) **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-in-Charge. Bedding shall consist of 1:3:6 Concrete or as designated in drawings conforming to the requirements of Section 5 – Plain & Reinforced Concrete and shall be 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-in-Charge. 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.

iii) **Extruded Concrete Kerbs and Channels** a) Excavation and Bedding

Excavation and bedding shall conform to the requirements as described under (i)(a) above. 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 operate 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 wetted 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 vary by more than five (5) mm form 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 joins 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 Sub-section 21.1.25.2 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 Engineer-in-Charge. 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 under (i) and (ii) of this Sub-Section 21.30.3.

21.1.29.4 Measurement

Cement concrete Kerbs, Gutters and channel shall be measured in metre of length of the completed channel correct upto two places of decimal.

21.1.30 REPAIRING ASPHALT BITUMEN ROADS

21.1.30.1 Preparation

The surfaces and portions to be repaired shall be prepared by brushing cleaning cutting and dismantling as specified and directed by the Engineer-in-Charge.

21.1.30.2 Repairing

The surfaces prepared shall be repaired with the original constructions material as specified following the applicable specifications and directed by the Engineer-in-Charge.

21.1.31 PLACING PIPES

21.1.31.1 EXCAVATION

Excavation of trenches in natural surface and Roads for laying/replacing pipes shall be carried out as shown on drawings in natural surface or roadway in accordance with applicable provisions of Section 3 – Earthwork. Where necessary dismantling shall be done according to applicable provisions of Section 4 – Dismantling.

21.1.31.2 Laying of Pipes

The bed of trenches shall be prepared as specified.

The pipes as designated shall be laid in accordance with applicable provisions of Section 25 – Sewerage& Section 27 – Tube well & Water Supply.

21.2 ROAD STRUCTURES

21.2.1 GENERAL

The following are the major road structures;

a) Bridges
b) Culverts

The bridges are dealt with in a Section 10 – Road Bridges. The culverts and curbs are referred hereunder. The culverts are described various categories. All works shall be constructed according to drawings, specifications and as approved by the Engineer-in-Charge.

21.2.2 SLAB CULVERTS

21.2.2.1 Materials

Cement, fine and coarse aggregates, water and reinforcement steel shall conform to the respective provision of Section 5 – Plain & Reinforced Concrete. The burnt bricks shall conform with the provisions of Section 11 – Brickwork.

21.2.2.2 Excavation

The excavation as required shall conform to the provision of Clause 3.8.4 “Excavation in trenches for pipes cables etc.”

21.2.2.3 Construction Requirements

a) The laying cement concrete in foundation. It shall be laid in accordance with provisions of Section 5, Plain & Reinforced Concrete and in conformity with the lines, and grades shown on the plans.
b) The abutment and wing walls shall be constructed in cement mortar in brick masonry, or precast concrete blocks or stone masonry according to the applicable provisions of Section 11 – Brickwork or Section 9 – Block Masonry or Section 12 – Stone Masonry as specified.
c) Laying Reinforced Cement Concrete Slab: It shall be laid in conformity with the lines shown on the plan and in accordance with the provisions of Section 5 – Plain & Reinforced Concrete. d) Backfilling:

It shall be done in accordance with Clause 3.8.4 – Earthwork.

e) Construction of Parapets:

These shall be constructed in accordance with the lines and grades shown on the plan and in accordance with the provisions of (b) above.

f) Construction of Up-stream and Down-stream toe walls:

These shall be constructed in accordance with the lines and grades shown on the plan and in accordance with the lines and grade shown on the plan and in accordance with applicable provisions of above referred paras.

g) Construction of Floors:

Bricks on edge flooring in cement mortar shall be laid over cement, concrete in conformity with the lines and grades shown on the plan and in accordance with the provisions of the above referred paras.

h) Pre-mix Carpet:

It shall be laid over RCC Slab as shown on the plan in requisite thickness and in accordance with applicable provisions of Clause 21.1.20 – Asphaltic Concrete Road Mix. i) Plastering:

½" thick plastering shall be done with cement mortar in accordance with Section 11 – Brickwork and in conformity with the lines shown on the plans.

21.2.3 PIPE CULVERTS

21.2.3.1 Description

This work shall consist of the construction or reconstruction of pipe culverts, hereinafter referred to "conduit" in accordance with these specifications and in conformity with the lines and grades shown on the plans or established by the Engineer-in-Charge.

21.2.3.2 Materials

Materials shall meet the requirements specified as under;

i) Cast Iron Pipe:

This pipe shall conform to RS 78 for spigot and socket vertically cast pipe, RS 1211 for spigot and spun iron pipes and RS 2035 for flanged pipes for the specified diameter weight and thickness.

ii) Reinforced Cement Concrete Pipe:

This pipe shall conform to the requirements of ASTM Designation C-76 for Class-IV pipes "Reinforced Cement Concrete Pipes" for the specified diameter, weight, thickness and reinforcements.

iii) Joint Mortar:

Pipe joint mortar shall consist of one part Portland cement and two parts approved sand in accordance with Clause 11.7.2(ii) "Cement Mortar".

21.2.3.3 Excavation

It shall conform to provisions of Clause 3.8.4.

21.2.3.4 Construction Requirements

a) **Trenches:**

Trenches shall be excavated to a width sufficient to allow for proper jointing of the conduit and thorough compaction of the bedding and backfill material under and around the conduit. Where feasible, trench walls shall be vertical.

The completed trench bottom shall be firm for its full length and width. Where required, in the case of cross drains, the trench shall have a longitudinal camber of the magnitude specified.

Where conduits are to be placed in embankment fill, the excavation shall be made after the embankment has been completed to the specified height above the designed grade for those conduits specified on the plans.

b) **Bedding:**

The conduit bedding shall conform to one of the classes specified, when no bedding class is specified the requirements for Class "C" bedding shall apply.

Class "A" bedding shall consist of a continuous concrete base conforming to the plan and details.

Class "B" bedding shall consist of bedding conduit to a depth of not less than 30 per cent of the vertical outside diameter of the conduit plus 4 inches. This bedding material shall be sand or selected sandy soil all of which passes a 3/8 inch sieve and not more than 10 per cent passes a No. 200 sieve. The layer of bedding, material shall be shaped to fit the conduit for at least 15 percent of its total height. Recesses in the trench bottom shall be shaped to accommodate the bell when the bell and spigot type conduit is used.

Class "C" bedding shall consist of bedding the conduit to a depth of not less than 10 percent of its total height, the bed shall be shaped to fit the conduit and shall have recesses shaped to receive the bell.

c) **Laying Conduit:**

The conduit laying shall begin at the downstream end of the conduit line. The lower segment of the conduit shall be in contact with the shaped' bedding throughout its full length. Bell or groove ends

of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream. Flexible conduit shall be placed with longitudinal laps at the sides.

d) **Joint Conduit:**

Rigid conduits may be of bell and spigot or tongue and groove design unless one particular type is specified. The method of jointing conduit sections shall be such that ends are fully entered and the inner surfaces are reasonably flush and even.

Joints shall be made with (a) Portland Cement Mortar, (b) Portland Cement Grout, (c) Rubber gaskets or any other type as may be specified.

Mortar joints shall be made with an excess of mortar to form a bed around the outside of the conduit and finished smooth on the inside. For grouted joints, mould or runners shall be used to retain the poured grout. Rubber ring gaskets shall be installed so as to form a flexible watertight seal. When Portland Cement mixtures are used, the completed joint shall be protected against rapid drying by suitable covering material.

Flexible conduits shall be firmly joined by coupling bands. Conduit shall be inspected before any backfill is placed. Any pipe found to be out of alignment, unduly settled, or damaged shall be taken up and re-laid or replaced.

e) **Backfilling:**

After the conduit is installed, the trench shall be backfilled with selected material in accordance with specifications referred above.

When the top of the conduit is exposed above the top of the trench embankment, material shall be placed and compacted for a width on each side of the conduit equal to at least twice the horizontal inside diameter of the conduit, or as shown on drawings. The embankment on each side of the conduit, for a distance equal to inside diameter of the conduit, shall be of the same material and compacted in the manner described for backfilling. The remainder of the fill material shall not contain frozen lumps, stone in excess of 3 inch diameter, or other objectionable material. Compaction shall be achieved as provided for backfill or by rolling. The embankment shall be placed and compacted simultaneously on both sides of the conduit for the full width of the road bed upto an elevation one foot above the top of the conduit. Above this elevation the embankment shall be placed and compacted in normal manner, except where the imperfect trench method is prescribed.

f) **Imperfect Trench:**

Under this method, for rigid conduit, the embankment shall be completed as described above to a height above the conduit equal to vertical outside diameter of the conduit plus one foot. A trench equal in width to the outside diameter of the conduit shall then be excavated to within one foot of the top of the conduit, trench walls being as nearly vertical as possible. The trench shall be loosely filled with highly compactable soil, straw, hay, corn, stalks, leaves, brush or sawdust may be used to fill the lower ¼ to 1/3 of the trench. Construction of embankment above shall then proceed in a specified manner.

21.3 ASPHALT CONCRETE AND CEMENT CONCRETE SIDEWALK

21.3.1 GENERAL

This work shall consist of the construction of sidewalks which can be asphalt concrete, plain Portland cement concrete, or precast Portland cement concrete slabs (450x450) mm or smaller or interlocking concrete blocks all in accordance with these specifications and to the line, grade, levels and dimensions shown on the Drawings or as required by the Engineer-in-Charge.

21.3.2 MATERIAL REQUIREMENTS

a) Cement Concrete

The concrete shall be either 1:3:6 or 1:2:4 as indicated on the drawings and in accordance with Section 5 – Plain & Reinforced Concrete.

b) Asphalt Concrete

Asphaltic concrete shall conform to the requirements of Sub-Section 21.1.24 – Asphalt Concrete Wearing Course.

c) Expansion Joint Filler

Unless otherwise directed, the joint filler shall have a thickness of five (5) mm and conform to the requirements of Sub-Section 21.1.30.2.

d) Forms

Forms shall be of wood or metal as approved by the Engineer-in-Charge and shall extend to the full depth of the concrete. All forms shall be straight, free from warp and of adequate strength to resist bending.

e) Bed Course Material

Bed course material shall consist of sand, slag, gravel, crushed stone or other approved materials of such gradation that all particles will pass through a ½" (12.5mm) sieve.

f) Asphaltic Prime Coat

Asphaltic prime coat material shall conform to the requirements of Sub-Section 21.1.18.3 for Cutback Asphalt.

21.3.3 CONSTRUCTION REQUIREMENTS

21.3.3.1 Asphalt Concrete Sidewalk

a) Excavation

Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to minimum ninety(90) percent of the maximum dry density as determined by AASHTO T-191 Method. The surface shall be even conforming to the section shown on the drawings. All soft material shall be removed and replaced with acceptable materials.

b) Placing of Bed Course Material

The bed course material shall be compacted in layers not exceeding ten (10) cm to the depth shown on the drawings and to the line and grade of the finished sidewalk surface.

c) Priming the Bed Course Material

The prepared bed course material shall receive an application of prime coat in accordance with the requirements of Item 21.1.7 and approved by the Engineer-in-Charge.

d) Placing the Asphalt Concrete

The asphalt concrete shall be placed on the previously primed prepared bed only when, in the opinion of the Engineer-in-Charge the bed is sufficiently dry and weather conditions are suitable. The mixture shall be placed on one or more course of uniform thickness as shown on the Drawings. Each course shall be smoothed by raking or screeding and shall be thoroughly compacted by rolling with a hand operated roller or a type satisfactory to the Engineer-in-Charge. After compaction, the surfacing shall be of the thickness and section shown on the Drawings, shall be smooth even and of a dense and uniform texture. Forms, if used, shall be removed and the shoulders shaped and compacted to the required section.

21.3.3.2 Cement Concrete Sidewalk

a) Excavation

Excavation shall meet the requirements of Sub-Section 21.3.3.1(a).

b) Placing of Bed Course Material

Where indicated on the drawings the bed course material shall be placed in accordance with SubSection 21.3.3.1(b).

c) Forms and Expansion Joints

All forms shall be staked securely in position at the correct line and elevation. Expansion joint filler shall be set in the position shown on the Drawings before the placing of the concrete is started. The joint filler shall be placed 5mm below the top surface of the finished sidewalk.

d) Placing the Cement Concrete Material

The mixing, placing, finishing and curing of concrete shall be as provided in Section 5 – Plain & Reinforced Concrete.

Before the concrete has set, the surface of the concrete shall be trawled until it is of uniform smoothness and is true to the lines, elevations and surface required.

The surface shall be cut through to a depth of one(1) cm with a trowel at intervals of one(1) meter or where required, in straight lines perpendicular to the edge of the sidewalk. The surface shall then be brushed. The edges of the sidewalk and the transverse cuts shall be shaped with a suitable tool so formed as to round the edges to a one and half (1.5) centimeters radius.

e) Precast Elements

Precast concrete slabs or interlocking concrete blocks shall be set on the bed where indicated on the drawings or as directed by the Engineer-in-Charge to provide a smooth top surface without ridges or lumps at joints.

Precast concrete units shall be fair faced cast to the sizes and dimensions as indicated on the drawings. The concrete used for pre-cast unit shall conform to the specifications laid down in Sub-Section 5 - Plain & Reinforced Concrete. The Contractor shall be required to submit a sample of pre-cast unit for the approval of the Engineer-in-Charge. All pre-cast units shall strictly conform to the approved sample.

A pre-cast unit cracked or damaged before, during or after erection shall be removed from the works and replaced by the Contractor at his own expense. All pre-cast units shall be smoothly finished to the required lines, grades angles etc. Holes, grooves, pockets, hooks shall be provided as shown or as directed by the Engineer-in-Charge.

The units shall be properly stacked on a platform without causing any cracks of damage. Curing of all the pre-cast units shall be done in accordance with Sub-Section 5.3.7. – Plain & Reinforced Concrete.

21.4 BRICK EDGING

21.4.1 GENERAL

This work shall consist of brick installed on vertical edge between the pavement structure and shoulders in such a manner that the brick is laid on compacted shoulders and top of brick is flushed with the slope of road pavement.

21.4.2 MATERIAL REQUIREMENTS

a) Bricks

Quality of Bricks shall meet the material requirement as specified in Section 11 – Brickwork. b) Construction Requirements

A trench of appropriate dimensions shall be excavated to accommodate brick on vertical edge so that top of the brick becomes flushed with the top of road pavement and to ensure that one face of the brick remains in contact with the pavement structure. The cavities on the other face of the brick shall be refilled with the excavated shoulder material and properly compacted. The brick shall be laid in accordance with the line and grade of the road pavement. It shall be ensured that bricks are installed in vertical positions.

21.5 TRAFFIC ROAD SIGNS AND SAFETY DEVICES

21.5.1 GENERAL

This work shall comprise furnishing and installing traffic signs, permanent safety devices and post assemblies in accordance with these specifications and to the details shown on the Drawings. All sign faces and lettering shall be in accordance with National Highway Authority sign standards or as shown on plans. Prior to manufacture and fabrication of the signs the contractor shall submit to the Engineer-in-Charge for approval detailed drawings showing letter sizes, traffic symbols and sign layout. The permanent safety devices shall consist of road posts and hazard markers and will be provided as per specifications, drawings or as directed by the Engineer-in-Charge.

21.5.2 MATERIAL REQUIREMENTS

1. **Sign Panels**

Sign panels for regulator, warning and informatory signs shall be manufactured from aluminium alloy conforming to ASTM B-209, alloy 6061 T6 or 5052 H38 plates of three(3) mm thickness as shown on the drawings.

The blanks shall be free from laminations, blisters, open seams, pits, holes, or other defects that may affect their appearance or use. The thickness shall be uniform and the blank commercially flat. Perform shearing, cutting and punching before preparing the blanks for application of reflective material. The blanks shall be cleaned, degreased and chromate or otherwise properly prepared according to methods recommended by the sheeting manufacturer.

2. **Reflective Sheeting**

Reflective sheeting used on road sign made of flexible white or coloured, wide angle retro-reflective sheeting (herein after called sheeting), and related processing materials designed to enhance night time visibility. The sheeting shall consist of optical elements adhered to a synthetic resin and encapsulated by a flexible transparent plastic that has a smooth outer surface.

The sheeting shall have either a pre-coated pressure sensitive adhesive or a tack-free adhesive activated by heat applied in a heat vacuum applicator in a manner recommended by the sheeting manufacturer. Both adhesive classes shall be protected by an easily removable liner.

The manufacturer of the sheeting being offered shall furnish the process inks, clears and thinners produced by the sheeting manufacturer recommended for and compatible with the sheeting to meet the performance requirements of this specification and shall further be responsible for technical assistance in the use of these inks or alternatively sheeting can be used on sheeting. The sheeting manufacturer must provide documented evidence to the satisfaction of the Engineer-in-Charge that representative production materials of the type to be supplied has been used successfully in a substantial traffic signing program in similar climatic conditions for at least three years.

a) **Color Requirements**

Color shall be specified and conform to the requirements of Table 21.5(a).

Table 21.5 (a)
Color Specification Limits* and Reference Standards

Color	X	Y	X	Y	X	Y	X	Y	Reflectance (Y) Limit Min.	Reflectance (Y) Limit Max.	Munsell** Paper
White	.303	.287	.368	.353	.340	.380	.274	.316	27.0		5PB 7/1
Yellow	.498	.412	.557	.442	.479	.520	.438	.472	15.0	40.0	1.25Y 6/12
Red	.613	.297	.708	.292	.636	.364	.558	.352	2.5	11.0	7.5R 3/12
Blue	.144	.030	.244	.202	.190	.247	.066	.208	1.0	10.0	5.8PB 1.32/6.8
Orange	.550	.360	.630	.370	.581	.418	.516	.394	14.0	30.0	2.5YR 5.5/14
Brown	.430	.340	.430	.390	.550	.450	.610	.390	3.0	9.0	5YR 3.6
Green	.30	.380	.166	.346	.286	.4288	.201	.776	3.0	8.0	10G 3/8

***** The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 Standard colorimetric system measured with standard illumination Source C.

******Available from Munsell Color Company, 2441 Calvert Street, Baltimore, Maryland 21218. Catalog No. MCP-90040.

b) **Coefficient of Retro-reflection**

The coefficients of retro-reflection shall conform to the minimum requirements of Table 21.5(b). **Table 21.5(b)**

Minimum Coefficient of Retro-reflection
(Candelas per Foot-candle per Square Foot)

Observation Angle^{o}	Entrance Angle^{o}	White	Red	Yellow	Green	Blue	Brown	Orange
0.2	-4	250	45	170	45	20.0	12.0	100.0
0.2	+30	150	25	100	25	11.0	8.5	60.0
0.5	-4	95	15	62	15	7.5	5.0	30.0
0.5	+30	65	10	45	10	5.0	3.5	25.0

For screen printed transparent colored areas on white sheeting, the coefficients of retro-reflection shall not be less than 70% of the values for corresponding color in the above table.

The sheeting manufacturer unless otherwise approved shall provide a test report from a recognized laboratory stating that the sheeting meets the requirements according to BSI-873 Part 6, or FP-92 of FHWA. The brightness of the reflective sheeting totally wet by rain, shall be at least ninety (90) % of the above value.

The reflective sheeting shall be sufficiently flexible as to permit application over and adhesion to a moderately embossed surface. It shall not show damage when bent ninety (90) degree over a fifty (50) mm diameter mandrill.

The sheeting shall show no cracking or reduction in reflection after being subjected to the dropping of a twenty five (25) mm diameter steel ball from a height of two (2) meters onto its surface. For heat activated material the adhesive shall permit the reflective sheeting to adhere securely forty eight (48) hours after application, at temperatures of up to ninety (90) degree centigrade.

The reflective material shall be weather resistant and following cleaning, shall show no definite fading, darkening, cracking, blistering or peeling and not less than seventy five (75) % of the specified wet or dry minimum brightness values when exposed to weathering for five (5) years.

c) **Performance Requirements and Obligation**

The sign manufacturer shall submit a certificate from the sheeting manufacturer stating that the sheeting used for finished retro-reflective signs meets all requirements listed herein.

Sheetings processed and applied to sign blank materials in accordance with sheeting manufacturer's recommendation, shall perform effectively for the number of years stated in Table- 21.5(c) of this specification. The retro-reflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that; (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retro-reflection is less than the minimum specified for sheeting during that period listed in Table 21.5(c).

Table 21.5(c)
Minimum Coefficient of Retro-reflection Candelas per Foot Candle per Square Foot (.2" OBS, and -4° Entrance)*

Sheeting Color	Minimum Coefficient of Retro-reflection (7 Years)	Minimum Coefficient of Retro-reflection (10 Years)
White	212	200
Yellow	144	136
Green	38	36
Red	38	36
Blue	17	16
Brown	10	9

For screen printed transparent coloured areas on white sheeting, the coefficients of retro-reflection shall not be less than 50% of the values for the corresponding colour in the above table.All measurements shall be made after sign cleaning according to sheeting manufacturer's recommendations.

Where it can be shown that retro-reflective traffic signs supplied and used according to the sheeting manufacturer's recommendations have not met the performance requirements above the sheeting manufacturer shall cover restoration costs as follows for sheeting shown to be unsatisfactory during.

a) For entire seven years the signs manufacturer and sheeting manufacturer will replace the sheeting required to restore the sign surface to its original effectiveness.

b) In addition, during the first five years sign manufacturer and sheeting manufacturer will cover the cost of restoring the sign surface to its original effectiveness at no cost to the Employer for materials and labor. Samples of the reflective sheeting shall be approved by the Engineer-inCharge prior to the procurement by the Contractor.

3. Metal Posts

Wide flange of 10x10 centimetres metal posts shall be fabricated from structural steel conforming to the Specifications of ASTM A-283 Grade-D. In lieu of wide flange steel posts the Contractor may use tubular steel posts of minimum internal and external diameters of sixty three (63)mm and seventy five (75)mm respectively conforming to the specifications of ASTM A-501.

All posts shall be thoroughly cleaned, free from grease, scale and rust, and shall be given one coat of rust inhibitive, priming paint and two coats of grey paint. Length of the posts shall be such that their top flushes with the top of the sign penal, whereas bottom of sign panel is at least hundred and eighty (180) centimetres above shoulder level.

4. Plates

a) Plates shall be non-porous, smooth, flat, rigid, weather proof and shall not rust or deteriorate otherwise. It shall be so cut that there are no sharp edges and that the corners are rounded off to a radius of thirty seven and half (37.50)mm. Any trade mark or other printing shall be carefully removed with liquid thinner.

b) The High Intensity Grade sheeting for the background should cover the whole area of the sign plate.

c) Prior to application of the High Intensity Grade reflective sheeting, the sign plate shall be cleaned and shall be wax-free. They shall be degreased by vapour or by alkaline immersion and etched by scrubbing with abrasive cleaner. The plate shall be rinsed thoroughly and dried with hot air before applying the sheets.

d) The sheeting after application to the sign base shall not come off the edges, which shall be sealed, nor shall it peel off nor warp. The surface shall be smooth and free from any bubbles, pimples, edge chipping or edge shattering. It shall be washable and weather-proof.

5. Nuts and Bolts

All Nuts and bolts and metal washers shall be of heavily galvanized (G.I) quality, ten (10)mm diameter or aluminium alloy. The bolt heads shall be such that they do not protrude out too much nor show

very much on the front face of the plate. The heads should be flush with the plate face and covered with sheeting galvanized according to ASTM A-153.

6. Rubber Washer
   All rubber washers shall have thick walls and shall not get dry and brittle when exposed to weather at the site after they are in position during the life of the sign.
7. Caps over the pipes
   These can be heavy plastic or of aluminium well fitted so that they cannot be removed. Any good adhesive can be used with approval of the Engineer-in-Charge.
8. General
   a) Very large signs need not be made of one piece and in case, the Aluminium panels shall be used or the various pieces of sheet shall be joined by angle-irons in anti-corrosive materials, and, if necessary, with connecting cross pieces in order to ensure the solidity of the joint and with slanting struts embedded In the concrete as directed by the Engineer-in-Charge.
   b) All the nuts and bolts and metal washers must be heavily galvanized, or may be of stainless steel of high quality.
   c) Relevant holes to receive 10mm bolts shall be drilled into the pipes and the plates and not punched. These to be drilled through the plates before the application of scotchlite.
   d) After the plates are fixed with nuts and bolts, the nuts shall be TACK WELDED to the bolts against pilferage.
9. Concrete Foundation Blocks
   The concrete for the foundation blocks shall be in situ 1:3:6 concrete in accordance Section 5, Plain & Reinforced Concrete and shall of the size 450x450x650mm for category 1 & 2 and 600x600x750mm for category 3.

10. Road Posts and Hazard Markers
    The road posts and hazard markers used as permanent safety devices shall conform fully with the requirements of the statutory instruments, current British standards and chapter four of the Traffic signs manual. The safety devices shall consist of delineators and detours of verge master, flex master, edge master, passing place post and chevron-flex etc. and will be manufactured from highly durable tough plastic material with standing vehicular impact. These shall be a High Intensity Grade reflective sheeting for maximum visibility by both day and night and consequently be resistant to impact, damage and vandalism.

21.5.3 CONSTRUCTION REQUIREMENTS

1. Excavation and Backfilling
   Holes shall be excavated to the required depth of the bottom of the concrete foundation as shown on the Drawings. Backfilling shall be carried out by using the surplus excavated material if approved by the Engineer-in-Charge and shall be compacted in layers not exceeding fifteen (15) cm in depth.
   Surplus excavated material shall be disposed of by the Contractor as directed by the Engineer-inCharge.
2. Erection of Posts
   The posts shall be erected vertically in position inside the formwork of the foundation block prior to the placing of the concrete and shall be adequately supported by bracing to the prevent movement of the post during the setting process of the concrete. The posts shall be located at the positions shown on the Drawings.
3. Sign Panel Installation
   Sign panels shall be installed by the Contractor in accordance with the details shown on the Drawings. Any chipping or bending of the sign panels shall be considered as sufficient cause to require replacement of the panels at the Contractor's expense.
   The exposed portion of the fastening hardware on the face of the sign shall be painted with enamels matching the background colour.
   All newly erected traffic road signs shall be covered with burlap or other material until their uncovering is ordered by the Engineer-in-Charge.
4. Categories of Signs

Traffic road signs shall be of three categories according to type of construction. a. Warning Signs

Constructed with single post and sign of equilateral triangle shape as shown in drawings category-1 b. Regulatory Signs

Constructed with single post and sign of circular shape, as shown in the drawings, category 2. c. Informatory Signs

These signs shall be rectangular in shape and constructed with one, two or three numbers of posts or as shown on the drawings. Dimensions may vary according to the requirements, however total area of sign shall be as under:

Category 3 a	=	One sq. meter
Category 3 b	=	Two sq. meter
Category 3 c	=	As shown on drawings

d. Additional panel

If any panel is required to be installed, it shall be of the sizes 60x30 cm or 90x30 cm.

5. Installation of Safety Devices

Safety devices comprising of road posts, delineators of various types, fixed/portable safety barriers and hazard markers e.g. verge-master, flex-master chevron-flex, big-max, edge-master and passing place post and other etc., shall be installed in accordance with the techniques and methods laid down in the manufacturer's manual or guide and in conformity to the line and level and locations shown on the drawings or as directed by the Engineer-in-Charge to ensure maximum visibility and safety, even in adverse weather conditions. These shall be constructed strictly with the specifications and full assistance by the manufacturer for installation with precision. These safety devices shall be used as delineators at sharp curves of highways verges, high embankments, culverts, bridges, as a visual and physical deterrent for prohibiting car parking on grass verges and protecting kerb-side areas on public and private roads.

6. Sign Faces

a) Design

All sign faces shall be of the type, colour, design and size as shown in the plans. Size and spacing of letters shall be as under;

1. The Urdu writing shall be in "Persian" character.
2. The Urdu and English writing shall be about the same in length width and spacing.
3. English letters are to be in lowercase except the first letter of the word, which is to be in capital
4. Height of Capital letters 21 cm
5. Height of lowercase letters 17 cm
6. Stroke Width and Width of border 3.5 cm
7. Space between words and border (at least) 5 cm
8. Space between words 5 cm
9. Space between digits of numerals 4 cm
10. Height of numerals same as capital letters 23 cm
11. Space between lines (at least) 5 cm
12. Size of letter for km. height K-23cm 8 cm
13. Width of letters for km including spacing K-8 cm - 9.6 cm
14. The size and spacing for Urdu letter and Word will generally conform to the dimensions shown above for English letters
15. The spelling of place names in Urdu and in English shall be as written in the Survey of Pakistan maps

b) Shop Drawings

The contractor shall submit to the Engineer-in-Charge for approval, three copies of drawings for all special sign faces and all sign faces bearing messages, showing the design and/or arrangement and spacing of both the Urdu and English signs messages. Official town names and their spelling shall

be as provided by the Engineer-in-Charge. Size and style of lettering shall be as shown on the plans or as otherwise approved by the Engineer-in-Charge.

7. Storage of Signs

Signs delivered for use on a project shall be stored off ground and under cover in a manner approved by the Engineer-in-Charge. Any signs damaged, discoloured or defaced during transportation, storage or erection shall be rejected.

21.5.4 MEASUREMENT

Length of the finished work shall be measured in running metres along the edges of the road correct to a cm.

21.6 PAVEMENT MARKING

21.6.1 GENERAL

This work shall consist of furnishing non reflective or reflective chlorinated rubber based or thermoplastic paint material or retro-reflective preformed pavement marking (tape) as specified for sampling and packing, for the preparation of the surface and for the application of the paint to the pavement surface all in accordance with these Specifications. The paint shall be applied in conformance to the size, shape and location of the markings as shown in the Drawings.

21.6.2 CHLORINATED RUBBER PAINT

1. Material Requirements

A standard and acceptable quality of Chlorinated rubber based paint shall be used. The paint shall be ready for application and shall be of a smooth quality. The paint shall be homogeneous, well dispersed to a smooth consistency and shall not cake, liver, thicken, curdle, gel, settle badly or show any objectionable properties after period of storage not to exceed six(6) months.

a) White Traffic Paint – Composition

1.	Pigment	Titanium Dioxide Rutile & extenders	
2.	Vehicle	Modified Chlorinated Rubber Plasticized and Resin Blend	%
		Solvents	%
		Additives i.e. flow leveling, adhesion improving agents, anti-oxidants, siccatives etc.	
3.	Paint Composition	Pigments	% by wt.
		Vehicle Solvent and Additives	% by wt.

b) White Traffic Paint

1.	Pigment	Chrome Yellow and Extenders	100% by wt.
2.	Vehicle	Same as for white traffic paint	
3.	Paint Composition	Pigments	55 $\pm$ 4% by wt.
		Vehicle Solvent and Additives	45 $\pm$ 5% by wt.

c) Block Traffic Paint

1.	Pigment	Chrome Yellow and Extenders	100% by wt.
2.	Vehicle	Same as for white traffic paint	
3.	Paint Composition	Pigments	55 $\pm$ 4% by wt.
		Vehicle	45 $\pm$ 5% by wt.

The volatile material shall be of such character that has a minimum solvent action of asphalt and such that the resins and non-volatile components will be entirely dissolved in the volatile material and will not precipitate from the solution on standing. The non-volatile material shall be of such quality that it will not darken or become yellow when a thin section is exposed to the sunlight. Other pavement

marking paint may be submitted by the Contractor as an alternative to the above, for the approval of the Engineer-in-Charge.

2. Ballotini for Reflective Road Paint

The grading of ballotini dispersed in the paint shall be as follows:

Sieve Sizes	Percentage Retained
	0
	30
	50
	80
	100

Glass beads shall conform with AASHTO Designation M-247. At least ninety percent (90%) glass beads shall be transparent, reasonable spherical and free from flows.

The proportion of ballotini to paint shall be not less than five hundred (500) grams per litre of paint.

3. Photometric Requirements for Reflective Road Paint

Other reflective road paints may be considered for use by the Engineer-in-Charge provided they have minimum brightness values at two tenth (0.2) degree and half (0.5) degree divergence expressed as candle power per meter per square meter of surface coating as follows:

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		White		Yellow	
Divergence Angle	(Degree)	0.2	0.5	0.2	0.5
Incidence Angles	4 (Degree)	237	118	129	75
Incidence Angles	40	75	43	43	32

4. Construction Requirements

Traffic markings shall be applied with approved equipment capable of applying the paint at the specified width and at the specified rate of application. In no case shall the contractor proceed with the work until the equipment, method of application and rate of application as established by a test section have been approved by the Engineer-in-Charge.

The painting of lane markers and traffic strips and include the cleaning of the pavement surface, the application, protection and drying of the paint coatings, the protection of pedestrians, vehicular or other traffic on the pavements, the protection of all parts of the road, structures or appurtenances against disfigurement by spatters, splashes or smirches of paint or of paint materials, and the supplying of all tools, labour and traffic paint necessary for the entire work. The paint shall not be applied during rain, wet weather when the air is misty, or when in the opinion of the Engineer-inCharge, conditions are otherwise unfavourable for the work. Paint shall not be applied upon damp pavement surfaces, or upon pavements which have absorbed heat sufficient to cause the paint to blister and produce a porous paint film.

The application of paint shall preferably be carried out by a purpose-made machine but where brushes are used only round or oval brushes not exceeding 10 cm in width will be permitted. The paint, shall be so applied as to produce a uniform, even coating in close contact with the surface being painted. Traffic paint shall be applied to the pavement at a rate of one(1) litre to two and half (2.5) square meters or less. Contractor shall provide adequate arrangements that applied paint is not disfigured by moving traffic, till its complete drying and sticking to road surface.

21.6.3 HOT- APPLIED THERMOPLASTIC ROAD PAINTS

21.6.3.1 Material Requirements

1. Aggregate

The aggregate shall consist of light coloured silica sand, calcite, quartz, calcined flint, or other material approved by the Engineer-in-Charge. 2. Pigment and Extender

a) White Material

The pigment shall be titanium dioxide complying with the requirements of Type-A (anatase) or Type-R (rutile) of BS-1851.

b) Yellow Material

Sufficient suitable yellow pigment shall be substituted for all or part of the titanium dioxide to comply with the other requirements of this specification.

c) All Material

The extender shall normally be whiting (i.e. calcium carbonate prepared from natural chalk) complying with the requirements of BS-1795. The manufacturer may substitute lithopone complying with the requirement of BS 296 for any or all of the whiting.

d) Binder

The binder shall consist of synthetic hydrocarbon resin or with the approval of the Engineer-inCharge, gun or wood resin, plasticized with mineral oil.

e) Composition of Mixture

The proportions of the constituents of the mixed material as found on analysis shall comply with the requirements of Table 21.6(a)

Table 21.6(a)
Proportions of Constituents of Mixture

Constituent	Percentage by mass of total mixture	
	Minimum	Maximum
Binder (resin and oil)	18	22
Pigment	6*	-
Pigment and extender	18	22
Ballotini	20	-
Aggregate		
Pigment	78	82
Extender and ballotini		

*For titanium dioxide only. No minimum is specified for yellow material.

Where specified, 10% in the case of material to which surface ballotini is to be applied by pressure application.

The grading of the combined aggregate, pigment, extender and ballotine (where specified) as found on analysis shall comply with the requirements of Table 21.6(b).

Table 21.6(b)
Grading of Combined Aggregate, Pigment, Extender and Ballotini

Sieve	Percentage by mass passing Sprayed
2.80 mm	100
600 µm	75-95

21.6.4 SAMPLING AND TESTING

1. Sampling

For the purpose of carrying out the test, it is essential that adequate and representative samples be taken in the manner prescribed in specification BS 3262 at following stages.

a) At the manufacturer's plant

b) After it has been re-melted by the road application contractor.

2. Testing

The samples shall be prepared and tested in accordance with B.S. Specification 3262 (1976) Appendix A to H. The test results shall conform the following properties.

i. Softening Point

The softening point measured in accordance with Appendix C shall be not less than 65^{o}C.

ii. Colour and luminance a) White Material

The luminance factor of white material as delivered by the manufacturer shall be measured in accordance with Appendix-D and shall not be less than 70 whereas the luminance factor of material

obtained from an applicator or melter on site after re-melting measured in accordance with Appendix-D shall not be less than 65.

b) Yellow Material

The colour of yellow material shall be approximately BS 381C Colour No.355, Lemon. The luminance factor of yellow material as delivered by the manufacturer shall be not less than 60 whereas the luminance factor of material obtained from an applicator on melter on site after remelting measured in accordance with Appendix-D shall not be less than 55.

3. Heat Stability

a) White Material

When tested in accordance with Appendix-E, the luminance factor of white material as measured in accordance with Appendix-D shall be not less than 65.

b) Yellow Material

When tested in accordance with Appendix-E, the luminance factor of yellow material as measured in accordance with Appendix-D shall be not less than 55.

i. Flow Resistance

In testing the flow resistance a cone made and tested in accordance with Appendix-F, shall not slump by more than 25%.

ii. Skid Resistance

When tested in accordance with Appendix-G, the skid resistance of a newly laid marking prepared under the stated conditions shall be not less than 45.

21.6.5 MANUFACTURING, PACKING AND STORING OF PAINT

1. Manufacturing

The paint shall be produced in a plant owned and operated by the manufacturer following a process which has been used by the manufacturer for at least five (5) years to produce paint. The equipment for mixing and grinding shall be clean, modern and in good condition.

2. Packing

i. The material shall be supplied in sealed containers which do not contaminate the contents and which protect them from contamination.

ii. Each container shall be clearly and indelibly marked with the manufacturer's name, Batch number, date of manufacture, re-flectorization (if applicable), colour, chemical type of binder and maximum safe heating temperature.

3. Storing

The material shall be stored in accordance with the manufacturer's instructions and any material that is in damaged containers of which the seal has been broken, shall not be used.

4. Certification

The Contractor shall furnish a certificate from manufacturer that the material he proposes to use has the required properties, stating the maximum and minimum proportions and grading of the constituents, the acid value of the binder, the setting time, the maximum safe heating temperature, the temperature range of the apparatus and the proposed method of laying.

5. Application of Material to the Road

a) Preparation of Site

The thermoplastic paint shall only be applied to surfaces, which are clean and dry. Immediately before the application of paint, the surface shall be cleaned with mechanical broom, compressed air or other approved means to remove surplus asphalt, oils, mud, dust and other loose or adhered material. The material shall not be applied if the road surface is at a temperature of less than 5^{o}C. b) Preparation of Material on Site

The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material and such that local overheating will be avoided. The temperature of the mass shall be within the range specified by the manufacturer and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material shall be used as expeditiously as possible and for thermoplastic

material, which has natural resin binders or is otherwise sensitive to prolonged heating the material shall not be maintained in a molten condition for more than 4 hours.

i. After transfer to the laying apparatus, the material shall be maintained within the temperature range specified by the manufacturer and stirred to maintain the right consistency for laying.

ii. On concrete carriageway a tack coat compatible with the marking material shall be applied in accordance with the manufacturer's instructions prior to the application of thermoplastic material. c) Laying

Carriageway centre lines, lane lines and edge lines shall be laid to a regular alignment by self propelled machine. Other markings may be laid by hand, hand propelled machine or self propelled machine as approved by the Engineer-in-Charge. The Surface produced shall be uniform in texture and thickness and appreciably free from blisters and streaks.

d) Re-flectorization by Surface Application

When surface application of ballotini is required, additional ballotine (400 g/m^2 to 500 g/m^2 from the machine) shall be applied by pressure concurrently with the laying of the line with sufficient velocity to ensure retention in the surface of the line. The bollotini so sprayed shall give uniform cover and immediate reflectivity over the whole surface of the marking.

Ballotini dispensed on the surface of the markings shall conform to the following grading:

Sieve	Percentage by mass passing
1.7 mm	100
600 µ	80 – 100
425 µ	45 – 100
300 µ	10 – 45
212 µ	0 – 25
75 µ	0 – 5

Not less than 90% by mass of the bollotini shall be of transparent glass spherical in shape and not more than ten percent (10%) shall be oval in shape or have other flaws. The ballotini shall be made of soda glass.

e) Thickness

Unless otherwise approved by the Engineer-in-Charge, the material shall be laid to the following thicknesses.

a) Sprayed lines other than yellow not less than 1.5mm

b) Sprayed yellow edge lines not less than 0.8mm

The minimum thicknesses specified are exclusive of surface applied ballotini. The method of thickness measurement shall be in accordance with Appendix-H of BS 3262 (1976).

6. Trial Section

In no case shall the contractor proceed with the work until the equipment, method of application and rate of application conforming, the required thickness (as established by a test section) have been approved by the Engineer-in-Charge.

21.6.6 RETRO-REFLECTIVE PREFORMED PAVEMENT MARKINGS

1. Materials Requirements

The performed markings shall consist of white or yellow films with pigments selected to conform to standard highway colours. Ceramic and glass beads shall be incorporated to provide immediate and continuing retro-reflection. Ceramic skid particles shall be bonded to a top urethane layer to provide a skid resistant surface.

The preformed markings shall be capable of being adhered to asphalt cement concrete (ACC) or Portland Cement Concrete (PCC) by a pre-coated pressure sensitive adhesive. A primer may be used to precondition the pavement surface. The preformed marking film shall mold itself to pavement contours by the action of traffic. The pavement marking film wearing courses during the paving operation in accordance with the manufacturer's instructions, approved by the Engineer-inCharge. Following proper application and tamping the markings shall be immediately ready for traffic. The

bidder, when bidding, shall identify proper solvents and/or primers (where necessary) for proper application and recommendation for application that will assure effective product performance. The preformed markings shall be suitable for use for one year after the date of receipt when stored in accordance with the manufacturer's recommendations.

The marking film shall be durable retro-reflective plisot polymer pavement marking film for performed longitudinal markings subject to low to medium traffic volumes and moderate wear conditions such as repeated shear action from crossover or encroachment on channelization lines. The retro reflective pavement marking film shall consist of mixture of high quality pigmented polymeric material, with a reflective layer of ceramic and glass beads and a layer of skid resistant ceramic particles bonded to the top urethane wear surface. The film shall have a pre-coated pressure sensitive adhesive. The edges of the preformed tape shall be clear cut and true.

2. Colour

The daytime colour of the white film shall provide a minimum initial Luminance factor, Y of 80 and shall conform to the following chromaticity requirements:

X = 0.290, Y = 0.315; X = 0.491, Y = 0.435; X = 0.512, Y = 0.486; X = 0.536, Y = 0.463.

Measurements shall be made in accordance with ASTM E-1349, using illuminant "C" and 0/45 (45/0) geometry, Calculations shall be in accordance with ASTM E-308 for the 2° standard observer.

3. Reflectance

The white and yellow films shall have the following initial minimum reflectance values as measured in accordance with the testing procedures of ASTM D-4061. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandals per square foot per foot-candle (mcd. ft^2), fc^{-1}). The metric equivalent shall be expressed as millicandals per square meter per lux (mcd. m^{-2}), lx^{-1}).

Description	White	Yellow
Entrance Angle 86.00°	86.5°	86.5°
Observation Angle	1.0°	1.0°
Specific Luminance SL [(mcd. ft^{-2}), fc^{-1}]	300	175

4. Skid Resistance

The surface of the retro-reflective films shall be shall provide an initial minimum skid resistance values of 55 BPN as measured by British Portable Skid Tester in accordance with ASTM E-303.

5. Patch ability

The pavement marking film shall be capable of use for patching worn areas of the same type of film in accordance with the manufacturer's instructions.

6. Reflectance Retention

To have a good, effective performance life the ceramic and glass beads must be strongly bonded and not be easily removed by traffic wear. The following test shall be employed to measured reflectivity retention.

7. Taber Abraser Simulation Test

Using a Taber Abraser with an H-18 wheel and a 125 gram load, the sample shall be inspected at 200 cycles, under a microscope, to observed the extend and type of bead failure. No more than 15% of the beads shall be lost due to pop-out and the predominant mode of failure shall be "wear down" on the beads.

8. Beads

The size, quality and refractive index of the ceramic and glass beads shall be such that the performance requirements for the marking shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched.

9. Bead Retention

The film shall be ceramic and glass bead retention qualities such that when a 2"x6" (5.08cm x 15.24cm) sample is bend over a ½ inch (1.27 cm) diameter-mandrel, with the 2 inch dimension

perpendicular to the mandrel axis, microscopic, examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%. 10. Thickness
The film without adhesive shall have a minimum thickness of 0.030 inch (0.76mm).

11. Effective Performance Life

The film, when applied according to the recommendations of the manufacturer, shall provide neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The film shall be weather resistant and through normal traffic wear shall show no fading, lifting or shrinkage which will significantly impair the intended usage of the marking throughout its useful life and shall show no significant tearing, roll back or other signs of poor adhesion.

12. Installation

The markings shall be applied in accordance with the manufacturer's instructions.

21.6.7 CEMENTITIOUS MARKING COMPOUND

Cementitious marking compound shall be used for concrete, surface dressing and bitumen to provide enhanced night and wet, weather visibility. This compound will be applied at following locations:

- Kerbs – Pavements and car park area.
- Roundabout – vertical and sloping faces.
- Traffic Islands – vertical edges and bull noses, etc.
- Traffic Dividers – black and white chevrons.
- Concrete wall and faces – on high speed intersections and traffic merging.

21.6.8 MEASUREMENT

The markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any) correct upto the two places of decimal.

21.7 REFLECTORIZED PAVEMENT STUDS

21.7.1 GENERAL

The work shall consist of furnishing and installing reflectorized pavement studs set into the travelled way of the type in accordance with the specifications and at the locations shown on the Drawings or as directed by the Engineer-in-Charge.

21.7.2 MATERIAL REQUIREMENTS

1. Reflectorized Studs

Reflectorized studs shall be "cat-eyes" either the 'Flush Surface' type for Raised Profile type having the following characteristics.

a) 'Flush Surface' Type The 'Flush Surface' reflector shall be the short base type having a maximum base area of 18 cm x 14 cm or as shown on the Drawings.

The base shall be formed in cast-iron with adequate webbing to ensure a firm key to the road when installed.

The pad shall be highly resilient and durable rubber reinforced with canvas and shall have an anticipated life of at least five years. The pad shall be so designed as to produce a self-whipping action of the reflector when depressed.

The reflectors shall be made of impact and abrasion resisting glass and shall be hermetically sealed into a copper socket.

b) 'Raised Profile' Type

The 'Raised Profile' reflectors shell consist of an acrylic plastic filled with an adherent epoxy compound moulded from methyl methacylate into the shape of a shallow frustum of a pyramid having base dimension of approximately 10cm x 10cm and thickness not more than two(2) cm or as shown on the drawings.

The shall contain one or two prismatic reflector each inclined at an angle of thirty(30) degree to the horizontal and having an area not less than twenty(20) square cm or as indicated on the plans. The reflectors shall attain the following standards for their photometric and physical qualities: i) Photometric Requirements

The reflectors shall have the following minimum specific intensity values (S.I) expressed as candle power per foot candle of illumination at the reflector on a plane perpendicular to the incident light.

Description	C O L O U R		
	Crystal	Yellow	Red
Divergence Angle(in degree)	0.20S.I.	0.20S.I.	0.20S.I.
Incidence Angle			
0	3.00	1.80	0.75
20	1.20	0.72	0.30

The reflector for testing shall be located with the center of the reflecting face at a distance of one and half (1.5m) from a uniformly bright light source having an effective diameter of half (0.5) centimetre. The width of the photocell shall be 1.27 cms and shall be shielded from stray light. The distance from the centers of the light source and photocell shall be 0.53 cms.

Failure of more than 4% of the reflecting faces shall be cause for rejection for the lot. ii) Strength Requirements

The reflectors shall support a vertical load of 1000 kg when tested in the following manner.

A reflector shall be centered horizontally over the open end of a vertically positioned hollow metal cylinder 75 mm internal diameter, 25 mm high and wall thickness of 6 mm. The load shall be applied to the top of the reflector through a 6mm diameter by 6mm high metal plug centered on top of the reflector.

Failure shall constitute either breakage or significant deformation of the marker at any load less than 1000 kg.

2. Adhesive

When 'Raised Profile' types of reflectors are used, adhesive in two parts having the following ingredients shall be applied to the stud for bonding to the pavement surface.

Package A	Kg/Liter
Epoxy Resin	0.94
Titanium Dioxide	0.07
Colloidal Silica	0.05
Talc	0.345
Package B	Kg/Litre
Modified Asphaltic Amine	0.24
Hardener (Reinchold 2611)Modified Asphaltic Amine	0.472
Hardener (Reinchold 2613)Carbon Black	0.0022
Colloidal Silica	0.04
	0.650

Equal volumes of Package A & B should be mixed together until a uniform colour is obtained. Not more than one quart of adhesive shall be prepared at one time.

3. Cement Mortar

Cement mortar shall consist of one(1) part Portland Cement to three(3) parts of fine aggregates.

21.7.3 CONSTRUCTION REQUIREMENTS

1. Flush Surface Type

The stud shall be installed into the pavement in accordance with the manufacturer's instructions but shall also comply with the following requirements;

Cavities in the pavement shall be clearly cut to the dimension of the pavement stud and shall allow a clearance of one(1) cm around the stud base. The longitudinal center line axis of the cavity shall be the same as that required for the pavement study when laid to correct line and direction. The walls of the cavity shall be splayed back at an angle of approximately thirty(30) degree to the vertical to facilitate a "dove-tail" joint after the mortar has set.

The bottom of the cavity shall be leveled with asphalt concrete prior to placing the stud base, which shall be pounded into position with Pounder Foot attached to a pneumatic drill.

The depth of cavity shall be such that when the stud base and reflectors have been installed, the elevation of the floor of the lens socket shall not be greater than two(2) mm or less than one mm above the pavement surface.

The stud shall be grouted into position with asphalt concrete containing fine aggregate only or with a cement mortar as described in Sub-Section 21.7.2(3) above when the studs are installed into a cement concrete pavement.

2. Raised Profile Type

The pavement studs shall be installed in accordance with the manufacturer's instructions or to the requirements of the Engineer-in-Charge.

21.8.4 MEASUREMENT

The quantity of deep patching to be paid for shall be measured in Nos. or approved by the Engineer.

21.8 DEEP PATCHING

21.8.1 GENERAL

This work shall be carried out in patches of roads where the existing road base material has moved and is lying in loose condition. Requirement under this item is to remove the existing road base and to strengthen it to take new layer of aggregate or water bound macadam base.

21.8.2 MATERIAL REQUIREMENTS

Fresh aggregate base or water bound macadam base may be required to be added to existing road base. Specification for such material shall conform to materials requirements of Sub-Section 21.1.11.2 or 21.1.12.2.

21.8.3 CONSTRUCTION REQUIREMENTS

Patches of roads in which surface courses have broken and road base has moved, the material which has lost its compaction shall be removed. Next layer shall be watered and compacted, thereby the removed material shall be placed back duly screened to remove plastic contamination, by hand picking and passing through sieve No.4 after properly watering and mixing. Material will be re-compacted in layers not exceeding fifteen (15) cms (6 inches) thick with approved equipments. Additional material will be added, if needed particularly non-plastic fines passing sieve No.4.

21.8.4 MEASUREMENT

The quantity of deep patching to be paid for shall be measured in square meter of the area demarcated or approved by the Engineer. The minimum area will be taken as 0.5 square meters irrespective of the size of the pot hole.

21.9 IMPROVED SUBGRADE

21.9.1 DESCRIPTION

This work shall consist of the formation of the roadbed, under sub-base or base course as the case may be, with an approved blend of materials, uniformly mixed, compacted, shaped and finished to the lines, grades and typical cross-sections shown on the Drawings, or in thickness as directed by the Engineer-in-charge .

Improved sub-grade as herein referred to may be defined as material suitable for embankment to which better quality of material is blended improper proportion to improve its strength properties or performance.

21.9.2 MATERIAL REQUIREMENTS

The major component of improved sub-grade shall consist of material conforming 21.1.8. The blending material shall be any soil that classifies as A-1(a), A-1(b), A- 2-4 or A-3 according to AASHTO M-145 with PI of not more than 6.

The blended mixture when compacted to ninety five (95) percent of the maximum dry density determined by AASHTO T 180-0 Method, shall exhibit a laboratory soaked CBR (96 hours) of not less than 20, or as specified in the drawings.

21.9.3 CONSTRUCTION REQUIREMENTS

21.9.3.1 Preparation

The surface of the roadbed on which the improved sub-grade is to be constructed shall be compacted to the density specified under 21.1.8.3(a).

21.9.3.2 Proportioning of Materials

Prior to start of construction, the proportion of each material to be incorporated for improved subgrade shall be established as approved by the Engineer-in-Charge. The Engineer-in-Charge shall specify a single percentage of each material to be blended and shall establish. The gradation of the resulting mixtures along with the ranges of permissible gradation tolerances to obtain the required CBR for the' improved sub-grade.

The blend proportions thus established shall apply only when each material to be used is obtained from same source. Should a change in source of material be made, a new proportion shall' be established. When unsatisfactory results or other conditions make it necessary, the Engineer-incharge may require additional laboratory tests.

21.9.3.3 Mixing and Spreading

Improved sub-grade may be constructed with any combination of machines or equipment that will yield results meeting these specifications.

a) Stationary Plant Method

The soil ingredients and water shall be mixed in an approved mixing plant (Pug Mill). The plant shall be equipped with feeding and metering devices that will add the materials to be blended in the specified quantities. Water shall be added during the mixing operation in the quantity required for proper compaction, which is approximately optimum moisture content plus or minus two (2) percent. The mixing time shall be such that to secure a uniform mixture. After mixing, the blended material shall be transported to the job site while it contains the sufficient moisture and shall be placed on the roadbed by means of an approved mechanical spreader. The mixture shall be spread at rate that will produce a uniform compacted thickness conforming to the required grade and cross-section. Compaction shall start as soon as possible after spreading and shall continue until the specified relative compaction is achieved.

b) Travelling Plant Method

The travelling plant shall be either a flat transverse shaft type or a windrow type pug-mill. After the materials have been placed by a mechanical spreader or windrow sizing device, the materials shall be uniformly mixed by the travelling mixing plant. During the mixing operation, water shall be added as necessary to bring the moisture content of the mixture to the percentage suitable for proper compaction

c) Road Mix Method

The materials shall be transported to the site and spread in layers on the roadbed in the quantities required to produce the specified blend. After the materials for each lift have been spread, the materials shall be mixed by motor graders and other approved equipment until the mixture is uniform throughout. During mixing operation, water shall be added as necessary to bring the moisture content to the proper compaction.

21.9.3.4 Compaction

Unless otherwise permitted by the Engineer-in-Charge based on the performance of the compacting equipment used as determined from the trial section each layer of improved sub-grade shall be placed in horizontal layers of uniform loose thickness not exceeding twenty (20) centimetres. Each layer shall be compacted to the density conforming to the requirements specified 21.1.8.3(a).

In-place density determinations of 'the compacted layers shall be made in accordance with AASHTO T-191, T-238 or other approved methods.

21.9.3.5 Trial Sections

Prior to the formation of the improved sub-grade, the Contractor shall construct three trial sections of 200 meter length one (1) for each blend of improved material proposed to be incorporated for improved sub-grade, or as directed by the Engineer-in-Charge. The compacting equipment to be used in the trial sections shall be the same equipment that the Contractor intends to use for main work, accepted by the Engineer-in-Charge.

The object of these trials is to' determine the proper moisture content, the relationship between the number of passes of compacting equipment, density obtained for the' blended material, and to establish the optimum lift thickness that can be effectively compacted with the equipment used. No separate payment will be made for this work, which will be regarded as a subsidiary obligation of the Contractor under pay Item No. 110.

21.9.3.6 Protection of Completed Work

Any part of the completed improved sub-grade shall be protected and well drained and any damage shall be repaired as directed by the Engineer-in-Charge without additional payment.

The Contractor shall be responsible for all the consequences of traffic being admitted to the improved sub-grade. He shall repair any ruts or ridges occasioned by his own traffic or that of others by reshaping and compacting with rollers of the size and type necessary for such repair. He shall limit the improved sub-grade preparation to an area easily maintained with the equipment available. Sub-grade preparation and placement of succeeding layer to follow each other closely. The improved sub-grade, when prepared too soon in relation to the placing of the layer above it, is liable to deteriorate and in such case the Contractor shall, without additional payment, repair or recompact the improved sub-grade as may be necessary to restore it to the state specified herein.

21.9.3.7 Templates and Straightedges

The Contractor shall provide for the use, of the Engineer-in-Charge, satisfactory templates and straightedges in sufficient numbers to check the accuracy of the work, as provided in these specifications and no subsequent work shall be permitted until the improved sub-grade level have been checked and approved by the Engineer-in-Charge.

21.9.3.8 Tolerance

The allowable tolerances for the finished improved, sub-grade surface prior to placing the overlying sub-base, base or asphaltic concrete course are given in the relevant, Table for Allowable Tolerances in these specifications.

21.9.3.9 Measurement

The unit of measurement for payment shall be cubic meter of the compacted and accepted subbase/base material as measured in place. Measurement shall not include any areas in excess of that shown on the drawings except the areas authorized, in writing, by the Engineer.

Measurement of cement content used shall be the number of metric Ton consumed to stabilize subbase/base. This quantity of cement used shall not exceed the theoretical percentage established in the laboratory.

Bituminous curing material shall be measured by the metric Ton. The Contractor shall furnish in duplicate certified weigh tickets from the batch scales of commercial plants

21.10 BITUMEN STABILIZED SUBGRADE

21.10.1 DESCRIPTION

The work shall consist of performing all operations in connection with, construction of bitumen stabilized sub-grade and all incidentals in accordance with the specifications in conformity with the lines, grade, thickness and typical cross-sections shown on the plans or as directed by the Engineer.

21.10.2 MATERIAL REQUIREMENTS

21.10.2.1 Soil

This method will only apply to sites with naturally occurring non plastic material such as sand, if the material is brought at site, it shall be non- plastic having uniform gradation.

21.10.2.2 Bitumen

Bituminous material used for sub-grade stabilization shall comply with the requirement as per relevant tables specified in 21.1.18 "Asphaltic Materials" for hot mix asphaltic concrete or can be viscous cut back that requires heating in areas where moisture content of sand is high, necessitating heating and drying of sand.

In dry areas, where natural moisture content of sand is low, the bituminous binder shall be fluid cut back conforming the requirements as given 21.1.18 “Asphaltic Materials".

Bitumen emulsion or foamed penetration grade bitumen can also be used subject to the approval of Engineer after trial test.

Bitumen-sand mixture for the grade of bitumen selected shall be ascertained by trial mixes using Marshall Test to determine the quantity of bitumen required using either heated or unheated sand. The quantity of bitumen required will generally lie between three (3) to six (6) percent by weight of dry sand, the higher proportions being required with fine-grained materials.

21.10.3 CONSTRUCTION REQUIREMENTS

Equipments, tools, and machines used for bitumen stabilized sub-grade shall be subject to the approval of Engineer-in-Charge and shall be maintained in satisfactory working conditions all the times. Mix in place method of bitumen stabilization will be subject to the approval of Engineer-inCharge to ensure full control of bitumen content, uniform and thorough mixing and satisfactory processing of the material to the full depth of the layer, For scarification of in situ material and spreading of Bituminous material, grader with blade and bitumen distributor shall be used.

The stabilized soil shall be left un-compacted after pulverization and mixing to allow for evaporation of volatile materials thus increasing stability and decreasing water absorption particularly in fine grained sand when temperature is low.

21.10.3.1 Compaction

Immediately after completion of spreading, aeration and shaping operation, the mixture shall be thoroughly compacted with rubber or pneumatic tyred rollers. Compaction shall continue until entire width and depth of sub-grade is uniformly compacted to give soaked (96 hours) unconfined compressive strength according to design requirement to meet traffic loading. Steel wheeled tandem roller shall be used to carry out final rolling of compacted surface to eliminate the tyre marks.

To determine the efficiency of mixing, spreading, degree of compaction of equipment and suitability of construction method, trial sections as directed by the Engineer-in-Charge, shall be prepared by the contractor before main work of stabilization is started.

If thickness of compacted layer is less than 20 centimetres, it shall be laid as single operation where as if thickness of compacted stabilized layer is more than twenty centimetre, material shall be placed in two or more layers, each within the range of eight (8) to twenty (20), centimetres in compacted thickness.

The results of CBR test for measuring the strength of bitumen stabilized materials or cone stability test for designing bitumen-sand mixture shall not supersede those of Marshall Test unless agreed by the Engineer. In-situ density of compacted layer shall be determined using method as described by AASHTO - T-191, AASHTO - T-205 or AASHTO - T-238 and shall be minimum ninety five (95) % modified AASHTO according to the above mentioned methods.

Frequency of testing in field and in laboratory will be according to relevant schedule for sampling and testing of these specifications.

21.10.3.2 Tolerance

Compacted layer shall comply with the tolerance requirements as specified in relevant, "Table for Allowable Tolerances" in these specification.

21.10.3.3 Weather Limitation

The laying of bituminous courses shall be avoided as for as practicable during wet weather and shall be suspended when free standing water is present on the surface. The stabilized material shall not be laid' on any surface, which is frozen or covered with ice or snow and laying shall cease when the air' temperature reaches five (5) degree C on a falling thermometer. Laying shall not commence until the air temperature is at least five (5) degree C on a rising thermometer unless otherwise directed by the Engineer-in-Charge and also if wet weather threatens to be prolonged the preparation and laying of stabilized mix shall be suspended.

21.11 DRESSING AND COMPACTION OF BERMS

21.11.1 DESCRIPTION

This work shall consist of scarification of berms, which are undulated or out of level. The existing material shall be scarified,· watered, mixed and properly levelled and compacted according to specification described here under or as directed by the Engineer-in-Charge .

21.11.2 MATERIAL REQUIREMENTS

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.

21.11.3 CONSTRUCTION REQUIREMENTS

21.11.3.1 Dressing of berm without the use of extra material

In case the berms show undulation of more than 5 cms in level from the reconstructed pavement structure, the berms shall be scarified to a depth of 15 cm and material will be watered, mixed and compact with appropriate equipment approved by Engineer-in-Charge.

21.11.3.2 Dressing of berm with the use of extra material

In case the difference of elevation of existing berm with respect to reconstructed road structure is less than 15 cm than 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 road. Existing and fresh material shall be properly mixed, watered and compacted as directed by the Engineer-inCharge.

21.11.3.3 Compaction requirement

Compaction requirement of the fresh and existing material shall be in accordance with the type of material used in berms, as under:

Depth in cms	Compaction requirement as per AASHTO'T180 (D)
0- 15	95% for common earth material
(0Top - 15	100% for sub-base material

(Top

21.11.3.4 Compaction of slopes

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

21.11.3.5 Measurement

The unit of measurement for payment shall be cubic meter upto second decimal place for the compacted and accepted bitumen stabilized subbase/base course as measured in place. Measurement shall not include any area except the area authorized in writing by the Engineer. Measurement of bitumen binder used shall be the number of metric Ton used to stabilize sub base or base course. The quantity of bitumen used shall not exceed the theoretical percentage established in the laboratory.

21.12 PAVEMENT WIDENING

21.12.1 DESCRIPTION

This work shall consist of the widening of the existing pavement and finishing of the completed work in accordance with the specifications and in conformity with the lines, grades, thickness of each pavement component and typical cross-sections shown on the plans or as directed by the Engineer-in-Charge.

21.12.2 MATERIALS

Materials for the construction of "Pavement Widening" shall conform to the requirements specified in relevant items of Sub-base .and Base course in these specifications.

21.12.3 TRENCHING

The contractor shall excavate along the edge of the existing pavement for the full depth and width as indicated on the Drawings or as directed by the Engineer-in-Charge. The bottom of the trench shall be compacted with rollers and/or tampers approved by the Engineer-in-Charge to minimum ninety five (95) % of the maximum dry density as per AASHTO T-191 method. If the plans do not call for a specific type of compaction, the sub-grade, sub-base or base shall be compacted by rolling with an approved type trench roller until the entire surface is smooth, firm and at the designated elevation. Adequate provisions shall be made for drainage of the trench to prevent damage to the sub-grade. Prior to placing any widening material, the trench shall be cleaned of all loose Material. The edge of the existing pavement .shall be thoroughly cleaned. The trench must be approved by the Engineer-in-Charge, before placing any widening material. All subsequent layers shall be compacted to the degree as shown under relevant item of these specifications

21.12.4 SPECIAL PROVISIONS FOR HANDLING TRAFFIC

Widening operations shall be permitted on only one (1) side of the pavement at a time and excavation of trenches shall be permitted only sufficiently in advance of other operations to ensure a continuity of the operations of excavating, placing widening material and rolling.

Re-flectorized barricades shall be placed along open trenches day and night. Lighting shall be placed at each barricade at night. Barricades and lights shall be approved by the Engineer-inCharge. The barricades shall be placed at intervals not to exceed one hundred (100) meters or as directed by the

Engineer-in-Charge. The Contractor shall make adequate provision to enable traffic to cross open trenches at intersecting roads; streets and private entrances.

21.13 SCARIFICATION OF EXISTING ROAD / BREAKING OF ROAD PAVEMENT STRUCTURE

21.13.1 DESCRIPTION

This item shall consist of scarification of existing road surface or breaking of existing road pavement structure to ensure bondage of new layer with the existing road pavement and to ensure drainage of water below the surface of freshly laid aggregate base. The surface on which the base material is to be constructed shall be approved and accepted by the Engineer-in-Charge prior to placing the crushed stone base aggregate.

21.13.2 CONSTRUCTION REQUIREMENTS

The method of scarification of road surface or breaking of pavement structure shall be proposed by the contractor and approved by the Engineer-in-Charge in accordance with the requirements under site conditions.

After the existing pavement structure has been broken off, the material shall be removed and disposed off outside the right of way, according to the satisfaction of the Engineer-in-Charge. The surface obtained after scarification or breaking the existing pavement shall be compacted to the density prescribed under 21.1.8.3.

21.13.3 MEASUREMENT

The quantity for road pavement structure broken and removed, to be paid for shall be measurement in Cu. meter to a depth as shown in the drawings/cross sections or as specified by the Engineer and in the area earmarked by the Engineer for such purpose.

The quantity for road pavement structure scarified, to be paid for shall be measured in Sq. meter as shown in the drawings/cross sections or as specified by the Engineer and in the area earmarked by the Engineer for such purpose.

21.9 PAYMENT

21.9.1 COMPOSITE RATE

The measurement and payment for the items of the work of Road and Road Structures 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-inCharge.

21.9.2 LABOUR RATE

The measurement and payment for the items of the work of Road and Road Structures 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.

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22 . SHEET PILING

22.2 GENERAL

This work shall consist of performing all operations in connection with furnishing driving, cutting off complete in place and strictly in accordance with these Specifications and as shown on the Drawings.

A detailed proposal for the piling shall be delivered by the Contractor to the Engineer-in-Charge well in advance of the start of work. The proposal shall include full details of materials, equipment and method to be used in the construction of piles. Work on piling shall not commence until the Contractor's proposals have been approved by the Engineer-in-Charge and communicated to him.

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 Engineer-in-Charge.

22.3 MATERIAL REQUIREMENTS (STRUCTURAL PILES)

Structural steel piles shall be rolled steel sections of the type, weight and shape called for on the Drawings. The piles shall be structural steel conforming to the requirements of ASTM A-36, except that steel produced by the Acid Bessemer process shall not be used.

The steel piles shall be coated with red lead paint conforming to AASHTO M-72, unless otherwise specified or as directed by the Engineer-in-Charge.

22.4 HANDLING OF PILES

All piles shall be lifted by means of suitable bridle or sling attached to pile at marked pick up points to avoid damage to piles. They shall be properly loaded and carted to the specified place and unloaded in workman like manner and sorted at specified place(s) for further use. Piles which may have been injured during handling, loading or unloading or carriage by the contractor will be rejected and replaced by the contractor at no cost to the employer.

22.5 CONSTRUCTION REQUIREMENTS

a) Location and Site Preparation

Piles shall be used where indicated on the Drawings or as directed by the Engineer-in-Charge.

All excavations for the foundation in which the piles are to be driven shall be completed before the driving is begun, unless otherwise specified or approved by the Engineer-in-Charge. After driving is completed, all loose and displaced materials shall be removed from around the piles by hand excavation, leaving clean solid surfaces to receive the concrete for foundations.

b) Determination of Pile Length

The criteria for pile length and bearing capacity will be determined by the Engineer-in-Charge 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 appropriate 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.

c) Pile Driving

All piles shall be driven accurately to the vertical or the batter as shown on the Drawings. Each pile shall, after driving, be within fifteen (15) cm from the theoretical location underneath the pile cap or

underneath the super-structure in the case of pile bents. All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again. Piles shall be used only in places where a minimum penetration of three (3) meters in firm materials; or five (5) meters in soft materials can be obtained. Where a soft stratum overlies a hard stratum, the piles shall penetrate to hard material upto a sufficient distance to fix the ends rigidly.

All pile driving equipment shall be subject to the Engineer-in-Charge's approval. The Contractor shall be responsible for sufficient weight and efficiency of the hammers to drive the piles down to the required depth and bearing capacity. Hammers shall be gravity hammers, single acting steam or pneumatic hammers or diesel hammers. Gravity hammers shall not weigh less than sixty (60) percent of the combined weight of the pile and driving head and not less than 2,000 Kg. The fall shall be adjusted so as to avoid injury to the pile and shall in no case exceed one (1) m unless otherwise specified or approved by the Engineer-in-Charge. The plant and equipment furnished for steam hammers shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The boiler or pressure tank shall be equipped with an accurate pressure gauge and another gauge shall be supplied at the hammer intake to determine the drop in pressure between the tank and the hammer. When diesel hammers are used, they shall be calibrated with test piling and/or test loads.

Water jets shall be used only when permitted in writing by the Engineer-in-Charge. When water jets are used, the number of jets and the nozzle volume and pressure shall be sufficient to erode the material adjacent to the pile freely. The jets shall be shut-off at a depth not less than three (3) M before final tip elevation is reached, and the piles driven solely by hammer to final penetration as required by the Engineer-in-Charge.

Piles shall be supported in line and position with leads while being driven. Pile driving leads shall be constructed in such a manner as to afford freedom of movement of the .hammer, and shall be held in position by guys or steel braces to ensure rigid lateral support to the pile during driving. The leads shall be of sufficient length to make the use of a follower unnecessary, and shall be so designed as to permit proper placing of batter piles. The driving of piles with followers shall be avoided if practicable and shall be done only under written permission from the Engineer-in-Charge.

The method used in driving piles shall not subject them to excessive and undue stresses producing deformation of the steel. Manipulation of piles to force them into proper position, if considered by the Engineer-in-Charge to be excessive, will not be permitted.

The doll-eying of the piles shall be done by protecting tops with driving heads, caps or cushions in accordance with the recommendations from the manufacturer of the pile hammer and to the satisfaction of the Engineer-in-Charge. The driving head shall be provided to maintain the axis of the pile in line with the axis of the hammer and provide a driving surface normal to the pile.

Full-length piles shall be used where practicable. Splicing of piles when permitted shall be done as shown on Drawings or approved by the Engineer-in-Charge. All piles shall be continuously driven unless otherwise allowed by the Engineer- in-Charge.

22.5 PILE RECORDS

The contractor shall keep records of piles driven or installed. A copy of the record shall be given to the Engineer-in-Charge within two (2 days) after each pile is driven;

- Pile Type & Dimension
- Driving Equipment type, weight and efficiency of hammer etc.
- Depth Driven and tip elevation.
- For gravity and single acting hammers the height of drop.
- For double acting the frequency of blows.
- Final set for last 20 blows for every ten piles and when the Engineer-in-Charge so requires the penetration along the whole driven depth shall be recorded.
- Details of any interruption during driving.

- Level of top of pile immediately after driving and the level when all piles in the group are driven.
- Details of Re-driving.
- Any other relevant information.

22.6 DAMAGED OR 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 intended use, or any pile driven out of proper location shall be removed and replaced.

The Engineer-in-charge may require the contractor to pull certain selected piles after driving for test and inspection to determine to conditions of the piles. Any pile so pulled and found to be damaged to such extent 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 contractor shall furnish, drive a new pile to replace the damaged pile. Piles pulled and found to be sound and in a satisfactory conditions be re-driven.

22.7 MEASUREMENT AND PAYMENT

22.7.1 COMPOSITE RATE

The measurement and payment for the items of the work of Sheet Piling 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.

22.7.2 LABOUR RATE

The measurement and payment for the items of the work of Sheet Piling 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 at designated location as defined in the Contract Agreement.

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24. SURFACE DRAINAGE

24.2 SCOPE

The work covered by this Section consists in furnishing all plants, labours equipments, appliances and materials and performing all operations in connection with the construction of Surface Drainage in accordance with the Drawings and this Section of Specifications.

24.3 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.

24.4 CONSTRUCTION REQUIREMENTS

24.4.1 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 slabs 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 slabs 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 24.2 above.

The preparation of the trench, aligning and grading shall be carried out in the same manner as required for sewers.

No extra shall be payable 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.

24.4.2 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.

24.4.3 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.

24.4.4 CONNECTION WITH SEWERS

The surface drains shall be connected with sewers through gully gratings or as shown on drawings.

24.4.5 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.

24.4.6 TESTING OF DRAINS

After completion the drain shall be tested for flow by filling upto the full section.

24.4.7 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.

24.4.8 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.

24.4.9 FOUNDATION FOR REIMBURSEMENT AND TEGA

76 mm or as specified cement concrete shall be provided under reimbursement and Tega.

24.4.10 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.

24.5 MEASUREMENT AND PAYMENT

24.5.1 COMPOSITE RATE

The measurement and payment for the items of the work of Surface Drainage 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.

24.5.2 LABOUR RATE

The measurement and payment for the items of the work of Surface Drainage 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 at designated location as defined in the Contract Agreement.

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25 SEWERAGE

25.1 SCOPE

The work covered by this section of the specifications consists in furnishing all reinforced concrete pipes, plant, labour, equipment, appliances and materials and in performing all operations required for installing and testing the sewer pipes in strict accordance with the specifications of this section and the applicable drawings and subject to the terms and conditions of the contract.

25.2 RELATED WORKS SPECIFICATIONS

- Section 3 – Earthwork
- Section 5 – Plain & Reinforced Concrete
- Section 11 – Brickwork
- Section 27 – Tube-well & Water Supply
- Section 28 – Iron Steel & Aluminum Works

25.3 SEWER LINES

25.3.1 MATERIALS

All materials used in the manufacture of reinforced cement concrete pipes for use shall conform to ASTM Designation C-76-03 or latest revision and also with the following specifications.

a) Cement

The Portland cement to be used in the manufacture of reinforced concrete pipes shall conform to the requirement of BS-12/ASTM Designation C-150 (latest revision).

b) Aggregates

The coarse/fine aggregate to be used in the manufacture of concrete pipes to be furnished and installed shall be generally in accordance with the provisions of Section 5 – Plain & Reinforced Concrete.

c) Water

Water to be used in the manufacture of pipes shall be in accordance with the provisions of Section 5 - Plain & Reinforced Concrete approved by the Engineer-in-Charge.

d) Steel Reinforcement

The material shall conform to the specifications contained in Section 5 – Plain & Reinforced Concrete.

e) Brick Ballast

Brick ballast shall have a maximum gauge of 1½ inch and shall be graded down to ¾ inch and shall not contain more than 10% which will pass through screen made of ¼ inch diameter bars spaced at ¾ inch centre to centre.

25.3.2 NON-REINFORCED CEMENT CONCRETE PIPES

The non-reinforced cement concrete pipes shall conform to ASTM C-14, latest revision Class II equivalent. Pipe ends shall be thus tongue and groove or bell and spigot. The physical dimensions shall be as described in applicable provisions of ASTM C-14.

25.3.3 REINFORCED CONCRETE PIPES

25.3.3.1 CLASSES OF PIPE

The reinforced cement concrete pipes to be furnished and installed shall be of the strength Class II or specified otherwise on the Drawings.

Following technical criteria shall be adhered to:

Class of Pipe	:	Class-II
Concrete Strength	:	4000 Psi (Cylinder Test)

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-76-82 or latest revision.

For pipes smaller than 12 inches dia BSS 556, Class-L shall be strictly followed:

25.3.3.2 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-76-79 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., and also pay for the carriage of such samples and all other expenses contingent to tests.

25.3.3.3 PIPE DIMENSIONS

The internal diameters and wall thicknesses of reinforced concrete pipes under this contract shall be as set forth in ASTM Designation C-76-82 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:

12 inch dia pipe	**:**	2.00 inch
15 inch dia pipe	**:**	2.25 inch
18 inch dia pipe	**:**	2.50 inch
21 inch dia pipe	**:**	2.75 inch
24 inch dia pipe	**:**	3.00 inch
27 inch dia pipe	**:**	3.25 inch
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:

1.	Wall thickness	1 inch
	Reinforcement square inches	
2.		0.05
	per linear foot of pipe wall	
3.	Concrete strength	4000 Psi (Cylinder Test)
4.	Inside diameter at the mouth of socket	12½ inch
5.	Depth of socket	2¼ inch
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.

25.3.3.4 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.

25.3.3.5 JOINTS FOR CONCRETE PIPE SEWERS

The joints for concrete pipes shall be as specified and could be as follows:-

a) 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 exfilteration 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.

b) 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 out side 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 tile pipe at the Joint shall be cleaned of all surplus mortar and brushed to a smooth finish. The out side 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.

25.3.3.6 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 contract.

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.

25.3.3.7 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 I 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.

25.3.3.8 INSTALLATION

2 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.

3 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. c) Placing of Bedding

i) 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 ¼ inch 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.

ii) Crushed Stone Bedding

Crushed stone bedding shall be from an approved source. It shal1 be obtained from a dark colored igneous rock such as granite 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 to ¾ inch when sifted 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.

d) Laying of Sewers

Neither any sewer pipe nor the bedding shall be laid or placed till the alignment of the sewer and its levels and gradients have been carefully checked and tested with the trench excavation and found correct.

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 open pipe shall be closed with a tapered wooden plug to keep out foreign matter.

25.3.3.9 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

.

ix) 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.

x) Plug all pipe outlets discharging into the upstream manhole.

xi) Measure the groundwater elevation and determine the average head over the test section.

xii) Measure infiltration leakage at the outlet of the test section. Because leakage allowances are small, measurements are best made by either timing the 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.

xiii) 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.

xiv) If the test section fails, it is not prohibited that it be repaired and retested in accordance with this practice.

xv) 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.

xvi) 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

xii) Conduct testing from manhole to manhole or between or between more than two manholes. The length of main tested shall not exceed 700 ft.

xiii) Determine the groundwater elevation at both ends of the test section. If the groundwater 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.

xiv) Plug all pipe outlets discharging into the upstream manhole and the test section outlet. Fill the sewer line with water.

xv) 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.

xvi) 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.

xvii) 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.

xviii) 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.

xix) If the test section fails, it is not prohibited that it be repaired 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).

xx) 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.

xxi) 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.

xxii) 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).

f) 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 permission maximum stated above.

g) Cleaning of Sewer Lines

The Contractor shall clean all the sewer lines at no extra cost with the method approved by the site Engineer-in-Charge prior to handing it over to the Owner.

25.3.3.10 MEASUREMENT

The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

25.4 UN PLACTICIZED POLYVINYL CHOLRIDE PIPES

The UPVC pipes to be furnished and installed shall be of the Class B to Class E, as specified on the Drawings. The design requirements for these classes of UPVC pipes shall be as described in Pakistan Standard Designation PS 3051 or British Standard BS 3505.

25.4.1.1 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.

25.4.1.2 PRESSURE TESTING

It is recommended to test the pipeline in accordance with PS standards 3051 and BS 3505.

25.4.1.3 MEASUREMENT

The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed. The length shall be taken along the centre line of the pipes over all fittings such as bends, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

25.5 MANHOLES

25.5.1 MATERIALS

Brick masonry, Portland cement concrete, and other materials shall meet the specified requirements of the relevant sections of the specifications, listed under clause 25.2 and elsewhere as necessary. Cast iron frame shall conform to the specifications as per B.S.S. 497, Manhole steps shall be of galvanized mild steel.

25.5.2 CONSTRUCTION REQUIREMENTS

Manholes shall be constructed with brick masonry laid in 1:3 cement sand mortar, built on 1:2:4 concrete base slab and as specified. The cover slab shall be 1:2:4 reinforced cement concrete, fitted with cast iron frame which shall have reinforced cement concrete cover as shown in the drawing. Reinforcement and concrete shall conform to the requirements or Section 5 – Plain & Reinforced Concrete. The outside and inside of the walls shall be plastered (½ inch thick) with 1:3 cement sand mortar and two coats of hot PB-4 bitumen shall be applied outside. At the bottom of manholes for sewers, a proper channel as per Drawings, shall be constructed in the whole length of the manhole along the centerline of the sewers, to lead the sewage from one sewer to the other. Galvanized mild steel steps shall be installed at 12 inches interval inside the manhole during the construction of the manhole walls. Cutting holes into the wall for the steps after construction will not be permitted. Top rung shall be 18 inches below the manhole cover and the lowest not more than 12 inches above the benching (floor).

Depth of manhole shall be from invert level of sewer to the top of manhole.

Where specified cast iron manhole covers conforming to the dimensions and weights as shown on drawings shall be used.

25.5.3 DROP MANHOLE

The Contractor shall construct drop manholes wherever shown in the drawings or ordered by Engineer-in-Charge. The Contractor shall make the drop connection as shown on the drawings or ordered by the Engineer-in- Charge.

25.5.4 MEASUREMENT

The manhole covers shall be enumerated under relevant items.

Manholes shall be enumerated under relevant items. The depth of the manhole shall be reckoned from the top level of C.I. cover to the invert level of channel. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

25.6 CAST IRON VENTILATING SHAFTS

Cast Iron Pipes & specials shall conform to BS-78 for spigot and sockets vertically cast pipes; BS-1211 for spigot and socket spun iron pipes and BS-2035 for flanged.

The work shall carried as specified shown on drawings and approved by the Engineer-in-Charge in accordance with applicable specifications.

25.6.1 MEASUREMENT

The Cast Iron ventilating shafts shall be measured in Kgs upto two decimal place.

25.7 CLEANING OF LINES

The lines shall be cleared of silt and other clogged material in the pipeline as directed by the Engineer-in-Charge.

25.8 PAVEMENT RESTORATION

The paved surfaces which are cut shall be restored to the original condition according to drawings and as approved by the Engineer-in-Charge.

25.9 MEASUREMENT AND PAYMENT

25.9.1 COMPOSITE RATE

The measurement and payment for the items of the work of Sewerage 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.

25.9.2 LABOUR RATE

The measurement and payment for the items of the work of Sewerage 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.

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26. WELL SINKING

26.1 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.

26.2 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.

26.3 MATERIALS & 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.

26.4 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 for 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, 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 unwatering 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 placement 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.

26.5 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 sinkage 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.

26.6 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.

26.7 MEASUREMENT AND PAYMENT

26.7.1 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.

26.7.2 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.

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27. TUBE-WELL AND WATER SUPPLY

27.1 CONSTRUCTION OF TUBE-WELLS

27.1.1 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.

27.1.2 DRILLING

27.5.2.1 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 for water for construction requirements, the disposal of water, cuttings and refuse from the operations away from the tube-well.

27.5.2.2 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.

27.5.2.3 DRILLING PROCEDURE

The bore hole shall be drilled either by direct or 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 tubewell casing may, be installed concentric with the hole and within the tolerance specified for plumpness 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-inCharge 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.

27.1.2.4 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.

27.1.2.5 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 labelled 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 Engineer's field headquarters.

27.1.2.6 MEASUREMENT

Dimensions shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of boring. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools, equipment for excavating, driving

27.1.3 INSTALLATION OF TUBE-WELL COMPONENTS

27.1.3.1 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.

27.1.3.2 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, injuries, scars and ovalties. 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. 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 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.

27.1.3.3 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 fields 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.

27.1.3.4 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 of the 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 shall be painted with lines I inch wide, and shall be positioned on the casing in accordance with the Engineer's instructions.

27.1.3.5 MEASUREMENT

The net length of pipes as laid or fixed, shall be measured in the running metres correct to a cm. specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

27.1.4 GRAVEL SHROUDING

27.1.4.1 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.

27.1.4.2 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 Department 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.

27.1.4.3 SPECIFICATIONS

The gravel shrouding shall be clean, washed, water worn, hard, well rounded of siliceous material, without platty 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.

U.S. Standard Screen Number	Percentage Passing
1 cm (3/8 inches)	100
No. 4	75 – 100
No. 8	35 – 65
No. 14	05 – 30
No. 16	00 – 15
No. 35	00 – 00

27.1.4.4 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. (1.80 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. (1.5 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 upto 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.

27.1.4.5 MEASUREMENT

Gravel Shrouding Shall be measured in cubic meter correct upto 2 decimal place.

27.1.5 GROUTING OF PUMP HOUSING CASING

27.1.5.1 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.

27.1.5.2 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.

27.1.5.3 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 emplaced 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.

27.1.6 DEVELOPMENT AND TESTING

27.1.6.1 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 wheather 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.

27.1.6.2 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.

27.1.6.3 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/litre. 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 upto 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-inCharge.

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.

27.1.6.4 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	2hour (minimum)
Step pumping	4 hours (one hour each of the rated capacities 35%, 70%, 105%, & 140%)
Pumping period (Constant discharge test)	2 hours

27.1.6.5 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-inCharge 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.

27.1.6.6 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.

27.1.6.7 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.

27.1.6.8 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.

27.2 TUBE-WELL PUMPING FACILITIES

27.2.1 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.

27.2.2 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.

27.2.3 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.

27.2.4 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.

27.2.5 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, including 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 NEMA flanged 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 145-61 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 prelubrication 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.

27.2.6 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.

27.2.7 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”.

27.2.8 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.

27.2.9 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.

27.2.10 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 upto 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 alongwith 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 $\pm$ 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 A.S.T.M. 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.

27.2.11 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.

27.3 WATER SUPPLY

27.3.1 MATERIALS

27.3.1.1 PIPES

Material of the water supply pipes shall conform to the respective specifications and other requirements specified hereinafter. The pipes shall be new and unused unless otherwise specifically specified or directed by the Engineer-in-Charge. The standard length of pipes of each material as specified shall be used.

a) Polyethylene pipes and Fittings

Polyethylene pipes for supply to underground and overhead tanks complying ISO 4427:1996 & DIN 8074,8075.

Providing, fixing, jointing and testing Polypropylene Random (PPR) pipes of approved make pressure pipe for cold and hot water as per DIN 8077-8078,PN-20 for pipes and DIN 16962,PN-25 for fittings (polyfusion welded joints) inside building including fittings and specials (sockets, tees, elbows, bends, crosses, reducers, adaptor, plugs and union etc.) supported on walls or suspended from roof slab or run in chases including pipe hangers, supports, cutting and making good the chases and holes, complete in all respects. **b) Cast Iron Pipes and Fittings**

Cast iron pipes and fittings shall comply with ISO 13-1978 (E) or B.S. 78 for spigot and socket vertically cast pipes, B.S.1211 for spigot and socket spun iron pipes and B.S. 2035 for flanged pipes. (Not to be used in new construction).

c) Asbestos Cement pipes, Fittings and Specials

These shall conform to International Organization for Standardization Recommendation R160 "Asbestos Cement Pressure Pipe and joints" or British Standard Specification 486 "Asbestos Cement Pressure Pipe" or to Pakistan standard specification No. PS. 428 : 1984 of the class capable of withstanding a 400 ft. head test pressure. Short lengths of pipe machined overall shall be used at fittings for tying in the fittings and specials for asbestos cement pipes shall be cast-iron conforming to British Standard Specification 78: PART 2 Fittings: "Cast Iron Spigot and Socket Fittings", Class AV, except that the fittings and specials shall have the shapes, dimensions and tolerance required to fit the asbestos-cement pipes.

Rubber ring shall conform to Pakistan Standard Specification No. PS. 1915: 1987.

(Not to be used in new construction).

d) Galvanized Iron Pipes and Fittings

The galvanized iron pipes shall conform to B.S. 1387 Specifications for "Steel Tubes and Tubular suitable for screwing to B.S. 21 pipe threads" and shall be of medium grade. All screwed pipes and sockets shall conform B.S. 1740. A complete and uniform adherent coating of zinc white will be provided for galvanized iron pipes and fittings. **e) M.S Pipe**

All mild steel pipes shall conform to ASTM designation A53, Schedule 40 "Standard Specification for Welded and Stainless Steel Pipes". All pipes shall be internally cement mortars lined and externally bituminous coated. M.S. short pieces shall be flanged at both ends. The flanges shall conform to B.S. 4504, part 3 (PN 16). M.S. pipe pieces shall be externally protected by applying two coats of red oxides (of approved quality) and bituminous coating (grade 10/20) at the rate of 0.4 lb/Sq.ft.

f) Un-plasticized Polyvinyl Chloride Pipe and Fittings

Un-plasticized polyvinyl chloride (uPVC) pipe and fittings if approved by the Engineer-in-Charge shall confirm to BS 3505. The pipes shall be class B. The pipes and fittings shall not be stored directly exposed to sunlight handled or laid in conditions where ambient temperatures may cause distortion or damage. In extreme conditions, pipes and fittings may have to be stored under water. **g) Joints for Un-plasticized Chloride Pipe**

Joints for un-plasticized polyvinyl chloride pipe shall be the Z type consisting of a socket with rubber gasket, or approved equal, and assembled in accordance with the pipe manufacture's recommendations.

h) Ductile Iron Pipes and Fittings

Ductile iron pipes shall be made from a suitable spheroid graphite iron centrifugally cast in lined or unlined metal moulds in conformity with the ISO Standard 2531 Class K9 or its equivalent. The pipes shall have spigot and socket ends employing elastomer gaskets for making push-on joint. Pipes with mechanical joints shall be used wherever rigidity is required and shall have flanges with appropriate nuts and bolts and the gasket. Fittings and specials shall be of ductile iron made to match the type and size of pipes. Except tees, all standard fittings shall conform to ISO Standard K12 whereas tees shall conform to K14.

i) Measurement for all types of Pipes

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include pipe and fittings such as bends, tees, elbows reducers, crosses, plugs, sockets, nipples and nuts. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore the largest bore shall be measured.

27.3.1.2 SLUICE (GATE) VALVE

Valves shall be wedge gate valves conforming to British Standard Specification 5163. Ends of valves shall be suitable for the type of pipe to which the valves will be connected.

MEAUREMENT

As mentioned in Section23

27.3.1.3 CHECK VALVES

Check valve shall comply with the requirements of BS 5153 latest revision for pressure rating of 16 bar. The valve shall be of swing type and shall be of quick acting single door type.

MEAUREMENT

As mentioned in Section23

27.3.1.4 FIRE HYDRANTS

The metal of the fire hydrant shall conform to B.S. 750 and shall be of screw down streamline pattern. The body shall be best quality, closed grain, grey cast iron with spindle of manganese bronze having tensile strength of not less than 11.0 tons per square inch (1.63 kg/mm^2) machined from solid rolled bars, the seating valves and other parts shall be of best quality gun metal with Brinell Hardness No. 80. The direction of closing shall be by clockwise rotation and outlet shall have screwed joint for accommodation 2-1/2" dia hose connection. Inlet flanges of hydrant shall be suitable for jointing with flanges of hydrant bends and tees. All fire hydrants shall be coated with three coats of solution from an approved manufacturer to give a uniform protective coating on cast iron.

MEAUREMENT

As mentioned in Section23

27.3.1.5 SURFACE BOXES

The surface boxes shall be manufactured as per drawings. Cover and frame shall be of cast iron.

27.3.1.6 FERRULES

Brass ferrules of the sizes required shall be provided with M.S straps and cast iron saddles as approved by the Engineer-in-Charge.

27.3.1.7 APPROVAL OF MATERIALS

As soon as practicable but within 30 days after receipt of notice to proceed and before any materials or equipment are purchased, the Contractor shall submit for approval by the Engineer-inCharge a complete schedule, in triplicate, of materials and equipment to be incorporated in the work, together 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-inCharge. No consideration will be given to partial lists submitted from time to time. Approval of materials and equipment under deviations from the specifications shall not be granted unless the attention of the Engineer-in-Charge has been directed to the specific deviations. Laboratory results and certifications, specified or otherwise required, shall be submitted prior to delivery of the material and equipment to site.

27.3.2 INSTALLATION

27.3.2.1 HANDLING

Pipe and accessories shall be handled in such a manner as to ensure their delivery to the trench in sound, un-damaged condition. If any pipe or fitting is damaged, the repair or replacement shall be made by the Contractor at his expenses in a satisfactory manner. No other pipe or material of any kind shall be placed inside of a pipe or fittings. Pipe shall be carried into position and not dragged. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material at the cost of the Contractor. Rubber gaskets that are not to be installed immediately shall be stored in a cool dark place and protected against the direct rays of the sun.

27.3.2.2 CUTTING OF PIPE

This shall be done in a neat and workman-like manner without damage to the pipe. Unless otherwise authorized by the Engineer-in-Charge or recommended by the manufacturer, cutting shall be done with a mechanical cutter of approved type. Wheel cutters shall be used wherever practicable.

27.3.2.3 LOCATION

Where the location of the water pipe is not clearly defined by dimensions on the Drawings, the water pipe shall be located as directed by the Engineer-in-Charge.

27.3.2.4 EXCAVATION IN TRENCHES AND BACKFILLING

The trenches shall be set out to suit alignment of the pipe lines. The trenches shall be carefully trimmed at sides and bottom of that pipe lines when laid shall rest on the firm bed throughout the length. Shallow joint holes shall be left for the joint, where necessary. Where pipe line is to be laid in plains the depth of cover, i.e., the normal distance from ground level to the top of the pipe be kept at about 800 mm and shall not be less than 750 mm except due to special reasons where the Engineer-in-Charge directs in writing to the contrary.

27.3.2.5 PLACING AND LAYING

Pipe and accessories shall be carefully lowered into the trench by means of derrick ropes, belt slings, or other suitable equipment. Under no circumstances shall any of the water line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers shall be of wood and shall have broad flat faces to prevent damage to the pipe. Except where necessary in making connections with other lines or authorized by the Engineer-inCharge pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bell coupling and joints. Pipe that has the grade or the joint disturbed after laying shall be taken out and re-laid. Pipe shall not be laid in water. The water shall be kept out of the trench until the materials in the joints have hardened or until caulking or joining is completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substances will enter the pipes or fittings. Where any part of a coating or lining is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner as approved by the Engineer-in-Charge. Pipes shall be installed in accordance with recommendations of the pipe manufacturer. Pipe ends left for future connections shall be valved, plugged or capped, and anchored, as shown on drawings or as directed, where connections shall be made by using specials and fittings to suit the actual conditions.

27.3.2.6 JOINTING

a) General

The joints shall be in accordance with the recommendations of the manufacturer or as approved by the Engineer-in-Charge.

Connections between different types of pipes and accessories shall be made with transition fittings where recommended by the pipe manufacturer.

b) Cast Iron/ Ductile Iron Pipes and Fittings The jointing could be any of the following:

Rubber Gasket Joints

Rubber gasket joints may be used for socket and spigot pipes, where called for Rubber gasket joints shall be made using specified rubber gaskets, conforming to PS-428: 1984 and ISO 1601980 made to fit the applicable socket and spigot pipes. An approved rubber ring lubricant (but not grease), shall be used for joining the pipes. Care shall be taken to avoid contamination of the gasket and lubricated surface, with earth or other undesirable material during installation.

Lead Caulked Joints

The socket joints of the pipes and special castings shall be made with lead and white spun yarn. The joints shall be made by forcing the spigot end of one pipe into the socket end of the preceding one. A gasket of spun yarn being then driven and caulked into the joint keeping the pipes concentric. The gasket shall either be driven in complete rings, or better still a spiral coil of yarn shall be inserted. In the former case, care shall be taken that the joints of the successive rings do not coincide. Each ring shall be packed with a thin steel "yarning" tool and then lightly hand caulked to ensure that the yarn is solidly packed. Short pieces of yarn forming less than a complete ring shall not be used. The yarn shall be caulked to such a depth as to leave clear the following depths measured from the faces of the sockets for the lead joints.

Pipe dia. (cm)	Finished Depth of Lead Joints (mm)
5 to 12.5	40
15, 18	45
20, 23	48
25, 30	50

A jointing ring shall be placed round the barrel and against the face of socket. Molten lead shall be poured in to fill the remainder of the socket. Before making any joint, care shall be taken to remove all thick bituminous material or coal tar from the spigot end and from the inside of the socket. Both shall be thoroughly cleaned and dried before the joint is made after the lead has solidified in the joint, the jointing ring shall be removed and the lead shall be caulked right round the joint to make up for the shrinkage of the molten metal on cooling. The joint shall be set back by caulking, not less than 4 mm inside the face of pipe socket.

Lead Wood Caulked Joints

This type of lead caulking shall be done where it shall be inconvenient or dangerous to use molten lead for joints for example, in cases such as inverted joints or in wet trenches. The spun yarn shall first be inserted and caulked into the socket as described under jointing with molten lead. Lead wool or lead yarn shall then be introduced in the joint in strings not less than 6 mm thick and the caulking repeated with each turn of lead wool. The whole of the lead wool shall be compressed Into a dense mass. The joint shall then be finally finished flush with face of the socket. The lead wool brought to site shall be properly protected and packed with wax paper or polythene sheet, to prevent oxidation.

Flanged Joints

These shall be made using 3 mm rubber insertion jointing discs accurately cut. The bolts of the joints are to be tightened up systematically and uniformly in such a manner that the tension in all the bolts shall be similar and there shall be no tendency to distortion. No bolt shall be stressed beyond its elastic limit.

c) G.I / M.S Pipes and Fittings

Screwed Joints

All screwed joints, both internal and external, shall be examined before jointing, to ensure that the threads are perfect for the full depths of the joints. The jointing shall be such that the ends of pipes or Specials remain equidistant from the middle of the socket and space between them in the centre of the socket is not more than 6 mm. All burrs from the ends of the threaded joints shall be removed.

To make the joints water tight thin strands of best quality country cotton yarn smeared over carefully with genuine Red lead shall be used. A paste of genuine red and white lead mix shall be lightly smeared over the threads to act as a lubricant and to make up for imperfections in the threads when the pipes are screwed up. No red and white lead paste or cotton yarn shall project outside the ends of the joints

Flanged Joints

In the case of pipe lines laid in open country whether in trenches or on the surface, flanged joints shall be provided at intervals of not more than 500 feet. The flanges shall be screwed on to the pipes in the same manner and using the same jointing composition as already described for screwed joints so as to be water tight. All flanges shall be screwed home and the end of the pipe projecting in front of the flange faces shall be neatly cut off, filed and made perfectly smooth and not to project ahead of the faces of the flanges so as not to interfere with the accuracy of the joints. Each flanged joint shall be made by inserting an accurately cut disc of tough multiple rubber insertion about 3 mm thick of approved quality between the flanges. The bolt holes in the rubber insertion as well as in the flanges shall be, drilled to template. The bolts shall be pulled up gradually and evenly so as to ensure a perfect joint. They shall, however, not be over-strained.

d) Asbestos Cement Pipes

Comete Couplings

Comete couplings manufactured in asbestos cement and provided with two jointing rings, one at each end shall be used. The rings shall be supplied by the pipe manufacturer. They shall be lip seal type conforming to P.S-1438, latest version, "Rubber sealing rings for joints in asbestos cement water piping". The joints shall not only withstand internal test pressures but also provide adequate safeguards against seepage of ground water into pipe lines.

Flanged Joints

Gaskets for flanged joints shall conform to the requirements of Standard Specifications for "Sheet Buffer Packing" (ASTM Designation: D 1300-59). Grade No.1, black colour, and thickness of 8 mm.

e) PVC Pipes

The joints in the pipe line shall be "Z" type rubber ringed joints. For jointing with specials like valves, special stub flanges and steel flanges drilled to shape and size of flange on the special fitting will be used. For jointing with CI or asbestos cement pipes special, socketed pieces or spigotted pieces or pieces with stub joints on one end and socket or spigot on the other end shall be used.

Pipes should be jointed outside on the side of trench and then lowered into prepared trench with necessary bedding already in place. Heavy fittings will be jointed in the trench. For achieving reliable and satisfactory installation, factory made fittings must be used and due consideration be given to thermal effect on PVC .and to supporting heavy fittings like valves, independently so that these do not bend or damage the pipe. On hot days the pipe should be allowed to cool off in the trench before being fixed to valves etc., so as to avoid stresses on shrinkage. Hot air in the body of pipe be released through air valves or through taps connected to saddled tappings. Use of 'Z' type joint reduces the risk of shrinkage as it allows movement. Branching shall be done by special welding process, which shall be obtained from the manufacturer and should preferably be done by his crew or by specially trained workers.

Only special jointing solution and other items like rubber rings supplied by the manufacturer shall be used. The solution should be applied uniformly, evenly and thinly. A thick layer will not improve but may weaken the joint. Only tapping saddles made from gun metal and supplied by the manufacturer

of pipes will be used for making house connections. End connections with screwed GI pipes will be made with special socked and screwed connecting pieces obtained from the pipe manufacturer.

27.3.2.7 DEFLECTION

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets will be 2" for Asbestos Cement Pipe unless otherwise recommended by the manufacturer. If the alignment requires deflections in excess of the specified limitations special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set-forth, as approved.

27.3.3 MASONRY CHAMBERS FOR SLUICE VALVES,

Valves Fire Hydrants etc.

Masonry chambers shall be constructed according to the drawings or as instructed by the Engineer-in-Charge. The concrete and masonry work shall be according to the provision of the relevant Sections.

27.3.4 SETTING OF FIRE HYDRANTS, VALVES AND SURFACE BOXES

Fire hydrants shall be located and installed, as shown on drawings. Hydrants shall be set plumb and in accordance with the manufacturer's instructions.

Valves and surface boxes shall be installed as shown or directed, and shall be set plumb. Surface shall be centered on the stems or operators. Concrete, concrete pipe, brick, brick ballast used in chambers shall conform to the relevant clause of the Specification. Where feasible, valves or operators shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box to the satisfaction of Engineer-in-Charge on all sides of the box, or to the undisturbed trench face if less than 4 ft.

Hydrants and valves shall have the interiors cleaned of all foreign matter before installation. Surface boxes shall be lighted and the hydrant or valve shall be inspected in open and closed positions to ensure that all parts are in working condition.

27.3.5 FERRULE CONNECTIONS

Service connections to water mains shall be made either by drilling and tapping the main after the pressure has been shut off, or by use of special tapping apparatus whereby the main can be drilled and tapped and the ferrule introduced while the main is still under pressure. The later method shall be used for trunk mains or in other cases where it would be inconvenient to shut off the water while the connection is being made. In order to make a service connection to an asbestos cement water main, a malleable iron saddle piece with a flat boss shall be first bolted round the main with a rubber washer between the main and the boss. The boss and the pipe shall then be drilled and tapped together, giving a continuous thread through the boss and the wall of the main.

27.3.6 THRUST BLOCKS

Plugs, caps, tees, bends and fire hydrants shall be provided with concrete thrust blocks. Backing shall be placed between solid ground and the hydrant or fitting to be anchored. The area of bearing shall be as shown on the Drawing. The backing shall be so placed that fitting joints shall be accessible for repair. The concrete shall be 2000 psi plain cement concrete.

27.3.7 PIPE BEDDING

Fine sand as pipe bedding material shall be used for A.C. pipe and C.I. fittings. The sand shall be free from clay, site, salts, organic impurities and debris. Approval of pipe bedding materials shall be obtained from the Engineer-in-Charge prior to placing.

27.3.8 PAVEMENT RESTORATION

The Contractor shall restore paved surface which have been cut, as part of the work under the excavation items and at no extra cost to the owner/employer.

27.3.9 FLUSHING

The Contractor shall provide facilities for flushing the line. Water for flushing the line shall be arranged by the Contractor. Flushing of line shall be done section by section. For each valved section of pipeline the Contractor shall make a temporary hose connection between the water pipeline and the pipeline under test. Water shall be pumped into the section flushed. Other arrangements for storing and pumping of water shall be subject to the approval of Engineer-inCharge. Due precautions shall be taken by the Contractor for the disposal of water. The pipeline shall be flushed by keeping all the branching pipes open. Flushing shall be continued until clean water starts flowing through the other end. Section by section, the entire pipeline shall be flushed at a minimum flushing velocity of 2.5 ft./sec.

27.3.10 LEAKAGE TEST

Flushing of the pipeline shall be followed by a leakage test. The Contractor shall provide facilities for performing the leakage test. Water and pumping facilities shall be provided by the Contractor. Before the testing of pipeline the Contractor shall ensure that concrete backing blocks have been provided where necessary. The test shall be performed only after all concrete work in contact with pipe to be tested has set for a minimum of 24 hours. All joints shall be left exposed. Leakage test shall be performed by keeping the end of the pipeline closed by proper plugs blocked to resist 150 per cent of the working pressure. While filling the line all valves and openings shall be kept open and water shall be filled in slowly. When the pipeline is completely filled with water and all air expelled, water shall be pumped into the pipeline to a minimum pressure of 150 percent of actual working pressure and the test pressure shall be maintained for at least 1 hour. Each and every joint shall be inspected for leaks and for all visible leakage and displacement leakage test shall be performed by the Contractor, for the newly laid pipeline. A measured quantity of water shall be pumped into the pipeline. No piping installation will be accepted until the leakage is equal or less than the number of imperial gallons per hour as determined by the formula:

$$L = 0.00054\ ND / P$$

Where

L = Leakage in Imperial Gallons

N = Number of joints

D = Nominal diameter of pipe in inches

P = Average test pressure (psi) during test

In the event of the pipeline failing the leakage test, the Contractor shall locate and repair the defective pipe, fitting or joint at his expenses. For dewatering the line for repairs the Contractor shall follow the instructions given by the Engineer-in-Charge for disposal of water. After repairs of the line, the Contractor shall retest the line. The line will not be accepted until it passes the leakage test.

27.3.11 RETESTING AFTER BACKFILL

After the pipe trench has been backfilled, the entire length shall be subjected to a leakage test as a whole unit. The Contractor shall repair the line if it fails to pass the leakage test requirements specified hereinbefore. The test shall be repeated and repairs affected until the pipeline passes the leakage test.

27.3.12 PIPELINE DISINFECTION

27.3.12.1 GENERAL

The Contractor shall furnish all equipment, labour and material for the proper disinfection of the pipeline. Disinfection shall be accomplished by chlorination after the lines have been tested for leakage but before they have been connected to the main system. Disinfections of the pipelines shall be done in the presence of the Engineer-in-Charge's representative with equipment approved by him.

27.3.12.2 CHLORINATION

A chlorine and water mixture shall be supplied by means of a solution feed chlorination device. The chlorine solution shall be applied at one end of the pipeline through a trap, in such a manner that as

the pipeline is filled with water, the dosage applied to the water entering the pipe shall be at least (25 ppm) or enough to meet the requirements given hereinafter.

Chlorinated water shall be retained in the pipeline for a period of at least 24 hours. After the chlorine treated water has been retained for the required time, the chlorine residual at the pipe extremities and at such other representative points shall be at least 10 parts per million. This procedure shall be repeated until the required residual chlorine concentration is obtained.

During the process of chlorination the pipeline, all valves or other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

27.3.12.3 BY ADDING CHLORINATED LINE

Chlorinated line is dissolved in water tank and is lead into mains along with water for sufficient to ensure complete freedom from pollution. In general the following amount of chlorinated line for each 3.5 meter length of main will be sufficient.

Diameter of main (mm)	100	150	200	250	300
Chlorinated line in (mm)	10	20	40	60	85
Chlorinated line in table Spoonful	0.5	1	2	3	4

27.3.12.4 BY ADDING BLEACHING POWDER

After the main have passed the pressure test, they shall be thoroughly scoured out; and further to ensure that the pipe system is free from injurious matter, it shall be filled with solution of bleaching powder (calcium hypocholorite) or of permanganate of potash and allowed to remain there for 24 hours. After the period, the system shall again be scoured out and filled with the water of supply main.

27.3.13 FINAL FLUSHING

Following complete disinfection of the pipeline, all treated water shall be thoroughly flushed from the pipeline at its extremities. Treated water and water used for flushing the pipelines shall be disposed of in a manner instructed by the Engineer-in-Charge. Fresh treated water shall be filled in the line and water tested from presence of coliform, the test result should indicate negative coliform presence. If the test indicates any positive coliform, the entire process of disinfection shall be repeated or improved upon until coli form free samples are obtained.

27.3.14 SAMPLING AND TESTING

Disinfection of the pipeline and appurtenances shall be the responsibility of the Contractor. The first set of samples will be collected for analysis by the Engineer-in-Charge. Should the samples reveal presence of coliform the Contractor shall again disinfect the pipeline and appurtenances at his own cost for sampling and testing for subsequent retests until coliform free samples are obtained.

27.3.15 CLEAN - UP

Upon completion of the installation of the water supply lines, distribution system and appurtenances, all debris and surplus materials resulting from the work will be removed and disposed off in a manner satisfactory to the Engineer-in-Charge.

27.3.16 INDICATION PLATES

The indication plates shall be installed in accordance with the drawings and as directed by the Engineer-in-Charge.

27.3.17 WASHOUTS

The design and locations of washouts shall be illustrated on the Drawings to be approved by the Engineer-in-Charge. Exact positioning shall be determined with regard to topography and to the approval of the Engineer-in-Charge. At least 10 ft. of the washout pipe-work, inclusive of the isolating valve, measured from the centre line of the pipeline, shall be laid at the same time as the pipeline and suitably capped to prevent ingress of foreign material. The minimum gradient for the washout pipe-work shall be 1 in 100.

27.4 POLYETHYLENE (PE) PIPES AND PIPE FITTINGS

27.4.1 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 polyethylene Pipes and Pipe fittings, in accordance with the Contract or as directed by the Engineer and the manufacturer's recommendations.

27.4.2 MATERIALS

27.4.2.1 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 authorising any deviations from specifications.

27.4.2.2 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.

27.4.2.3 PIPE

Pipes shall conform to International Standards Organisation (ISO) recommendations, I.S.O4427: 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

27.4.2.4 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 4427:1966(E)

27.4.2.5 FITTINGS

Compatable fittings and specials for use with polyethylene Pressure Pipes shall be of the appropriate class and shall conform to International Standard/National standard. Fittings and specials shall have the required shapes, and dimensions of turned ends to fit the polyethlene pressure pipes.

27.4.3 HANDLING AND STORAGE

27.4.3.1 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.

27.4.3.2 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.

27.4.3.3 OFF-LOADING

Cranes shall be used for off-loadifllg. 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 paded to prevent the pipe being damaged and shall be fitted with locking device. Steadying ropes are essential.

27.4.3.4 STORAGE

Pipes, and fittings damaged during handling, transporting or lowering shall be rejected and replaced at the contractor's expense. storage hall be under shade so that all polyethylene pipes &fittings are not exposed to sunlight and extreme heat.

27.4.3.5 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.

27.4.4 JOINTING

Jointing hall be made by butt fusion/socket fusion using plain/socket ended polyethylene fittings except for joining of valves and appurtenances.

27.4.5 LEAKAGE TEST

It shall be in accordance with the specification setforth under 27.3.10

27.4.6 MEASUREMENT

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include pipe and fittings such as bends, tees, elbows reducers, crosses, plugs, sockets, nipples and nuts. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore the largest bore shall be measured.

27.5 MEASUREMENT AND PAYMENT

27.5.1 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 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-inCharge.

27.5.2 LABOUR RATE

The measurement and payment for the items of the work of Tube-well & Water Supply 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.

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IRON STEEL AND ALUMINUM WORKS

28.1 IRON AND STEEL WORKS

28.1.1 SCOPE

This Section covers general requirements of Iron steel, steel work fabrication, methods including precautions for erection of steel structures, painting and other general requirements incidental to steel work, for complete job as shown on the design drawings or as directed by the Engineer-in-Charge.

The applicable requirements of this section as determined by the Engineer- in-Charge shall apply to all Iron and structural steel works. The work covered by this section, consists of supply of all material, labour, plant, equipment and appliances including welding, bolts, nuts, washers, anchor bolts, embedded parts etc., fabrication, erection and painting in accordance with the specifications and as per drawings and as directed by the Engineer-in- Charge.

28.1.2 CODES AND STANDARDS

The work shall conform to the requirements of the following Codes and Standards, unless otherwise specified.

ASTM A-36-81	Structural steel specifications
ASTM A-307-80	Specifications for carbon steel bolts.
BS 729-71	Hot dip galvanized coating on iron and steel articles.
AWS D-12	Recommended Practice for welding steel

28.1.3 SUBMITTALS

Prior to execution of work and sufficiently in advance, the Contractor shall submit the following to the Engineer-in-Charge for approval:

a) Shop Drawings

Shop Drawings, which shall show full construction details, quantities and locations, with metal gauges, reinforcing, cut-outs, holdfasts & attachment to adjacent construction and materials. b) Samples

Representative samples of a typical metal window and ventilator, hardware, accessories and any other product required.

For metal doors and shutters, cross-sections of typical welded jointed or assembled frame, in specified thickness showing reinforcing, welding and prime paint coat.

c) Methodology

Methodology for fabrication, installation, erection and fixing.

28.1.4 QUALITY ASSURANCE

a) Type and Form of Product

All metal doors, windows, ventilators and shutters shall be the product of reputable manufacturer and. shall be of the type indicated on the Drawings and shall conform to the requirements specified herein. b) Metal Doors and Shutters

All metal door and shutter frames shall be made of good quality cold rolled steel; exterior frames and doors shall be galvanized steel.

Frames shall be fabricated form locally available hot flush hollow pressed sections, 'Z' section angle, tee and channel or pipe sections as specified in the drawings. Materials shall conform to ASTM-A-36.

All frames shall be secured to the structure with strong wrought iron holdfasts. Holdfast shall be 50 mm wide and 6 mm thick and shall be secured to frames. Attachment shall be concealed.

Shutters shall be double skin made of frames of any of the sections noted above with faceplate of at least 18 S.W.G. or as shown in the drawings.

The internal surfaces of frames and shutter including frame shall be painted with one coat of epoxy primer or as specified.

External surfaces in contact with or embedded in concrete shall not be painted, greased or oiled. However, such surfaces shall be given a cement wash after sandblast cleaning. All other external surfaces shall be given two coats of primer and two coats of epoxy enamel paint or as specified.

Accessories such as hinges, steel standard track, roller and guides, standard bracket, anchors, bolts, locks handles, latches, L--drops, stoppers, hydraulic door closure shall be heavy duty and shall conform to the requirements shown on the drawings or as directed by the Engineer -in-Charge. c) Metal Window and Ventilators

- Window frame and ventilator sections shall be of mild steel.
- Hinges shall be subject to the approval of the Engineer-in-Charge.
- All operating hardware shall be of bronze lacquered iron as specified.

d) Structural Steel

All structural steel shall conform to the requirements of ASTM A-36 or equivalent.

e) Welding

All welding shall be executed and inspected in accordance with the provisions of the applicable code of the American Welding Society.

f) Bolts

All bolts, including anchor bolts shall conform to the requirements of ASTM A-307 or equivalent.

28.1.5 DOORS AND WINDOWS

28.1.5.1 DELIVERY AND STORAGE

a) Doors shall be packed individually in a manner which will ensure complete protection of all door surfaces and shall be stored in upright position, under cover, in a manner so as to prevent rust and damage.

b) Frames shall be supplied with removable angle spreaders securely fastened to the bottom of each joint. The spreaders shall not be removed until frames are secured in place.

c) Windows shall be delivered in a manner that prevents damages to the units and shall be stored off the ground, under cover, in a manner so as to prevent rust or damage.

28.1.5.2 PRODUCTS – GENERAL REQUIREMENTS

a) All contours and arises in metal door shall be true and sharp as can be produced in the thickness of metal required.

b) Construction joint of steelwork welded to full depth and width, or equivalent splice plates shall be welded on unexposed faces of frames. Exposed surfaces of welded joints shall be dressed and ground smooth to produce invisible connections.

c) Reinforcement and stiffeners shall be welded to the inside of the frame surfaces.

d) Window frames and ventilators shall conform to the sections shown on the detailed Drawings and all corners shall be electrically flash welded and finished smooth.

e) Weather baffles shall be integrally rolled and shall provide contact on all the four sides of the operating ventilators.

f) Weep holes and drips shall be provided for drainage in accordance with Drawings or instructions of Engineer-in-Charge.

g) All windows shall be designed for exterior glazing to accommodate glass thickness specified.

h) Ventilators shall show in or out, as indicated on the Drawings and shall be mounted over heavy steel pivots with brass pins.

i) Push bars for out swinging windows shall be a notched device for fixed settings and designed to lock shutters in open/closed position.

j) In-swinging windows shall be provided with a casement for fastener, designed and arranged to close with wedging erection to draw each leaf firmly into contact with window fixed rail.

k) Windows shall be provided with all necessary clips and anchors required for securing the windows to the structure.

28.1.5.3 FABRICATION OF DOORS AND WINDOWS

a) Shape

The steel sections shall be thoroughly straightened in the shape by methods that will not injure it before being laid off or worked in any way.

b) Cutting and Forming

All members shall be so cut and formed that they can be accurately assembled without being unduly cracked strained or forced into position.

c) Jointing

The jointing of different parts of the members of mild steel shall be carried out by welding process in conformity with the requirements of American Welding Society for such joints. Welding points shall be made quite smooth by filing them and making smooth.

d) Galvanizing

If required all exterior doors frames, anchors reinforcing and related items shall be fabricated from hot dipped galvanized steel, conforming to BS-729, Part-1. After fabrication all welds shall be touched up with liquid zinc.

Window frames and ventilators shall be hot dipped galvanized after fabrication conforming to BS-729 Part-1 as specified.

28.1.5.4 FABRICATION OF ROLLING SHUTTERS

a) Shutters

The shutter shall be fabricated using standard galvanized corrugated segments of the required length according to size of the shutter and of 22 gauge thickness. These segments shall be inter-linked properly to allow rotation for smooth rolling up and down. In order to reduce noise during operation, 2 inch (50 mm) wide wire reinforced canvas belt shall be riveted (using aluminum rivets) to both shutter ends. The aluminum rollers shall be installed at top.

b) Guide

The guides for the shutter shall be fabricated from mild steel plates and shall be embedded to wall or columns by providing necessary anchors.

c) Main Rollers

The main rollers, mounted on the supporting pipe, on which the shutter has to roll up, shall be of mild steel with deep groove ball bearings and provision for greasing.

d) Supporting Shaft

The supporting shaft shall be of standard mild steel pipe, strong enough to support the load of the shutter with minimum deflection. This shaft shall have adequate supports at the ends fabricated from mild steel plates. Each shutter shall have separate bracket supports. However, due to space limitation for mounting, the same may be made common for adjacent shutter. e) Coil Spring

On each end, between the bracket support and the roller coil, a spring shall be provided. The spring shall be of spring steel one end of which shall be fixed to the pipe and the other to the roller. These springs shall be suitable to balance the weight of the shutter to allow smooth operation. f) Cover

The cover shall be fabricated from 22 gauge galvanized steel sheet of uniform shape and size without deformations.

28.1.5.5 INSTALLATION

a) Doors, Windows and Ventilators

The Contractor shall be responsible for proper protection and installation of all items furnished. Should the prime coat be damaged, or rust scale appears, he shall at his own expense and at the Engineer-in-Charge's direction, have all exposed surfaces cleaned to bare bright and re-primed with an approved priming coat before finish painting.

All items shall be installed plumb and square and shall be solidly anchored in a good workman-like manner in accordance with the approved Shop Drawings. The Contractor shall be responsible for the protection of installed items from damages by other trades. All items shall be left in operating neat and clean condition free from dirt, finger marks, etc. The Contractor shall be responsible for final cleaning before final acceptance.

b) Wire Gauze

Unless otherwise specified or directed by the Engineer-in-Charge, the wire gauze to be fixed with doors, windows and ventilators shall be 22 gauges having 12x12 mesh and shall be from an approved manufacturer.

c) Shutters

The installation of all components of the shutter shall be done true to line and level and in perfect plumb. It should be ensured that the shutter should roll up automatically after initial manual lifting upto a desired height. The shutter closing should also be easy smooth and unobstructed. The operation shall be performable by a single person.

28.1.5.6 PRIMARY COAT AND FINISHING

a) The non-galvanized doors, windows and ventilators shall be painted with primary coat of red oxide and good quality double boiled linseed oil or any approved anti-corrosion paint after proper grinding. Afterwards two coats of synthetic enamel paint of approved make and shade shall be given.

b) Two coats of red primer and one coat of synthetic enamel paint shall be applied on all components of shutters except galvanized shutter, after fabrication and before installation. One coat of synthetic enamel paint shall be applied to all exposed surfaces after installation. Before applying paint all surfaces shall be cleaned from rust, burrs, scale, dust or grease.

c) The finished work shall be strong and rigid; neat in appearance and free from defects. Plain surfaces shall be smooth and free from warp or buckle. Molded members shall be clean, straight and true. Fastenings shall be concealed where practicable.

d) The painting as specified shall be carried out in accordance with the applicable provisions of Section 17, Painting and Varnishing.

28.1.5.7 MEASUREMENT

a) Shutters

The width and height of shutters shall be measured to the nearest cm. The area shall be calculated in square metre correct to two places of decimal.The rate shall include the cost of materials and labour involved in all the operation described above. Nothing extra shall be paid for cement concrete block or wooden blocks nor anything deducted for these from the measurement of the masonry wall.

b) Rolling Shutter

Clear width and clear height of the opening for rolling shutter shall be measured correct to a mm. The clear distance between the two jambs of the opening shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height. The area shall be calculated in square metres correct to two places of decimal. The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover and spring except ball bearing and mechanical device of chain and crank operation, which shall be paid for separately.

c) T-Iron Doors, Windows and Ventilators Frame

T- iron door windows and ventilator frames shall be measured in running metre, along the centre line of the frame correct to a 1mm and weight calculated on the basis of standard tables. No deduction or extra payment shall be made for making holes and making arrangement for fixing fittings including packing wherever necessary. No deduction will be made for not providing tie bars in case of windows and ventilators.

d) Pressed Steel Door Frames

The length shall be measured in running metre correct to a cm along the centre line of the frames.

e) Items of work for which unit of measurement is Kg in CSR

Doors

The weight of finished section shutters of different sizes, inclusive of all fixed /welded fittings i.e. hinges pivots lugs, brackets striking plates etc, shall be worked out before fixing of shutters (exclusive of weight of glass panes, glazing clips, putty etc.). Sectional weight of steel members only shall be measured without weight of glass panes etc. Any loose fittings such as casement stays/fasteners etc. shall be enumerated and paid for separately.

Unit of measurement shall be Kg and Weight of cleats, brackets, packing pieces bolts nuts, washers distance pieces separators diapharam gussests (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

28.1.6 GLAZING

28.1.6.1 APPLICABLE STANDARDS

Latest editions of the following British Standards are relevant to these specifications wherever applicable.

BSI	**British Standards Institution**
952	Glass for glazing
5051	Security glazing Part I & II
CP.152	Glazing

28.1.6.2 GENERAL

a) Each type of glass shall have the manufacturer's label on each pane, and the labels shall remain on the glass until final cleaning.
b) Glazing sealant shall be as recommended by the manufacturer for the particular application.
c) Spacer shims (distance pieces) shall be plasticized polyvinyl chloride (PVC). Thickness shall be equal to space shown on drawings between glass and rebates, bead or cleat. Depth shall give not less than 6mm cover of glazing sealant.
d) Contractor shall submit samples for each type of glass, minimum 100mm x 100mm in size with protective edges. Samples of glazing sealant minimum 0.1 liter of specified types shall be submitted. Samples of minimum of three glass blocks shall also be submitted.
e) Contractor shall submit 300 mm long sample of each type of glazing gasket.
f) Contractor shall also submit printed materials manufacturer's installation instructions for specified glazing glass block gaskets, compounds sealants and accessories including description of required equipment and procedures and precautions to be observed.

28.1.6.3 DELIVERY STORAGE AND HANDLING

a) Contractor shall deliver materials in manufacturer's original, unopened containers clearly labeled with manufacturer's name and address, material, brand, type, class and rating as applicable.
b) Contractor shall store the materials in original unopened containers with labels intact/protected from ground contact and from elements which may damage glass.
c) Contractor shall handle the materials in a manner to prevent breakage of glass and damage to surfaces.

28.1.6.4 MATERIALS

a) General

Glass shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to fit the rebates so as to have a uniform clearance of 1.6 mm round the panes between the edges of glass and the rebates. All glass shall be best quality from reputable manufacturer as approved by the Engineer-in-Charge.

Unless otherwise indicated glass shall be of the following weight per square metre for various sizes mentioned below:

i) Not exceeding 300 x 350 mm - 4.3 Kg/M.
ii) Exceeding 300 x 350 mm but not exceeding 600x600 mm - 8.0 kg/M. iii)
Exceeding 600 x 600 mm but not exceeding 750x750 mm - 9.0 kg/M. iv) Exceeding
750 x 750 mm but not exceeding 900x900 mm - 9.8 kg/M.
v) Plate glass 6 mm thick shall be used where size of glass exceeds 900mm either in breadth or in length or in both.

b) Sheet Glass

Sheet glass shall be of thickness and size shown on the Drawings. Each glass shall be bedded with a thin layer of good quality putty as approved by the Engineer-in-Charge and should be fixed with glazing bead securely screwed and finished off neatly.

c) Obscure Glass

Obscure glass shall not be less than 5 mm thick with one side smooth and polished whereas the other side with pattern to be selected by the Engineer-in-Charge, if specified, sheet glass shall be made obscure by grinding off the polish from one side.

d) Plate Glass

Plate glass shall be first quality polished transparent glass, conforming to the applicable requirements of BS 952. Unless otherwise indicated, plate glass shall be 6 mm thick with two surfaces ground smooth and polished so as to give clear undistorted vision and reflection.

f) Wire Reinforced Glass

Wire reinforced glass shall be 6.35 mm thick polished plate reinforced with Georgian wire conforming to the applicable requirements of BS 952.

g) Tinted Glass

The imported tinted glass for doors, windows and ventilators shall be of specified thickness and tint and shall be from a manufacturer as approved by the Engineer-in-Charge. The tinted glass shall comply with the applicable specifications of B.S. 952.

h) Solar Control Film/Glass

The approved Solar Control film shall be applied on all sun-facing glasses of doors and windows as indicated on the Drawings. It shall consist of aluminum vapour coated polyester film with water activated adhesive thereon. Color shall be soft grey. The film shall be optically clear from the inside. Total thickness shall be 0.025 mm to 0.033 mm.

h) Glass Blocks

The glass block shall be of specified size and shall be from a Manufacturer approved by the Engineer-in-Charge.

i) Putty

Putty for wood frames shall be of the best linseed oil conforming to the requirements of BS-544 and for metal frames best metallic putty. Wherever required the putty shall be colored to match with woodwork. The rebates, if not painted, shall be well primed with boiled linseed oil to prevent the wood drawing the oil from the putty.

j) Unbreakable Glazing (Poly Carbonate Sheet)

Unbreakable glazing material shall be LEXAN MR-4000 sheet as manufactured by GE Structural Product or approved equivalent and shall be provided as glazing where shown on the Drawings. It shall have the property of high impact resistance, weather resistance, clarity, 'and durability. It should be attractive and light weight.

28.1.6.5 BEADS AND SHIMS

Glazing beads shall be of deodar wood.

Spacer shims (distance pieces) shall be of plasticized polyvinyl chloride (PVC). Thickness shall be equal to space shown on the Drawings between glass and rebate, bead or cleat. Depth shall give not less than 6 mm cover of putty.

28.1.6.6 GLAZING SEALANTS AND COMPOUNDS

Contractor shall provide material colored to match frame in which glass is installed and only compounds known to be fully compatible with surfaces which they will contact as follows.

1) Two component polysulfide glazing for sealant.
2) One component acrylic glazing for sealant.
3) Acrylic-latex glazing sealant consisting of modified latex rubber and acrylic emulsion, non-hardening, non-staining and non-bleeding.
4) Cleaners, Primers & sealer as recommended by the sealant manufacturer.

28.1.6.7 ACCESSORIES

a) Glazing Sealant

It shall be tape or ribbon of polymerized butyl or mixture of butyl and polyisol butylene compounded with inert fillers and pigments, solvent based, 95 percent solids thread or fabric reinforced, paintable, non-staining.

b) Setting Blocks

It shall be chloroprene (Neoprene) 70 to 90 durometer hardness, compatible with sealant used, channel shaped and of the necessary height for proper perimeter clearance.

c) Channels, Gaskets, and spacer's
It shall be chloroprene (Neoprene), 40 to 50 durometer hardness compatible with sealant used.

28.1.6.8 INSTALLATION OF GLAZING

a) Preparation

All rebates and grooves shall be clean, dry and unobstructed at the time of glazing. The beads shall match the surrounds. Manufacturer's recommendations for the putty, metal surrounds and primer shall be followed.

b) General

All glazing shall be wind and watertight on completion. Edge clearance shall be equal all around each pane, and not less than 3 mm. No void or space shall be left at the back of bedding compound. Surplus bedding compound to top and side edges shall be stripped at an angle to avoid collection of water. Sand blasted glass shall be protected from oil attack by treating edges before fixing, and cleaning surfaces after fixing, as recommended by glass manufacturer. c) Glass

Glass shall be secured with spring clips or cleats as provided or recommended by the manufacturer. Back-putty shall be of regular thickness, not less than 1.5 mm short of sight line. Surface shall be brushed lightly to seal putty to glass.

d) Fixing

For bead fixing, setting blocks shall be located as required in BS 6262. Spacer shims (distance pieces) shall be used in all external bead fixing and located opposite each other on each side of glass not more than 600mm apart around the perimeter.

e) Control Film

All run-facing glasses shall be washed properly with potable water to render them free from any greasy matter. Solar control film shall be applied on cleaned glass by authorized servicemen for this work as approved by the Engineer-in-Charge. The film shall be applied on the glass before it is fixed at its appropriate place. The film shall be applied with approved adhesive in such a way that no air bubble is left between the glass and film and optical clarity is not affected.

f) Depth of Rebate

The minimum rebate depths will depend upon the area of the pane and block and exposure conditions as under:

For small panes upto 0.372 square metre in area inside buildings or for external panes not exceeding 0.093 square metre, the depth should not be less than 6.3 mm. For linseed oil or metal putty the depth should not be less than 7.9 mm for wood or metal and 9.5 mm for stone brick or similar material. For non-setting compounds, the depths should not be less than 9.5 mm.

The depth of rebate shall be increased for larger panes or for panel which butt together, and for exposed conditions. The increase in rebate shall be as shown on the Drawings or as directed by the Engineer-in-Charge.

28.1.6.9 INSTALLATION OF GLASS BLOCKS

The method and equipment used for transporting the glass blocks and neat white cement paste shall be such as that will not damage the glass block nor delay the mixed paste of white cement. Glass

blocks shall be laid as shown in the drawings or as directed by the Engineer-in-Charge. Both Horizontal and vertical joints shall be approximately not more than 1/16" in thickness and. completely filled with white cement paste. Each glass block shall be bedded firmly by tapping with the rubber hammer. All Horizontal and vertical joints shall be parallel to each other. All glass block shall be erected true to line plumb and level. Excess mortar at the outer edges shall be removed with cloth. After completion of days' work, the glass block wall shall be thoroughly cleaned with water and/or damp cloth as directed by the Engineer-in-Charge.

28.1.6.10 CARE AGAINST DAMAGE

While glazing operation is in progress great care shall be taken to avoid breakage or damage to the glass and adjoining glazing. The Contractor shall make good at his own cost, all glass broken by his workmen while cleaning or carrying out other operations. On the completion of the glazing work, all glass that has been set by the Contractor shall, if it becomes loose, within the maintenance period, be re-fixed at Contractor's expense.

No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass ad checked by the Engineer for water tightness.

28.1.6.11 PROTECTION AND CLEANING OF GLAZING

a) Remove all smears labels and excess glazing sealent. Leave clean inside and outside free from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with new glass at no additional expense to the Employer.

b) All glass surfaces shall be washed clean both inside and outside within two weeks prior to final acceptance by the Employer

28.1.6.12 MEASUREMENT

The width and height of glass shall be measured to the nearest cm. The area shall be calculated in square metre correct to two places of decimal

28.1.7 MISCELLANEOUS STEEL WORK

28.1.7.1 GENERAL

The work covered shall include furnishing; fabricating, installing and painting Miscellaneous

Steel Work including the following:

- Steel stairs
- Steel Joists, Protection angles and channels
- Steel Grating
- Steel Hand Rail
- Steel Gates
- Embedded plate, anchor bolts and other miscellaneous items

Drawings, material, fabrication, surface preparation shall conform to the applicable requirements of relevant clauses of these specifications. Any proposed deviation due to field conditions and availability of local material shall be submitted to the Engineer-in-Charge for approval a week prior to the start of the work.

a) Steel Stairs

i) General

Structural steel stairs complete with grating treads or checkered plate treads, landings, supporting structures, handrail supports etc. shall be furnished and installed in accordance with working drawings.

ii) Material

Except otherwise indicated in the working drawings, materials shall conform to the requirements of ASTM A36 (specifications for structural steel).

iii) Installation

The stairs shall be installed in a first class workman like manner. Connections to adjacent concrete structures shall be made with anchor bolts or shall be welded to embedded part at site as shown on the drawings. .

b) Steel Joists, Protection Angles and Channels

Steel protection angles joists and channels as shown on drawings and specified shall be erected true to line and level. Steel angles and channels shall be grouted and fixed in position by using anchors as shown on the drawings or as directed by the Engineer-in-Charge.

c) Steel Grating

Steel grating shall conform to the requirement as shown on drawings. All panels shall be banded on the all edges as specified.

d) Steel Hand Rail

Steel Hand Rail shall be fabricated in accordance with the drawing or as directed by the Engineer-in-Charge and shall conform to the applicable requirement of ASTM A53 for the type and class of pipe indicated.

28.1.8 FENCING

28.1.8.1 GENERAL

This work shall consist of constructing post and barbed wire fence or chain link fence in accordance with the details and at the locations shown on the Drawings or as directed by the Engineer-in-Charge.

28.1.8.2 MATERIALS

a) Barbed Wire

Barbed wire shall conform to the requirements of ASTM A-121 Class-1. The barbed wire shall consist of two (2) strands of twelve and a half (12½) gauge wire, twisted with two (2) points, fourteen (14) gauge barbs spaced ten (10) cm apart.

b) Chain Link Fabric

Chain link fabric shall be fabricated from ten (10) gauge galvanized wire conforming to AASHTO M-181 and shall be of the type shown in the Drawings. Before ordering the chain link fabric the Contractor shall submit a sample of the material to the Engineer-in-Charge for his approval. c) Concrete Posts

Concrete posts shall be made from 1:2:4 (4000 psi – 6”x12” cylinder strength) concrete in accordance with Section 5 – Plain & Reinforced Concrete. The posts shall be cast to the length shown on the detailed drawings and shall have a smooth surface finish.

d) Steel Posts

Steel posts shall be of the section length as specified or as shown on the Drawings. The posts shall be of copper bearing steel and shall confom to the requirements of AASHTO M-183 for the grade specified.

e) Wooden Ballies

The wooden ballies shall be of shisham or kail wood as specified and approved by the Engineer-in-Charge.

f) Steel Reinforcement

Steel reinforcement for the concrete posts shall be deformed steel bars Grade-60 or Grade-40 as specified conforming to the provisions of Section 5 – Plain & Reinforced Concrete.

The Concrete shall comply with provisions of Section 5 – Plain & Reinforced Concrete. g)

Hardware

Nuts, bolts, washers and other associated hardware shall be galvanized after fabrication as specified in ASTM 153.

28.1.8.3 CONSTRUCTION REQUIREMENTS

a) Erection of Posts

The posts shall be erected vertically in position, inside the formwork of the foundation block prior to the placing of the concrete and shall be adequately supported by bracing to prevent movement of the post during the setting process of the concrete. The posts shall be erected to the height and location shown on the Drawings or as directed by the Engineer-in-Charge.

b) Installation of Chain Link Fabric

The chain link fabric shall be set to line and elevation and pulled tight between each post before spot welding or other method of fixing is carried out.

Where splicing of the fabric is necessary or at joints the lapping of the chain link fabric shall be a minimum of ten (10) cm and shall occur only at the concrete post. No horizontal splicing will be permitted. The, fabric shall be fixed to the concrete post as shown on the Drawings.

28.2 ALUMINIUM WORKS

28.2.1 APPLICABLE STANDARDS

Latest editions of following ISO and British Standards are relevant to these Specifications wherever applicable.

ISO (International Organization for Standardization)

6612	Windows & Doors	-	Wind resistance tests
6613	Windows & Door	-	Air permeability test

BSI (British Standard Institution)

1227	Hinges
4873	Aluminum alloy windows

28.2.2 SUBMITTALS

a) General

The Contractor shall in general comply with the provisions of Clause 28.1.3 and 28.1.4. b)

Manufacturer’s Certificate

The Contractor shall on request get certificate signed by the manufacturer stating that each lot has been sampled tested and inspected and has met the requirements in accordance with these specifications and the same shall be furnished to the Engineer-in-Charge.

c) Guarantee

The manufacturer shall furnish his standard written guarantee against leakage of rain water excessive infiltration of dust air and all defects in materials, workmanship covering all the work under this section.

Such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or other provision of the Contract Agreement.

28.2.3 INSPECTION & TESTING

a) Contractor shall arrange tests and analysis if directed by the Engineer- in-Charge of scaled models of each Door, window ventilator type at the maker's works or any laboratory specified by the Engineer-in-Charge for the material supplied by him to be tested in the presence of the Engineer- in-Charge/Inspector to whom test certificates, proof sheets etc. shall be furnished. The models shall be submitted to the Engineer-in-Charge for approval prior to testing. Nevertheless neither the fact that the materials have been tested in the presence of the inspector nor that the Engineer-in-Charge may

have been furnished with test certificates in lieu of sending an inspector to the works shall affect the liberty of the Engineer-in-Charge to reject after delivery of materials found not in accordance with these specifications.

b) After approval of shop drawings and tests etc. the Contractor shall submit at his own cost one mock-up sample of each type of aluminum works complete with glazing, all components assembly method and required fittings and accessories prior to the actual fabrication of the bulk. The samples shall be returned to the Contractor for incorporation in the works after installation of at least 80% of the works.

28.2.4 PRODUCT DELIVERY AND STORAGE

a) The Contractor shall deliver doors windows ventilator and louvers in a manner preventing damage to units. The contractor shall store materials off the ground under cover in a manner preventing deterioration or damage.

b) All embedded parts and anchor bolts shall be delivered to the site carefully and keeping the fabricated shape and configuration. All these parts shall be suitably marked for identification.

28.2.5 MATERIAL

a) All the sections used for Doors, windows, ventilators & fly screens shall be of best quality aluminum products such as equal and unequal angles, channels, tubes, corrugated strips mouldings etc; in accordance with international standards conforming to ASTM B-308 & B-221.

b) Frames

The frames of aluminum doors, windows, ventilator, louvers and fly proof shutters shall be formed from rolled, strip or extruded aluminum and be at least 2mm thick deluxe section. Fastenings bolts and screws shall be made from hardened aluminum.

c) Fasteners shall be stainless steel of a type selected to prevent galvanic action with the components fastened.

d) Gaskets shall be vinyl glazing channel gasket according to commercial standard CS-230-60.

e) Hardware as required shall be manufacturer's standard hardware of aluminum, stainless steel or other corrosion resistant materials and shall blend in design with the frame finishes.

f) Joint sealant shall be approved elastomeric.

g) Fittings and fixtures shall be as per approved samples.

28.2.6 FINISHED COATING

a) General

The finished coating shall be as stated on the Drawings and applied strictly in accordance with the manufacturer's instructions.

The color of the coating shall be selected from available ranges if not stated in the drawing and or bill of quantities. The Contractor shall offer samples for approval prior to the final selection and the manufacture of these elements.

b) Anodized coating

The aluminum anodizing shall comply with BS 3987 and be integral color hard coat anodizing 550 kp/mm^2 hardness, minimum 25 microns thick.

The color of anodizing shall be as described on the drawings. Samples of color including limits of color variation shall be submitted to the Engineer-in-Charge for his approval before work commences. The Engineer-in-Charge reserves the right to reject the products of any supplier who cannot guarantee a reasonable limit of color variation, the acceptable limit of variation being at the Engineer-in-Charge's discretion.

c) Polyester Powder coating

All aluminum sections that are to receive a polyester powder coating shall be given a caustic etch followed by an anodic oxide treatment to obtain an architectural class 1 anodic coating. Anodization should be not less than 25 micron thickness.

All aluminum works shall be finished in colored electrostatic polyester powder coating as per DIN standard 53151, 53153, 53156 or equal and approved to Ral color subject to the Engineer-in-Charge's approval.

d) Coating Thickness

As and when instructed by the Engineer-in-Charge, the Contractor shall provide certificates from independent laboratories that the minimum thickness as specified has been applied to the aluminum sections. Failure to provide such information shall result in the complete installation being rejected and replaced at the Contractor's expense.

e) Dissimilar Materials

All aluminum surfaces that are to be in contact with cured concrete, mortar, steel and other metals shall have the contact surfaces protected wherever they may entrap moisture or corrosive elements. Metals that are to be in contact with mortar or concrete shall be protected with a two coat bituminous coating. Prime paint shall be applied to steel parts of anchors, anchor inserts, reinforcement, supports, and all parts after field welding or blotting with zinc chromate. Minimum dry film thickness shall be of 1 mil for zinc chromate.

28.2.7 FABRICATION

a) General

All nuts, bolts, washers and screws used for assembly and fixing shall be of adequate strength for their purpose within the design and shall be stainless steel grade 18/8.

All sealants used in the assembly of, and in the fixing of cladding and window framing, shall be non-setting to allow thermal movement without detriment to those joint sealants used for peripheral caulking and shall be one part silicone sealant and shall conform to BS 4245. All spliced joints between mullions will be sealed with an approved silicone product, compatible with other sealants and packing used. All ironmongery which is to have the same finish as the frames and shall be approved by the Engineer-in-Charge.

At all opening of windows and doors and where there are louvered screens and doors, a fly screen shall be provided to the approval of the Engineer-in-Charge, constructed following the principles & specifications as described elsewhere in this specification.

Glazing sections shall be set in special heat resisting PVC and of channel type. Separate glazing sections on each side of the glass will not be permitted.The following table indicates the basic requirements for window construction. The weights of framing make no allowance for beads, glazing bars, opening light framing, coupling mullions or transoms.

Classification	Min. weight of basic frame kg/m run	Max. superficial area of window in Sq. M.	Max. Dimension either way mm	Remarks
Light	0.60	1	1500	
Light	1.00	3	2000	
Medium	1.50	5	2500	
Medium	2.00	9	3000	
Heavy	2.50	12	3500	
Heavy	3.00	12	3500	With door

b) Sliding Windows and doors

Weather-stripping - high density acrilan wool weather pile shall be used. There should be double brushes at every contact between shutter and frame sections for complete insulation. These should be present consistently throughout the unit between the inside and the outside and no portions without it are permitted.

The rollers for sliding shutters for both windows as well as doors shall be of the adjustable type. The adjusting screws must be accessible in the assembled state of the shutters and a vertical adjustment of 7 mm should be possible.

All sections for sliding windows and doors should be hollow section and the cross section dimensions of the sections should not be less than 60x40mm.

The outer frame must be suitable for accommodating sliding fly screens as required.

The handle-latch set should have all visible surfaces finished as the aluminum sections. The handle must have a proper grip. A small projecting flange or recess in the shutter sections cannot be accepted to serve as handles. The latching mechanism should not be surface mounted but should be concealed within tile sections. Sash rails of vertical sliding windows are to be of tubular box sections with corner joints of outer frames and sashes interlocked, and the balance mechanism is to be an approved proprietary product.

c) Side hung windows, doors and ventilators

All windows and doors should be weather-stripped with heat resistant PVC sections. The weather protection should be achieved by a positive compressive action against the PVC section and should not depend on external contact with the PVC section. At every contact between two profiles two weather-stripping section should be provided to complete weather protection.

The bottom sections for hinged doors must be capable of being adjusted vertically if necessary. The gap between the bottom section and the floor should be covered with a pair of special splay-type PVC sections.

The shutter sections for both windows as well as doors shall be hollow section type and shall be overall size 57 x 45 mm and door sections shall be overall size 81 x 45 mm (including flanges).

The shutters of the windows and doors should be assembled with concealed corners of high rigidity. Hinges should be concealed within the sections.

Hinges shall be anodized aluminum with stainless steel pins and nylon washers. Handles shall be anodized aluminum finished to match the aluminum sections and mounted with self-lubricating nylon washers.

A mortice cylinder rim automatic deadlock of high quality with double pin tumbler Is to be used.

Windows shall have anodized aluminum handles, color as framing and a latching mechanism securing the shutter to the frame both at the top and bottom.

Fitting where required:

d) Single action door closer concealed in the head bar of the outer frame and mounted on an adjacent pivot at the threshold and deadlock fitted.

e) The left hand leaf of double doors with flush bolts at head and sill with deadlock fitted to the right hand leaf.

f) Escape doors to have panic bolt assembly with vertical elements concealed in the stile and door closer as in (a).

g) Fly screens

Fly screens shall be fitted to all opening leaves of windows or sliding doors, consisting of a separate metal sub-frame in with aluminum mesh fly wire. The fly screens shall be adequately secured with suitable dips, set screws or turn buckles and shall be removable for maintenance purposes. Fly screen doors shall consist of similar section to metal casement doors and shall be fitted with removable panels of fly wire.

The aluminum frame .to the fly screen shall be finished to match the framing of the window or sliding door with color and type of mesh to Engineer-in-Charge 's approval.

h) Glazing

The glass shall conform to specification laid down under Section 28.1.6; 'Glazing' and shall be free from all blemishes, bubbles, distortions and other flaws .of any kind and shall be properly cut to size as shown on drawings, so as to fit the grooves in window members. All the glass shall be best quality of approved manufacture or equivalent standard as approved by the Engineer-in-Charge.

28.2.8 ERECTION AND WORKMANSHIP

28.2.8.1 ERECTION

a) Raw plugs and anchoring bolts shall be embedded into the concrete or masonry for holding the doors, windows, ventilators and louvers in their correct position.

b) Care shall be taken to install the doors and windows, ventilators and louvers in line and plumb, solidly anchored in a good workman-like manner in accordance with the Drawings. Should any scale or scratch appear on the surface of doors, windows, ventilators and louvers the Contractor shall at .his own expense and at the Engineer-in-Charge's direction have all exposed surface cleaned to bare bright metal and made good as required.

All joints between structure and the metal shall be fully caulked and painted. All works shall be installed in strict accordance with the manufacturer’s instructions.

28.2.8.2 WORKMANSHIP

The Contractor shall be responsible for the protection and installation of all items furnished. All items shall be installed plumb and square and shall be solidly anchored in a good workmanship like manner in accordance with the manufacturer's instructions and as specified herein. All items shall be left in operating, neat and clean condition, free from dirt, finger marks, cement mortar stains etc. The Contractor shall be responsible for final cleaning before the final acceptance.

The glass panes shall firmly be secured in the rebates with the rubber gasket. Beads and grooves shall be ensured to be clean, dry and unconstructive at the time of glazing. The complete unit shall be airtight and watertight on completion.

No door and window shall be considered complete until the finger prints and other stains and marks have been removed from the surface of glass and aluminum.

Temporary protection shall be achieved by applying water soluble protective coating capable of withstanding the action of mortar.

Protective coating shall be applied in the manufacturer's plant to the exposed surface of all components after removing all fabrication compounds, mixture and dirt accumulations.

28.2.8.3 FINISHING

All exposed surfaces shall be carefully polished and all alloy defects, die marks scratches, strokes or other surface blemishes shall be buffed to a clear surface and given an anodic oxides treatment. The structural shape of aluminium members shall be of uniform quality, color and temper; clean, round, commercially straight and free from injurious defects

28.2.9 PROTECTION AND CLEANING

- Temporary protection shall be achieved by applying water soluble protective coating capable of withstanding the action of mortar.
- Apply coating in the manufacture(s plant to the exposed surfaces of all components.
- Before application of coating, remove all fabrication compounds, moisture and dirt accumulations.

28.2.10 DEFECTIVE WORK

In the event of non-conformance to specifications and drawings the aluminum work shall be rejected by the Engineer-in-Charge and the Contractor shall remove and - replace the rejected works by new work of same specifications.

28.2.11 MEASUREMENT

The height and breadth shall be measured correct to a cm. The height of the Window and Doors shall be measured as the length and breadth from outside to outside of the end . The area shall be calculated in square metres, correct to two places of decimal.

28.3 MEASUREMENT AND PAYMENT

28.3.1 COMPOSITE RATE

The measurement and payment for the items of the work of Iron, Steel and Aluminum Works 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.

28.3.2 LABOUR RATE

The measurement and payment for the items of the work of Iron, Steel and Aluminum Works 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.

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29 . HORTICULTURE

29.1 GENERAL REQUIREMENTS

29.1.1 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.

29.1.2 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 qualified 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.

29.1.3 SUBMITTALS

The Contractor shall submit catalogue data and literature of manufacturers and suppliers.

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 ordered a soils report is to be submitted by the Contractor for all soils to be used for preparation of ground. The Contractor shall arrange for 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
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 which 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.

29.1.4 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.

29.2 SOIL

Soil shall be sweet sand or washed marine sand 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 sites.

Material shall be stored in piles 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 oC
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 29.4(a).

Table 29.4(a)

Sieve Size (mm)	% by Pass
5.000	100
2.380	65 to 100
1.180	45 to 100

0.600	35 to 80
0.300	5 to 48
Sieve Size (mm)	% by Pass
0.150	0 to 15
0.075	0 to 3

29.2.1 SOIL CONDITIONERS & FERTILIZER

Peat shall be used where specified. Peat shall be a natural product of sphagnum moss peat/peat humus derived from a fresh water 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 than 4 and nor 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 2-2-2 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

- 10% Nitrogen
- 15% Phosphoric Acid
- 10% Potash
- or similar approved compound

29.2.2 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.

29.3 GRASS PLANTATION (LAWNS)

29.3.1 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, adverse drainage 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-tine ripper to a depth of 300 mm at 600 mm centres. Stiff clay and other cohesive subsoil shall be loosened with a single tine ripper to a depth of 450 mm at 1 m centres.

A minimum of 150 mm of approved soil in accordance with 29.2 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 30 mm 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.

29.3.2 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, in the 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 smooth with a light roller (empty) after you have applied it. 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 dark 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.

29.3.3 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 29.2.2.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.

29.3.4 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.

After 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.

29.3.5 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. 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 at 15 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.

29.4 IRRIGATION WATER

29.4.1 SALT CONTENTS

Irrigation water shall be provided by the Contractor from a source approved by the Engineer-inCharge 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

29.4.2 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 feet 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.

29.4.3 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.

29.4.4 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.

29.4.5 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.

29.5 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.

29.6 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 of the 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.

29.7 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-inCharge. 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.

29.8 TREE GUARDS

29.8.1 GENERAL

Tree guard shall be as specified and approved by the Engineer-in-Charge.

29.8.2 BITUMEN DRUMS GUARDS

Bitumen Drum shall be free of damage or any weathering. The drums shall be perforated as specified and painted with alternate lines of black/white enamel paint of an approved brand.

29.8.3 RCC GUARDS

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.

29.8.4 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.

29.8.5 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.

29.8.6 STEEL FRAME TREE GUARD

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.

29.8.7 G.I. BARBED WIRE

GI barbed wire where specified shall be fixed as shown on Drawings. The work shall comply with applicable provisions of Sub-Section 28.1.7 under - Iron Steel & Aluminium Works.

29.9 MEASUREMENT AND PAYMENT

29.9.1 COMPOSITE RATE

The measurement and payment for the items of the work of horticulture 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.

29.9.2 LABOUR RATE

The measurement and payment for the items of the work of horticulture 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.

ANNEXURE - A

DEFINITION OF SOILS

Soils can be considered a three-phase system of solids, liquids, and gases. The solid phase consists of mineral and organic particles separated by a network of pores, some filled with gases-air with its carbon dioxide and oxygen being most important-and others filled with water. The proportions of each phase vary with the type of soil and are further modified by time, environment, and human, plant, and animal activities.

GENESIS OF SOILS

The lithosphere, the solidified crust of the earth, currently is exposed over aquarter of the surface of the earth, with the remaining three quarters covered by water or ice. Oxygen, silicon, aluminum, calcium, sodium, potassium, and magnesium are the most abundant elements in the crust, accounting for about 90 percent of the lithosphere, although over 80 elements combined into 2000 compounds are present, The rocky crust, the parent rock for soil formation, is slowly fragmented into smaller pieces and into individual minerals by the action of wind, water, ice, and temperature changes. These fragments are altered by mechanical and chemical processes, mixed with organic materials, and changed by biological processes to form the extremely variable substance we can call soil. Rates of soil formation from rock vary not only with the nature of the parent rock, but also with time. Many soils are, on a geological scale, very young and are still being developed. Depending on climatic conditions, the nature of the parent rocks, and a host of biotic factors.soil formation may be measured in eons, in centuries, or in decades. The establishment of a new home ·garden can be an example of soil formation within a few years.

The type of parent rock is of major importance in the type of soils developed in a particular location. Sedimentary rocks produce soils that tend to be neutral or slightly alkaline, while soils formed above igneous granites are usually more acidic.

PHYSICAL PROPERTIES Texture

Many of the horticultural characteristics of soils depend upon the relative size of the mineral particles, termed texture; Texture is determined by the proportions of sand, silt, and clay that make up the soil. Sand is composed of compounds of silicon, primarily silicon oxides or quartz, Sand particles are comparatively large with a low surface-to-volume ratio (Table A.1).Because particles

may be large and irregularly shaped, there can be a large volume of space between the grains. Water enters easily, but passes out just as easily, so sand has little water-holding capacity. The large space between particles also means that sand has low cohesiveness. Sand tends to hold low amounts of plant nutrients.

Silt is chemically heterogeneous, composed of particles of whatever the parent rock was. Being smaller in particle size than sand, water-holding capacity is higher because the space between the individual particles is smaller. Silts have moderate to high level s of nutrients with low to moderate cohesiveness.

Clay particles are very small, with a high surface-to-volume ratio. Water- holding capacity is high, space between the particles may be almost nonexistent, and there is great cohesiveness of the particles. Many clays are composed of aluminum compounds, although other minerals are involved. Clays may be rich in nutrients. The minerals bound to clay may not always be available to plants because they may be tightly bound by electrostatic charges to the surface of the particles. Clays are separated into two major groups, those that swell when wet (and shrink when dry) and those that rarely swell. Swelling clays are usually composed of finer particles that play important roles in nutrient retention and soil cohesiveness.

Table A-1

Size Classification of Mineral Soil Particles According to the U.S. Department of Agriculture systems

Particle Name	Diameter (mm)	Particles per gram	Surface Area (cm2/g)
Boulder	Over 250		
Cobble	250-60		
Pebble	60-4		
Gravel	4-2		
Fine Gravel	2-1	100	10
Coarse Sand	1.0-0.5	700	25
Medium Sand	0.50 -0.25	6,000	50
Fine Sand	0.25 –0.1	50,000	100
Very Fine Sand	0.1 – 0.05	700,000	200
Silt	0.05 – 0.002	6,000,000	500
Clay	Less than 0.002	90,000,000,000	8,000,000

Fewsoils are composed of only one particle type, but are mixtures at all three plus organic matter. Several methods are available for determining the ratios among particle groups and when the proportions are plotted on a textural triangle (Figure A-1), mineral soils can be classified in horticultural terms. Textural analyses refer to the soils in the upper meter (39 in.) of the soil, that region in which most plant roots grow.

Horticultural soils can also be classified simply by their feel. A handful of soil is mixed with water to the consistency of putty and squeezed into a ribbon between thumb and fingers. The ribbon that forms is related primarily to the clay content of the soil. If clay makes up more than 45 to 50 percent of the soil.the ribbon will be long and flexible due to the high cohesiveness of clay. Failure to form a ribbon indicates a soil with a high proportion of silt, and a gritty feel suggests that the sand content is high. Ribbons that start to form but then beak are indicative of silty loams.

The formal designation of soil textures indicates the coarseness or fineness of soils, but not whether they are, in common terminology, heavy or light. These terms refer more to the ease of working or tilling soils than to texture, although heavy soils are almost always high in clay (when they aren't excessively stony).

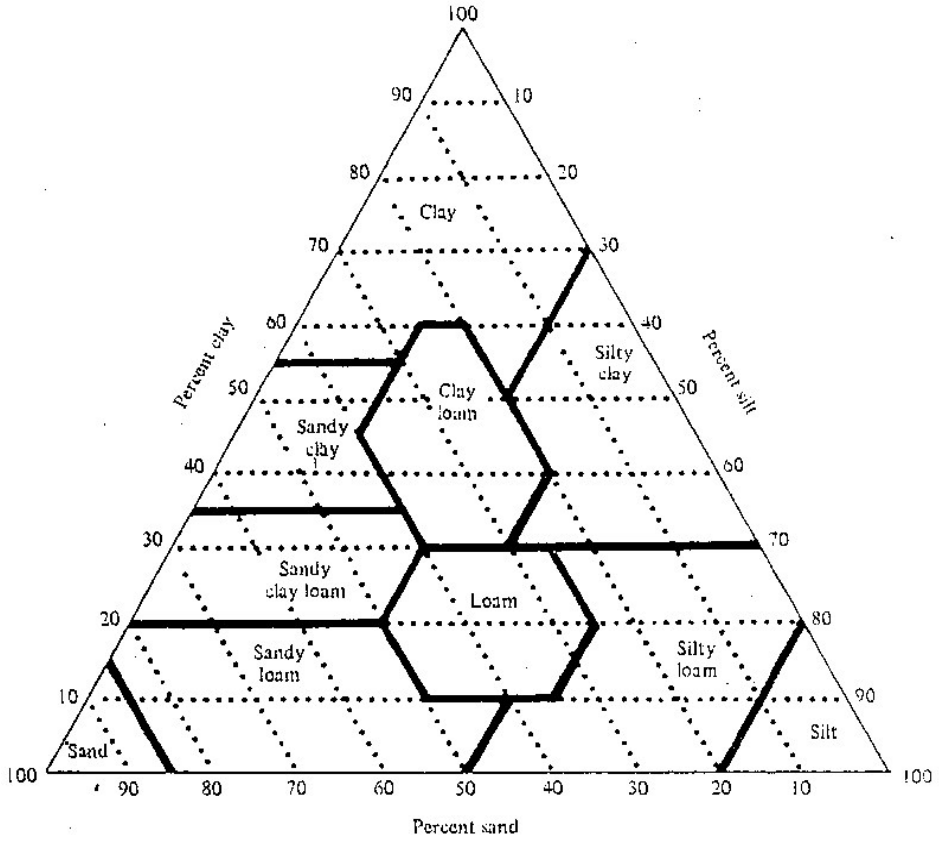

Fig A-1 Soil Texture Triangle

Pore space is usually determined by measuring the bulk density of the soil. Commonly expressed as the weight of oven-dry soil divided by the volume of oven-dry soil, or grams per cubic centimeter (g/cm3), soils with low bulk densities have large pore space volumes. A good horticultural soil will have a bulk density of 1.0 to 1.5 g/cm3 and a pore spacefraction of 0.4 to 0.6 (i.e., close to one-half of the total soil volume is pore space). The bulk density of heavy clay soils ranges from 1.0 to 3.0 g/cm3 and tillable silty loams range from 1.6 to 1.9 g/cm3.

WATER RELATIONS

From a plant's point of view, the soil in which it grows provides anchorage for its roots, a supply of air, and is the source of water and nutrients. The role of nutrients and of water in plant development is discussed later, but it is useful here to examine some of the water relations of soils. Water can exist in soils in all three physical phases, solid (ice), liquid, and vapor. Ice plays an important role in fragmenting rocks during soil genesis, and liquid and gaseous water are both involved in water retention, water movement through soil, and water uptake by plants. It should be remembered that

soil water always contains dissolved minerals and gases. This soil solution is taken up by plants and is the source of minerals required by plants.

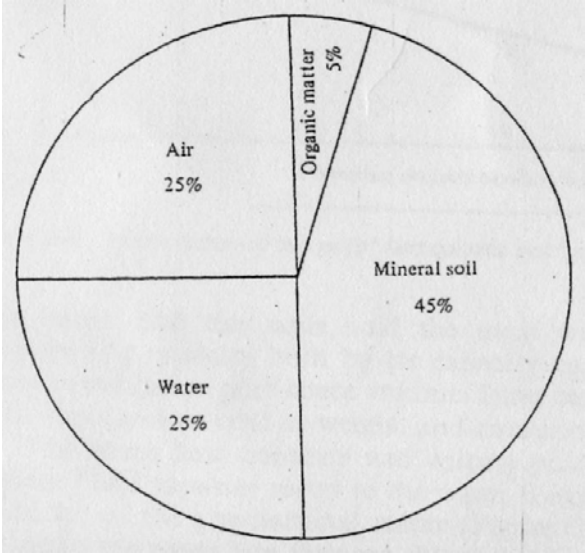

Fig A-2 Proportion of Soil Constituents

CHEMICAL PROPERTIES

Water, H20 or HOH, dissociates into two electrically charged particles or ions, one hydrogen ion (H+) and one hydro1tide ion (OH-). In pure water the number' of ions is very small relative to the number of un-dissociated molecules. One water molecule in over 500 million is dissociated; 1.0 mole of pure water (18 g) contains only 0.000001 moles of each ion, a number conveniently expressed as an exponential, 1 x 10-7.

Because of the difficulty of dealing with extremely small numbers, the concentration or activity of the hydrogen ions is given on a pH scale defined as:

$$pH = -\log [W]$$ For

pure water, the pH can be calculated as follows:

$$pH = \log (1/0.0000001) = \log 10{,}000{,}000 = 7$$

Since a log scale is used, a full unit change in pH is a 10-fold change in the concentration of a hydrogen ion (Table A-2).

Water in soils is not pure, but contains many Inorganic and organic chemicals that supply hydrogen or hydroxide ions which contribute to the total concentration of these ions in solution. The addition of hydrochloric acid (H+Cl-), for example, supplies additional hydrogen ions; the pH of the solution decreases as the concentration of H+ increases. When an alkali such as sodium hydroxide (Na+OH-) is added, some ofthe OH- combines with H- present in the solution to form water, and the pH increases as the number of H+ ions decreases. Soils at pH 7 are neutral in reaction (having an equal number of H+ and OH- ions) soils with pH values below 7 are acidic and those with pH values above are alkaline. In plant science, soils with H values from ph 6.5 to 7.5 are considered neutral.Acid soil range from ph6.5 to 4.0 and alkaline soils from 7.5 to 8.5. Soils with values below 3.5 or above 8.5 very rarely show good productivity.

The pH reaction of soils depends on many factors. Soils in areas of high rainfall tend to be more acidic than those of dry areas because alkaline components-sodium. potassium, calcium, and magnesium-are relatively easily leached. Soils witha high aluminum content or those formed from granitic parent rock are acidic, while those formed from limestone with a high calcium component are alkaline.

Table A-2

Hydrogen Ion Concentration and pH

H+ (moles/l)	pH	Soil Reaction	Substance With given pH	Soil types
10	0		Battery acid	
10-1	1			
10-2	2		Vinegar	
10-3	3	Acid toxicity	Lemon juice	Acidic peats
10-4	4	Very acidic	Orange juice	
10-5	5	Strongly acidic	Boric acid	Rainy region
10-6	6	Mildly acidic	Milk	Agriculture Horticulture
10-7	7	Neutral	Pure water	
10-8	8	Mildly alkaline	Sea water	
10-9	9	Strongly alkaline	Laundry soap	Arid region
10-10	10	Alkali toxicity	Laundry bleach	
10-11	11			
10-12	12		Ammonia	
10-13	13		Lye solution	
10-14				

Table A-3

Horticulture Soils Grouped Ph

Group	pH range	Type	Optimum for Representative plants
Medacid	4.0-5.5	Very low calcium_ Swamplands	Orchids, beets, heath family, swamp and mountain plants
Subacid	5.5-6.0	Low calcium___ Abandoned fields, uplands	Cereal grains, maples, woodland flowers
Minacid	6.0-7.0	Moderate calcium__ Garden loams, meadowlands	Most vegetables and ornamentals, lawn grass
Circumneutral	6.5-8.0	High calcium__ semitropical	Most fruits and nuts trees, food and forage legumes, asparagus

SALINITY AND SODICITY

Independent of the chemical nature of the compounds involved, soils that- contain high concentrations of salts present problems to the grower. By definition, soils in which more than 15 percent of the total cation exchange sites are occupied by sodium ions are considered to be sodic (sometimes called alkali soils), and those in which the sites are occupied by other cations in sufficiently high concentrations to impair plant growth are considered to be saline. Saline soils may result from the accumulation of almost any ionic substance, although those in which the excess salts are from sodium, potassium, or lithium usually have the additional problem of disruption of soil structure by de-flocculation of soil colloids and loss of adequate pore space. Occasionally, soils are found which are both saline and sodic.

Saline and sodic soils are found primarily in arid or semiarid regions where rainfall is limited and where extensive leaching does not occur. Even in regions with adequate precipitation, poor drainage conditions can lead to the accumulation of salts. Lands irrigated with water containing salts may, over a period of years, become saline or sodic. Soils near marine waters may become sodic as the fresh water is removed, allowing the infiltration of sea water.

LIFE IN THE SOIL

So far we have considered only the inorganic characteristics of soils, although we have mentioned how the presence of organic matter affects some of these characteristics. Many plants can grow satisfactorily under experimental conditions or in hydroponic culture in the complete absence of organic substance, but few plants do well in soils lacking organic matter. Microorganisms, plants, and animals all play roles in determining soil characteristics and productivity. For our purposes, we can separate organic soil constituents into two groups, those that are alive and those that are dead.

The numbers of living organisms in soil are staggering. In a gram of a good horticultural soil, there may be over 2 billion bacteria, 400,000 fungi, 50,000 algae, and 30,000 invertebrates, plus roots and other plant parts (Table A-4). There are also uncountable numbers of virus particles. Soil organisms are not uniformly distributed since soils are themselves not homogeneous. They are concentrated in films on the surface of soil particles and congregate on fragments of decaying biotic debris. The species and numbers of soil organisms vary with the season and with environmental conditions; fewer are found during droughts and in the winter than in periods of optimum moisture and temperature. Changes in plant cover also affect the organisms in the soil. Conversion of a forest to an agricultural pasture results in alterations in the flora and fauna of the soils. Modifications of soils by fertilization, tilling, liming, and irrigation also alter the composition of the biota.

Table A-4

Kinds & Amounts of Organisms & Organic Matter Typical Of a Horticultural Loam Soil in the North Temperature Zone

ORGANISMS	Dry weight	
	PERCENT	Kg/ha
Bacteria	0.1-0.2	2,000-3,000
Fungi	0.1-0.2	2,000-3,000
Algae	0.0001-0.0005	5-10
Invertebrates	0.001-0.005	10-50
Vertebrates	0.0001-0.0005	1-5
Plants root	0.5-5.0	5,000-50,000
Organic matter	4.0-8.0	75,000-150,000

Table A-5

Carbon to Nitrogen Ratio of Common Mulching Materials

	PERCENT CARBON(C)	PERCENT NITROGEN(N)	C:N ratio
Green cover crops			
Alfalfa	40	2.0	20:1
Clovers	40	3.0	13:1
Grasses	40	1.0	40:1
buckwheat	38	2.0	19:1
Mulches			
Peat moss	48	0.8	58:1
Fresh grass clippings	40	2.0	20:1
Dry leaves	40	1.0	40:1
Mixed mature compost	15	1.0	15:1
Straw	40	0.5	80:1
Sawdust	200	0.5	400:1
Rotted manures	30	1.5	20:1

ACIDIFICATION AND ALKALIZATION

Tolerance of plants to pH is fairly wide, ranging from about pH 4 (fairly acidic) to pH 8 (moderately alkaline). Many cultivated plants have a much narrower range. It is necessary to modify soil pH to ensure nutrient availability, reduction of metal toxicities, growth of desirable microorganisms, and conditions for in- creased crop productivity. The pH optimum for horticultural plants is species-dependent, but most will thrive at pH values between 5.5 and 7.0 and alteration of pH of soils within this range may not be necessary. Some alteration may be desirable to obtain the optimum for a specific crop, and alteration will be necessary for acidloving plants since their optimum values range from 4.0 to 5.5. Decisions on modifying soil pH should always be made on the basis of a soil analysis.

Acidification of soils can be done by several methods. Organic materials that provide hydrogenions, such as conifer needles, bark mulches. Sawdust mulches, cottonseed meal, oak leaves, and peat (sphagnum moss) are frequently used. Their acidifying potential is high and long lasting, but they

are slow acting since they must break down before releasing hydrogen ions. Much quicker, but not as long lasting, are a variety of inorganic chemicals (Table A-8). Among the least expensive is elemental sulfur, also called flowers of sulfur. Its use in poorly;' drained or heavy soils is questionable since the sulfur may be converted by microorganisms into toxic compounds. Ammonium sulfate [(NH4)2SO4], ammonium nitrate (NH4No3), and ferrous sulfate (FeSO4) are used for small areas, and urea or liquid ammonia are used for agricultural lands. It is difficult to predict the effects of these chemicals and the amounts to be applied since soil depth organic matter content, cation exchange capacity, and other factors are involved soil tests are vital.

Many crop plants do best at pH values near neutrality. Soils that are subjected to leaching of basic cations or that have been cropped for many years may require upward adjustment of pH.
With few exceptions, lime is the substance of choice to reduce acidity. It is inexpensive, readily available, easy to handle, and very effective. Lime is a generic term covering ground limestone or calcium carbonate (CaCO3)), slaked lime or calcium oxide (CaO), hydrated lime or calcium hydroxide [Ca(OH)2], and dolomitic. Limestone, which is a mixture of calcium carbonate and magnesium carbonate (MgCO3). Other liming substances include marl, ground oyster shells, hardwood ash, basic slag, and egg shells. All of these act. similarly by increasing the base saturation level of the soil and converting the exchangeable hydrogen ions into water. In order to determine the amount to he applied, a soil test is conducted. The liming substances have different neutralization capacities based on weight, but similar capacities based on the calcium content (Tables A-6 and A-7).

Limestone has a more immediate effect if it is finely ground, although this increases the chance of its being blown away during and after spreading. A compromise grind of 90% capable of passing a 20 mm screen and 25 % passing a 0.15 mm screen is usually used. Coarser grind are also available and less expensive. Lime does not move horizontally in soils to any extent and its vertical movement is limited even when it has dissolved in soil water. **Table A-5**

Some Characteristic of Common Soil Acidifying Materials

	Sulfur S	**Ferrous sulfate $FeSO_47H_2O$**	**Aluminum sulfate $Al_2(SO_4)_3$**	**Ammonium nitrate NH_4NO_3**
Solubility	Low	Moderate	High	High
Effect on pH	Slow	Moderate	High	High
Corrosivity	None	None	None	None
Effective time	long	Moderate	Moderate	Moderate

Table A-6

Filed Estimation of Calcium Carbonate ($CaCO_3$) Content of Soil

Percent CaCO3	**Sound**	**Effervescence**
0.1	None	None
0.5	Faint	None
1.0	Faint-Low	None
2.0	Distinct	Visible bubbles
3.0	Quite Distinct	Small bubbles
5.0	Very Distinct	Moderate bubbling
8.0	Very Distinct	Vigorous bubbling

Table A-7

AMOUNT OF ACIDFING SULPHUR OR ALKALINIZING LIMESTONENEEDED TO ALTER SOIL pH

To change upper 20cm		Sandy loam		Silty loam		Clay loam	
From pH	To pH	Lime[2]	Sulfur	Lime[2]	sulfur	Lime[2]	Sulfur
4.0	5.6	250	----	400	----	500	----
5.0	6.5	170	----	280	----	325	----
6.0	6.5	70	----	110	----	120	----
7.0	6.5	----	5	----	8	----	15
8.0	6.5	----	60	----	75	----	100

MULCHES AND COMPOSTS

The optimum %age of organic matter in a productive soil varies somewhat with climate, soil type and the nature of the crop, but generally it is about 5 to 15 %. As soils are tilled as microorganism gradually utilized the humus and other organic matter, and as leaching or erosion occurs, the amount of the organic fraction decreases. Among the many consequences of this are

1. Decreased soil porosity
2. Disruption of soil aggregates and loss of granularity
3. Decreased water-holding capacity
4. Decreased aeration
5. Increased erosion potential
6. Increased water evaporation
7. Decreased water buffering
8. Increased leaching nutrients
9. Alteration in favorable microorganism population
10. Increased temperature variations

These changes are more rapid in soils of tropical areas where temperature and rainfall are high but occur fairly rapidly even in temperature zones. For good productivity organic matter should be replaced.

Table A-8

Approximate Composition of Common Mulching Materials

	Nutrients(as present of dry weight)			
	Nitrogen	**Phosphorus**	**Potassium**	**Present dry weight**
Cow manure	1.5	0.4	0.8	20-30
Horse manure	2.0	0.3	2.0	20-30
Sheep manure	4.0	0.6	3.0	25-40
Poultry manure	4.0	2.0	2.0	30-40
Bone meal	0.1	10.0	0	100
Dried blood	13.0	1.0	1.0	100
Hay and straw	2.0	0.3	2.0	90
Cottonseed meal	6.0	1.0	2.0	100
Peanut hulls	2.0	0.1	0.7	100
Dried kelp	0.6	0	1.0	100
Wood ash	0.0	2.0	6.0	100
Hardwood sawdust	0.2	0.1	0.2	100
Softwood sawdust	0.1	0.1	0.1	100

Table A-9

CHEMICAL COMPOSITION OF PLANT –DERIVED SOIL ORGANIC MATTER COMPARED WITH THE PLANT TISSUE

Compounds	**Present dry w ight**	
	Soil organic matter	**Living plant tissue**
Cellulose	30-60	2-8
Hemicelluloses	15-30	0-2
Lignins	15-30	30-50
Proteins	2-12	1-5
Fats and waxes	1-5	1-4

SOIL MIXES FOR HOMES AND GREENHOUSES

Few house or greenhouse plants do well in soil dug out of the garden. Garden soils are usually too heavy and have variable composition. To standardize and control the substrate, potting mixes have been developed, Some containing soils and some soilless. A variety of all purpose and specialty mixes are commercially available, but for general use and volume production they are not cost efficient, and some contain sewage sludges contaminated 'with household and industrialwaste.

Potting mixes also called growing mixtures or soil mixes have advantages over top soil. They can be reproduced and are stable have excellent porosity, water holding capacity, cation exchange capacity and pest free. Because they are light in weight, large plants may topple or pulled from the pot, but the advantages outweigh the disadvantages.

Most potting mixes contain both plant-derived and inorganic materials with high water-holding capacity, resistance to compaction and high cation exchanges (Table A-10). Milled peat moss, leaf mold, shredded bark, humus, well-rotted manure, and wood chips are used. Inorganic constituents, such as sharp builder's sand, vermiculite, perlite, scoria (ground lava rock), and ground granite, improve drainage and increase pore volume. Small amounts of other substances are added to regulate pH and supply trace elements or nutrients

Table A-10

POTTING MIXING FOR HOUSE PLANTS , GREENHOSE, AND GARDEN TRANSPLANT USE

Ingredient	Cornell peat	University of California C	Johnines	Humus mix	Succulent and cacti mix	Epiphyte mix#1	Epiphyte mix#2	General house plant mix	Perennial container mix	Cornell seed starting mix	Johnines seed compost	Rooting cutting mix#1	Root cutting mix#2	Coniferous bonsai mix
Major ingredient														
Sphagnum peat(shredded)	2	1	3	1	1	1	1	1	1	1	1	1	1	1
Sharp sand (0.5-10mm)		1	2	1	1			1	1		1	1	1	1
Bark (shredded)									1					
Leaf mould or humus				1	1	1	1	1/2	1					
Sandy loam soil			7				1	2			2	1		1
Vermiculite	1			1		1							1	
Perlite	1													
Additives														
Dolomitic lime(ground)	20	300	250			75	150	100	50	50	100			
20 present superphosphate	50	50	50				50		75	25	100			25
Chelated iron	5	5					5		5	5				5
Fritted trace elememt	1								1					

ANNEXURE-B

LAWNS

Contrary to expectations, lawn installation and maintenance are among the more expensive and time-consuming horticultural activities, The individual grass plants are not only subject to many pests and diseases, but also are deliberately crowded 'and in intense competition for space, light, water, and nutrients. Nevertheless there is great personal desire and community pressure for a beautiful lawn to reduce dust and mud, to soften and enhance the landscape, and to sit and play on.

Table B-1

Grass Seed Mixtures

Situation	Hardiness zone	Composition
Sunny area	3-7	75% improved bluegrasses+25% improved red fescues
Shady area	3-7	75% improved red fescues+25% improved bluegrasses
Play area	4-8	80% improved tall fescues+20% perennial rye
Quick cover	3-9	75% annual rye+25% redtop
Rough lawn	3-8	33 1/3%ladino clover + 33 1/3% bluegrasses + 33 1/3 % tall fescues
Heavy traffic	4-8	60%fescues+ 20% bluegrasses +20% perennial rye
Overseeding	7-9	100% redtop

Establishing a good lawn demands quality seed, appropriate to the particular soil and climatic conditions. Many grass species have been selected and bred for particular characteristics (Table18-1). Within these, named cultivars have been developed that are generally superior to the unimproved species. The amed cultivars have the disadvantage of being almost isogenic (genetically uniform) To increase the lawn's survival under adverse conditions, most lawn grasses are sold as mixtures of two or more species. These mixtures are usually' keyed to hardiness zones, to environmental conditions in various lawn climatic regions, arid to the expected use of the lawn. In southern climates (Hardiness Zones 8 to 10) many lawns are established with a single species of grass, frequently as blends of several cultivars. Lawn grass seed should be labeled with the species and cultivars included, the germination percentage, the percentage weed seed (less than 1 percent is best), the percent of inert materials (less than 5 percent) and the percent of crop seed (less than 0.3 percent). Certified seed labels indicate that the plants were inspected in the field and were found to be true to type

SOWING

Sowing seed into a well prepared seed bed can be done by hand or with mechanical grass seeding machine. Since the seed is small, hand seeding, is made easier if the seed is thoroughly mixed with a carrier such as sand or topsoil. To ensure uniform distribution of seed, half the seed is sown in one direction and the other half at right angles to the first lot. After planting, the seed may be raked with a tooth rake to make sure that the seed is in direct contact with the ground. Rolling or treading the seeded area also ensures good contact. The seed should not be covered by more than 0.2 to 0.3 cm (1/8 in.) of soil for most cool-season grasses. Some varieties, such as the bluegrasses, germinate slowly, requiring over three weeks for full germination. Mulching the sown area conserves moisture, prevents the seed from being washed away by heavy rains, and prevents wide swings in temperature. A weed-free straw or hay cover is excellent when used at the rate of 100 kg/100 m2 (100lb/100 ft2). On steep slopes or banks, cheesecloth, sacking, or one of the commercially available mulching cloths can be used. The grass blades will grow through the mulch which usually rots away within a few months.

If the seedbed was properly prepared and adequately fertilized, additional fertilizer may not be needed for the first months of lawn growth. If fall planting was done, a light fertilization in spring when the grass begins to grow may be helpful, particularly if the plants are pale green or yellowish. A phosphorus deficiency is recognized as dark green plants with red stems and reduced growth.

To avoid compaction of the soil, new lawns should not be walked on for the first month following appearance of the seedlings. Mowing can begin at this time with mower height set at 2 in. Chemical weed control is best deferred for another month or can be done the following spring.

SODDING

Sod is pre grown turf consisting of a weed-free mixture of grasses appropriate to the area. It should be purchased locally. Rectangles or strips of a mature turf 1 to 3 years old. are cut with special equipment-to a thickness of 2 to 3 cm (I in.), with little soil below the mat of roots. Laying sod is expensive, but it is an effective method on slopes subject to erosion or where a line, mature lawn is to be established in a short time. In many areas sodding provides an excellent turf, usually weed free, that is permanent with proper maintenance.

In Hardiness Zones 4 to 8 sodding is most successful when done in the fall, although spring sodding may be done if adequate moisture and care are provided. In Hardiness Zones 8 to 10, where warm-season grasses are used, summer sodding is best. It is important that the sad is laid as soon as possible after delivery; a delay of even a few days will injure the turf since the root systems are exposed.

Soil preparation is identical to that used for seedbeds except that the soil is graded 2 to 3 cm (1 in.) lower near walkways to adjust for the thickness of sad. The bed must be well prepared and leveled to allow firm and close contact between the sod; and the soil. Rectangles or strips are planted as tightly together as possible, much as flooring tiles are laid: To minimize trampling or compaction of the soil, a board is laid over the soil surface to be sodded. After the sod is installed, the area is top-dressed with a thin layer of good topsoil and topsoil worked into the cracks between the pieces of sodding. The new lawn is light tamped or rolled to ensure good soil-sod contact and is watered immediately. Should be watered frequently for the first growing season to prevent root damage and to encourage good root penetration. A light application of superphosphate will accelerate root penetration.

Some grasses, particularly the warm-season species and the bent grasses, also be established from plugs or plantings (Table B-2). Plug sodding utilize small rectangles or discs of sodded grasses with adhering soil. These are plant 15 to 30 cm (6 to 12 in.) apart in well-prepared bed.

MAINTENANCE

If a fine, thrifty, weed-free lawn is desired, its maintenance becomes a significant part of management and cultivation. Unfortunately, lawns are neither work-free nor trouble-free. Fertilization. Liming, watering or irrigation, mowing. and control of animal and plant pests are the basic constituents of lawn management.

FERTILIZING

If soil nutrients are brought to an adequate level during site preparation, additional fertilization will be unnecessary for the hulk of the first growing season. Indeed, over-fertilization is inadvisable since a young root system is less tolerant of high levels of inorganic salts than is the root system of an established lawn. Excessive nitrogen results in succulent, soft growth that is less disease and insect resistant.

Lawns should not be fertilized when the grass or the soil is wet. But it is good practice to water thoroughly after spreading fertilizer to wash any chemicals off the leaves, This prevents burning and ensures that the fertilizer reaches and enters the soil.

There is some confusion about the amount or rate of fertilizer application. While the phosphorus and potassium components in standard fertilizer formulations are necessary for grass development, lawn grass growth is primarily dependent upon the amount of nitrogen supplied, and it is the nitrogen component that is given primary consideration in determining fertilizer applications. For lawn applications, the amounts needed are usually given as pounds of nitrogen per thousand square feet or kilograms per hundred square meters, To provide 1 lb N/ 1000 ft^2 (1kg N/100 m2) using a 10-10-10 fertilizer, 10 lb (4 kg) of fertilizer would be used.

Fertilizers may contain inorganic nitrogen as ammonium or nitrate ions, organically bound nitrogen, or a mixture of both, Inorganic nitrogen is immediately available to the plants, while organically bound forms release nitrogen slowly. When spring applications of fertilizer to coolseason lawns or summer applications to warm-season lawns are made, the combination formulations work well in spite of their high cost. For fall applications, where immediate uptake in cool weather is desired, only inorganic formulations are cost efficient.

'Fertilization schedules depend on the region and the grass type (figure18-3). Warm-season grasses put on most of their growth during the hot summer months and should be fertilized at the time of maximum growth. Bermuda grass, St.Augustine grass, zoysia, or Bahia grass benefit. from high fertilizer applications. Bermuda grass should receive 5 kg N/100 m2 (5 lb N/1000 ft2), St.Augustine grass and the zoysias 2 kg N/1OO m2,and Bahia grass 3 kg N/100 m2.

LIMING

It should be obvious that correction of soil pH should be done only when it needs correcting as determined by a soil test. In general, established lawns on sandy soils require liming every two to three years, while those on clay soils need adjustment only every five to six years. The lime is usually supplied in a finely ground or granular form and can be spread at any time of the year, although late fall or very early spring are best. Amounts vary according to need, but are in the range of 10 to 30 kg/100 m2 (10 to 30 lb/1000 ft2).

WATERING

Watering or irrigation of lawns is, for most areas of North America, a necessity. An acre (0.4 ha)of lawn can transpire 2400 gallons (9600 liters) of water per day in midsummer. Considerable damage will occur if soils dry to their permanent wilting point (-15 bars) for any length of time. Many lawn grass roots grow to 30 cm (1 ft) or more into the subsoil and moisture levels at this depth should not fall below -8 bars during the period when the grasses arc actively growing. It requires 2 to 5 cm (I to 2 in.)

of water to bring the upper 30 cm (12 in.) of a sandy or silty loam soil from near wilting point to field capacity. This amount of water will be transpired or lost by evaporation in a week under summer conditions. To replace this water, regular watering is required. In midsummer, when cool-season grasses stop growth and become summer- dormant, less, water is needed. if it is desirable to maintain growth during this time watering must be continued at somewhat higher rates than the 2 to 5 cm per week.

A light sprinkling of water several times a week is poor management practice. A good deal of this wafer is merely evaporated from leaf and soil surfaces and does-not enter the soil at all. The water that does enter the soil remains in the upper few centimeters and the grass roots become concentrated in this superficial horizon. The danger of massive root kill by even light droughts or a short period of hot weather is great. Watering should provide the amount needed to bring the upper 30 cm (12 in.) to field capacity and should be repeated when this layer is sti1l above the permanent wilting point-usually once a week or more frequently in very hot, dry weather with moderate to high winds.

MOWING

The fundamental rule on lawn mowing is to use only well-designed, well- maintained, and wellsharpened equipment. A dull blade, whether on it reel or a rotary mower, will shatter rather than cut grass blades cleanly and will increase the number of plants that die or become susceptible to infection. Although reel mowers involve more human effort, they preferable to rotary mowers because they cut cleaner and are less dangerous to use.

Cool-season grasses should not, except under special circumstances, be mowed closer than 5 cm (2 in.). Close mowing removes too much of the photosynthetic leaf blade tissue and depresses the growth of-root systems. It also exposes previously shaded stems to direct sunlight which may result in sun scald. Cool-season grasses should be mowed at frequent intervals during the growing period. It is a good general rule that lawns should be mowed when the grass length has exceeded the recommended height by no more than 1.0 to 1.5 cm (1/2 in.) where mowing shock is minimal. The warm-season grasses are generally cut shorter than the cool-season grasses, Bermuda grass is maintained at heights of 1.5 to 2.0 cm (5/8 in.) and the others at 2.0 to 2.5cm (3/4 to 1 in).

WEEDS

A bright green, well-trimmed, and weed-free lawn is not only an esthetic pleasure, but adds financial value to a property. Weed control is a necessary' cultural practice for most areas. Close to 50 species of weed plants invade lawns and require control if clean turf is to be maintained (Figure 18-4). Weed control starts with the turf itself. A healthy lawn, provided with adequate fertilizer, water, and lime and properly mowed, resists the invasion of the seeds of many lawn particularly if the turf is mowed to at least 3.5 to 5.0 cm (1.5 to 2.0 in.), a cutting height that is also best for lawn development.
Weedy species in lawns are separated into persistent (perennial) non persistent (annual) types and each type includes monocots and dicots. Two of the more troublesome weedy plants are the crabgrass and the nimble-wills. Both are monocots related to the lawn grasses. The crab-grasses are annuals, and nimble-will is a persistent perennial. The crab-grasses are vigorous C4. Photosynthetic plants and are particularly difficult to eliminate once they have become established. Other grass species that are problems for lawns are the creeping bent-grasses foxtails, Dallies-grass and quack grass.

Since the desired lawn grasses are usually as sensitive to herbicides as are the weedy species, special control measures are required in an established lawn. When lawns contain few weeds, hand removal is the least damaging method of control. Removal is best done after a rain or thorough irrigation since many weeds have relatively superficial root systems and it is easier to pluck out the entire plant when the soil is damp. Many weeds reproduce easily from rootstocks and failure to remove

the entire plant results in spread of the weed. This is particularly true for dandelion (Taraxacum), cinquefoil (Potentilla canadensis) and the plantains (Plantago spp.).

Both pre-emergence and post emergence herbicides are used in any thorough weed control program. The pre-emergence herbicides inhibit weed seed germination and early seedling growth, but have virtually no effect beyond that stage. They are effective in treating established lawns to eliminate crab-grasses, goose- grass (Eleusine indica), and creeping bentgrass all of which are resistant to most other herbicides. They may also be effective against seedlings of broad-leaved weeds, although post emergence herbicides are usually used for these plants. Pre-emergence herbicides are available as granules that at spread in early spring. They should not be used on new lawns since they can kill lawn grass seedlings.

The post emergence herbicides include 2, 4-dichlorophenoxyacetic acid (2, 4-D) and its derivatives plus a variety of other chemicals that interfere with a number of physiological activities including photosynthesis, respiration, and synthesis of various compounds. Many are available as spreadable granules or as liquid formulations used as sprays. With few exceptions, spray formulations are most effective against young plants: as many weeds age. their tolerance to herbicides increases.

Herbicides are human and animal toxins. and as with all chemicals, package directions should be followed exactly. They can injure or kill desirable plantings and should not be used in very hot weather where they volatilize or in wind conditions where they may be carried to other plantings. Spot applications can be made by tipping a stick with a paint brush or a piece of plastic foam and touching individual weeds with the herbicide. Although formulations of fertilizer plus herbicides are available for dual treatment of lawns, they are more expensive than purchasing and applying each separately, and the timing for optimum effectiveness of each may be different.

PESTS AND DISEASES

Three insect types are responsible for most lawn problems. Those that suck sap include the chinchbugs, some aphids, and scale insects. Plants of Augustine grass in the south are particularly plagued by chinch bugs. The webworms, occasionally called tobacco crambids, are larvae of moths that damage by feeding on grass leaves and stems. Armyworms, the larval stage .S. another moth, are leaf feeders. By far the most serious pests are grubs, the larval hatchlings of the Japanese beetle, Mayor June beetles, and the billbugs. Beetle grub damage is evidenced by death of patches of grass in June through early August and by observations of white grubs directly beneath the sod. These insect feed on the roots of grass plants just below the sod level and can destroy a large lawn area within a week.

The sap sucking insects and leaf feeders are controlled with appropriate insecticide sprays, usually applied in midsummer in the south and a few earlier in more northerly climates. Grubs can be controlled by preventing through sound cultivation practices, trapping or killing adults, use of biological , control and soil treatments with appropriate pesticides.

Other animal pests rarely present major problems. Termites damage the roots of some grass species in the Ohio River basin, wireworms occasionally attack grass rhizomes near potato fields, ants are more of a nuisance. Land crabs dig holes in southern lawns and arc controlled with a rotenone solution poured into each burrow. Mole burrows are unsightly and can result in uprooted plants. Moles feed on grubs, so that grub control almost invariably. Resolves the mole problem. No one has successfully dealt with neighborhood dogs, cats, and squirrels.

A well-managed lawn is the best disease control. Among the worst management practices in terms of disease development is over-fertilization with high nitrogen formulations. Hot, wet summers are unavoidable, but they should alter the gardener that special care must be exercised if serious fungal diseases are to be avoided. Among the most common diseases of lawn grasses are the mildews, rusts, and smuts. Mildew infections look as if the grass had been dusted with a white powder and are controlled with fungicides. Rusts and smuts rarely kill thrifty, deep-rooted grass plants and can usually be controlled by fungicides; Smuts attack tender leaves forming black, powdery spore masses on

curled leaves. In northern regions snow molds are a recurrent problem. The snow mold fungi attack overwintering leaves, and the results of their activity, dead circles or patches of grass, are seen when the snow melts. Unless the disease is far advanced, fungicidal treatments are effective.

REPAIR, RESTORATION AND RENOVATION

Even with reasonable maintenance. lawn repair, restoration or renovation becomes necessary. Soil compaction in traveled areas, the growth of shade trees, diseases, and neglect can individually or collectively create problems that must be corrected. These operations should be distinguished from routine maintenance.

Older lawns that show minor wear and tear can be repaired by relatively simple procedures. Chemical and hand removal of weeds is best done prior to mowing the lawn to 2.5 cm (1.0 in.). Clippings should not be added to a compose the heap, but collected and discarded. Fertilization to correct nutrient deficiencies, liming as indicated by soil tests, and accelerated maintenance techniques should be included. Repair work can be done at any time of year, but spring and fall are best.

Much has been written about the horrors of thatch buildup as a factor in lawn decline and waste of it is probably overstated. The stolon's of lawn grasses such as the bents and Bermuda grass are horizontal stems that extend along the ground and become intertwined. As stolon's die, they can form a thick layer of organic material that decomposes slowly, sheds water, causes soils to dry out, and harbors earwigs and other pests. True thatch is a fluffy, matted blanket of these stolon's above the soil.

GROUND COVERS

In many situations grass lawns are neither practical nor desirable. Heavily shaded areas including those on the north sides of structures, under mature trees, and behind hedges and tall fences rarely receive enough light to allow a good lawn to develop; Areas immediately adjacent to woodlots also rarely form good lawn. Steep banks are difficult to mow, are frequently dry and infertile, and rarely can be successfully seeded because of runoff and erosion, All of these situations are being handled by planting ground cover plants. These should not be considered as second choices or compromise plantings, many ground covers are handsome and colorful additions to the landscape (Table B-3). Contrasting textures, foliage colors, and splashes of flower color add greatly to the total view of a garden.

Most effective ground covers are herbaceous perennials or small woody shrubs. They may trail along the ground or spread by rhizomes so that bare areas are quickly covered. Some ground covers are essentially care-free, requiring only minimal fertilizing and watering, while others need as much or more attention as lawn grasses. Because of the large number of possible ground covers, selection is based not only on prevailing environmental conditions, but also on considerations of hardiness, foliage and flower interest, and the landscaping plan.

Many low-growing perennial flowering plants can be used as ground covers, Baby's breath (Gypsophila repens) turfing daisy (Matricaria tchihatchewe), some saxifrages, lily of the valley (Convaltaria majolis), and others can fill in shaded areas .For southern areas (Hardiness Zones 9 to 10), gopher apple (Geobalanus spp.), peperomia, creeping charley (Pilea hummulariaefolia) inch plant (Zebrina pendula), and several species of veronica are excellent shade-tolerant ground covers. Although not usually considered as ground covers, there are herbs to suit most conditions and locations. Included among those that are often used as ground covers are catnip, tarragon, mint, pennyroyal, burnet, germander, lovage.

Table B-2

Seeding of Planting of Lawn Areas

Latin Name	Common Name	SEEDS	Plugs or Plant	Mowing	Remarks

		Time	Rate (lb/1000ft^2)	Time	Rate (lb/1000ft^2)	Height (in)	
	Cool Season Grasses						
Agropyron crictatium	Crested Wheetgrass	F	1-2	----	---	2	Dry, cool areas
Agrostis canina	Velvet bentgrass	F	1-2	---	---	1	Humid, cool areas
A.gigantea	Redtop	F	1-2	---	---	1.5	Quick cover, short-lived.
A.stolonfera	Creeping bentgrass	F	1-2	F	1000	1	Humid, cool areas
A.tenuis	Colonial bentgrass	F/S	1-2	---	---	1	Humid, cool areas, finest lawns
Bouteloua grevilis	Blue gramagrass	S	1-2	---	---	1.5	Dry, cool areas drought resistant
Festuca rubre	Red fescue	F	3-5	---	---	2	Dry, cool areas shade resistant
F.ruba	Fescue improved	F	2-4	---	---	2	Water resistant, shade tolerant
F.ruba hetrophylla	Chewing Fescue	F	3-5	---	---	1.5	Cool areas, shade resistant
Lolium mulslorum	Annual ryegrass	F/S	4-6	---	---	2	Quick cover, short lived.
L.perenne	Perennial ryegrass	F/S	3-5	---	---	1.5	Used in mixtures with other grasses.
Poa pratense	Common blue grass	F	2-3	---	---	2	Drought resistant, rough use
P. pratense	Bluegrass improved	F	1-2	F	1000	2	Most common component in mixtures.
Trifolium repens	White Clover	F/S	2-4	---	---	1.5	Cool areas, nitrogen fixing legume.
T.r. forma lodigense	Ladino clover	F/S	2-4	---	---	---	Dry areas, rough lawns
	Warm season grasses						
Buchloe dactylsides	Buffalo grass	S	1-2	S	50	1.5	Drought resistant, rough use
Cynodon Dactylon	Bermuda grass	S	2-3	S/S	10	0.75	Southern areas, in acidic area
Emerochola optiroides	Centipede grass	S	2-3	S/S	10	1	Low maintenance invasive
Paspalum notaum	Bahia grass	S	2-3	---	---	1	Humid Warm areas, coarse textures
Stenotaphrum condatum	St. Augustine grass	---	---	S/S	30	1	Shade tolerant heat resistant
Zoysia Matrella	Japanese zoysia	S/S	1-2	S/S	30	1	Wear resistant, yellows in summer
Z.tenuifolia	Velvet Zoysia	S/S	1-2	S/S	30	1	Fine texture, yellows in summers

Table B-3

Some Ground Cover Plants

Latin name	Common name	Mature height(cm)	Light	Soil	Flowers	Hardiness zone
Acaena microphella	Sheepbur	0.5	FS	N	_	7
Achillea spp.	Yarrow	30	FS	N	_	3
Aegropodium spp.	Goutweed	35	FS	N	_	4
Ajuga repens	Bugleweed	20	FS	N	+	4

Akebia quinata	Akebia	Vine	Sh	N	_	5
Aloe spp.	Aloe	10	FS	N	+	9
Andromeda polifolia	Bog roesmary	30	FS	Wet	+	3
Arabis alpine	Rock ress	20	FS	N	+	4
Arctostaphylos spp,	Bearberry	30	FS	Wet	_	3
Arenaria verna	sandwort	8	FS	N	+	3
Armeria maritima	Thrift	30	FS	Wet	_	3
Cerastium spp.	Snow in summer	20	Sh	N	+	3
Chamaemelum nobile	Chamomile	15	FS	N	+	4
Convallaria majalis	Lily –of-thevalley	20	Sh	N	+	3
Cornus Canadensis	Bunchberry	18	FS	Wet	+	3
Coronilla varia	Crown vetch	60	FS	N	+	4
Dichondra micrantha	Dichondra	8	Sh	N	_	9
Duchesnea indica	Indian	5	Sh	Wet	_	6
	strawberry					
Erica carnae	Heath	25	FS	Acid	+	6
EUONYMUS FORTUNEI	Wintercreeper	15	FS	Wet	_	5
Fragaria chiloensis	Wild strawberry	12	FS		+	5
Galax urcreolate	Wandflower	15	Sh		+	4
Gaultheria procumbens	Wintergreen	1	Sh		+	4
Glechoma hederacea	Ground ivy	2	FS		_	4
Hadera helix	English ivy	Vine	Sh		_	6
Juniperis cvs	Creeping juniper	35	FS		_	4
Liriope spicata	Lilyturf	20	FS		+	7
Mitchella repens	Partrideberry	3	Sh		+	4
Mazus reptans	Mazus	3	Sh		+	4
Ophiopogon japonicas	Dwarf lilyturf	15	Sh		+	6
Pachysandra spp.	Pachysandra	30	Sh		_	5
Phlox subulata	Moss pink	15	FS		+	4
Phylanodiflora	Lippie	10	FS		_	6
Potentilla spp.	Cinquefoil	10	FS		+	5
Prunella vulgaris	Self-heal	5	FS		+	3
Sagina subulata	Pearlwort	10	FS		+	5
Sedum spp.	Stonecrop	10	FS		+	4
Teucrium chamaedrys	Germander	30	Sh		+	6
Thymus spp.	Thyme	4	FS		+	4
Veronica spp.	Speedwell	10	FS		+	4
Vinca minor	Periwinkle	15	Sh		+	5
Vtola spp.	violet	10	Sh		+	3

FS = full sun; Sh = partial shade; N = normal soil ; wet=can withstand wet soil; acid= requires pH

INSTITUTE OF BUSINESS ADMINISTRATION (IBA) KARACHI

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE

SUMMARY OF COST

IBA Institute of Business Administration Karachi
Leadership and Ideas for Tomorrow

MESA

S.NO	DESCRIPTION	COST BASED ON CSR 2012 (PKR)	ADD PREMIUM	TOTAL COST OF SCHEDULE BASED ITEMS (A)	ADDED COST DUE TO ADDENDA BY SINDH GOVT. (B)	NON SCHEDULE ITEMS BASED ON ANALYSED RATES (C)	TOTAL COST (A+ B+C)
1	CIVIL WORKS						
I	MAIN BUILDING						
a	GROUND FLOOR	4,403,272.65			716,655.00		
b	FIRST FLOOR	3,296,274.78			713,365.00		
c	SECOND FLOOR	3,307,164.78			710,410.00		
d	THIRD FLOOR	3,580,689.58			703,238.00		
e	FOURTH FLOOR	756,551.54			107,115.50		
	TOTAL FOR ONE BLOCK	**14,587,401.79**			**2,950,783.50**		
	TOTAL FOR FOUR BLOCKS						
	AV. COST PER SFT	COVERED AREA OF ONE BLOCK (SFT)					
2	UNDER GROUND WATER TANK 14500 GLS 2 NOS	352,722.65			55,760.00		
3	EXTERNAL DEVELOPMENT						
a)	ROADS	18,998,849.00			0.00		
b)	PATHS	2,496,620.16			0.00		
c)	RAIN WATER DISPOSAL	650,000.00			0.00		
d	HORTICULTURE						
	TOTAL						
	TOTAL FOR CIVIL WORKS - A						
4	PLUMBING						
a)	SOIL, WASTE & VENT PIPING						
b)	FITTINGS & FIXTURES						
c)	SEWER PIPE NETWORK AND MANHOLES						
d)	WATER, GAS AND FIRE SUPPRESSION PIPING						
	TOTAL - B						
	TOTAL FOR PLUMBING WORKS						
3	ELECTRICAL & COMMUNICATION WORKS						
A	WIRING & CONDUITING						
B	SWITCHES, SOCKETS, OUTLET & ACCESSORIES						
C	UPS INSTALLATION						
D	LIGHT FIXTURES & FANS						
E	MAIN. SUB-MAIN CABLES, CONDUIT & CABLE TRAY						
F	SWITCHBOARDS / DISTRIBUTION BOARDS						
G	EARTHING SYSTEM						
H	DATA, CCTV and WiFi system						
I	A.C DRAINAINGE						
	TOTAL ELECTRICAL Work - C						
	TOTAL AMOUNT OF COST PHASE-I						

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S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(a)	**GROUND FLOOR**				
1	**Jungle Clearance**				
	Jungle Clearance and removing within 100 ft (b) thick Item No 4 (b) Page 95 Chapter 18	39900.00	% Sft	151.25	60,348.75
2	**TERMITE PROOFING**				
	Providing anti-termite treatment by spraying / sprinkling / spreading Neptachler 0.5% Emulsion as an overall pre-construction treatment in slab type construction under the slab and attached perches or entrances etc. complete in all respect as per directions of the Engineer-in-Charge (Page No. 108, Item No. 92)	14490.13	SFT	9.74	141,133.82
3	**STONE SOLING**				
	Stone pitching including sub-base with hammer dressed stone on surface laid in courses including carriage of materials chains. (Page No. 32, Item No. 23) 6" THICK	2,932.94	%Cft	5,377.63	157,722.53
4	**NON STRUCTURAL LEAN CONCRETE**				
i)	Cement concrete plain including placing compacting, finishing and curing complete (including screining and washing at stone aggregate without shuttering (Page No. 16, Item No. 5-i) 1:4:8 Concrete				
a)	Under Footing	1,106	% CFT	11,288.75	124,895.91
b)	Under Plinth Beam	915	% CFT	11,288.75	103,334.40
c)	Under Floor	1,694	% CFT	11,288.75	191,217.31
		3,716	% CFT		
ii)	Concrete 1:3:6 under plinth Page No 16 Item No 5-(h)	329	% CFT	12,595.00	41,374.58
5	**POLY ETHYLENE SHEET**				
	Providing and laying single per layer of polyethylene sheet 0.13 mm thick for water proofing as per specification and instruction of Engineer Incharge (Page No. 38, Item No. 38).	3,388	SFT	10.70	36,248.93
6	**FORM WORK**				
	Erection and Removal of Centering for RCC or Plain Cement Concrete of Class ii Partal Wood Vertical Item No (ii) Page 18	3104.30	%SFT	3,127.41	97,084.19
7	**DAMP PROOF COURSE**				
(i)	**2" THICK HORIZONTAL**				
	Damp Proof Course with Cement Sand & Shingle Concrete 1:2) 1-1/2" thick mixed with Dampo item 69 (a) Page No 107	490.64	% SFT	1,934.82	9,493.02
(ii)	Verticle DPC of 3/4" thick CSM plaster 1:2 with Bitumen at 20 LBs per %Sft Item No70 Page No 107	876.00	% SFT	2,760.99	24,186.27
8	**RENDERING (PLASTER)**				
i)	**Internal Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 11-B	3387.75	% SFT	2,496.76	84,583.99
b)	**Cement Plaster 1:6 upto 12' height (Internal)**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 13-c	8292.50	% SFT	2,590.50	214,817.21
ii)	**External Plaster (in two coats)**				
a)	**Cement Plaster 1:4 upto 12' height**				
i)	3/4" thick Plaster (ONLY FOR Block masonary work) Page No. 52, Item No. 11-d	4738.75	% SFT	3,191.76	151,249.53
9	**FLOORING**				
i)	**FLOORING BASE CONC. 1:3 :6**				
a)	Cement Concrete plain including placing, compacting, finishing and curing complete including screening and washing at stone aggregate with out shuttering. (Ref. Item No 5 h, Page No16 1:3:6 Conc. Plain	846.94	% CFT	12,595.00	106,671.78
b)	Do 1:2:4 Concrete	86.46	% CFT	14,429.25	12,475.53
(ii)	**GLAZED (PROCELEAN) FLOOR TILES**				
a)	Laying floor of approved colour glazed tiles (Procelean) 1/4" thick in white cement and pigment on a bed of 3/4" thick Cement mortar 1:2 Item No 25 Page No 43 CSR 2012	2997.75	% SFT	27,747.06	831,787.49

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
b)	BUT IN BATH ROOMS (NON SKID)	330	% SFT	27,747.06	91,565.30
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(a)	**GROUND FLOOR**				
10	**DADO & SKIRTING**				
i)	**GLAZED TILES(PROCELEAN) DADO & SKIRTING 6" THICK IN ROOMS & CORRIDORS**				
	Glazed tiles (PROCELEAN) dado 1/4" thick laid in pigment over cement sand mortar 3/4" thick including finishing. Item No 38 Page No 45 CSR 2012	465.25	% SFT	28299.3	131,662.49
ii)	**GLAZED TILES ON DADO & SKIRTING 7'-0" height IN bath ROOMS**				
	Do- but in bath rooms upto 7-0" height	1529.50	% SFT	28299.3	432,837.79
iii)	**GLAZED TILES ON DADO & SKIRTING IN Kitchen 2'-0"**	188.00	% SFT	28299.3	53,202.68
11	**WOOD WORK**				
a)	**PANELLED DOOR 2" THICK WITH 1-1/2"X 2" Ist deodar Wood Frame**				
	First Class Deodar Wood Wrought ,Joinery in doors & Windows etc fixed in position including chowkhats hold fasts, hinges,iron tower bolts, chock cleats, handles and chords with hooks etc, Dodar Panelled or Panelled and Glazed or fully glazed 2" thick Item No 7 (a) Page 58.	80.00	PSft	1336.59	106,927.20
b)	**SEMI SOLID FLUSH DOOR1-1/ 2" THICK WITH 1-1/2"X 2" Ist deodar Wood Frame**				
	Providing & Fixing in Position door Windows & ventilators for Ist Class Deodar wood frames 1-1/2" thick and teak wood ply shutters of First Class deodar wood skeleton (Solid) stiled and ply wood Stiled and rail core of Partal wood and teak ply wood (3ply) on both sides including hold fasts, hinges, Aldrops, Iron Tower Bolts handles Cleats with cords etc Complete. Item No 51 Page No 51	367.50	SFT	1245.96	457,890.30
c)	**WOODEN ARCHIVES 2-1/2" X1/2" THICK IN ONE PIECE**				
	Providing and Fixing with sunk iron screws wooden Archives approved design /shape having width not less than 2-1/2 inches as directed by Engineer Incharge. (Item No 60 Page No 66)	577.00	RFT	49.97	28,832.69
12	**PAINT & VARNISH**				
(i)	**CEILING DESTEMPER**				
	Distempering three coats page no 54 item no 24 c	3387.75	% SFT	1079.65	36,575.84
ii)	**INTERNAL WALL PAINTING**				
	Preparing the surface and painting with matt finish Enamel including rubbing the surface with bathy (silicon carbide rubbing brick) filling the voids with zink / chalk / plaster of paris mixture, applying first coat premix, making the surface smooth and then painting 3 coats with matt finish of approved make etc. complete (new surface). Page No. 55, Item No. 36A+36-b. (3 Coats)	8292.50	% SFT	3,444.38	285,625.21
iii)	**EXTERNAL WALL PAINTING**				
	Preparing the Surface and painting with Weather Coat i/c Rubbing the surface with rubbing brick/sand paper, filling the voids with chalk /plaster of Paris and then paintining with weather coat of approved make (3 Coats) Page No 56 Item no 38-a & B	4738.75	% SFT	2567.95	121,688.73
iv)	**PAINT OVER IRON SURFACE**				
	Preparing surfaces & Painting Guard bars Gates, iron bars, gratins, railings including standard braces three coats Item No 5(d) Page No 70	1845.63	% SFT	1270.83	23,454.82
v)	**PAINT OVER WOODEN SURFACE**				
	French Polish Complete on new works. Item No 7(a) Page No71	2421.50	% SFT	3841.75	93,027.98
vi)	**SOLINGUM PAINT**				
	Solingum Painting Two Coats Applied Hot Item No 12 Page No 71.	1857.00	% SFT	869	16,137.33

INSTITUTE OF BUSINESS ADMINISTRATION (IBA) KARACHI

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE

SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
13	**WATER PROOFING**				
	Providing & Applying Hi Bond Sealer Water Proofing polymer Modified Cementious sulleries (WPMCS) to be used as Water Proofing, Anticorrosion, water resistance or curing member for fresh concrete having thickness 2mm in two coats upto 20'-0" height textured or trowel finish grey or coloured i/c preparing the surface for application as directed by Engineer.	3504.00	% Sft	2282.77	79,988.26
14	ADD EXTRA FOR USING SR CEMENT	1380.77	BAGS	40	55,230.80
	TOTAL COST IN PKR GROUND FLOOR BASED ON CSR 2012				**4,403,272.65**
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(a)	**GROUND FLOOR**				
	ADDITIONAL COST DUE TO ADDENDA I,II&III				
1	**CEMENT**				
	Adding Cost of Difference of Ordinary Port Land Cement Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	450.00	BAGS	325	146,250.00
2	**SAND**				
	Adding Cost of Difference of Fine Sand Aggregate as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	900.00	CFT	4.75	4,275.00
3	**CRUSH**				
	Adding Cost of Difference of Coarse Aggregate (Crushed Stone) as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	1250.00	CFT	10.66	13,325.00
4	**WOOD**				
	Adding Cost of Difference of Deodar Wood Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	100.51	CFT	5500	552,805.00
	TOTAL				**716,655.00**
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(b)	**FIRST FLOOR**				
1	**RENDERING (PLASTER)**				
i)	**Internal Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 11-B	3387.75	% SFT	2,496.76	84,583.99
b)	**Cement Plaster 1:6 upto 12' height (Internal)**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 13-c	8292.50	% SFT	2,590.50	214,817.21
ii)	**External Plaster (in two coats)**				
a)	**Cement Plaster 1:4 upto 12' height**				
i)	3/4" thick Plaster (ONLY FOR Block masonary work) Page No. 52, Item No. 11-d	4738.75	% SFT	3,191.76	151,249.53
2	**FLOORING**				
i)	**FLOORING BASE CONC. 1:3 :6**				
a)	Cement Concrete plain including placing, compacting, finishing and curing complete including screening and washing at stone aggregate with out shuttering. (Ref. Item No 5 h, Page No16 1:3:6 Conc. Plain	846.94	% CFT	12,595.00	106,671.78
b)	Do 1:2:4 Concrete	86.46	% CFT	14,429.25	12,475.53
(ii)	**GLAZED (PROCELEAN) FLOOR TILES**				
a)	Laying floor of approved colour glazed tiles 1/4" thick in white cement and pigment on a bed of 3/4" thick Cement mortar 1:2 Item No 25 Page No 43	2997.75	% SFT	27,747.06	831,787.49
b)	BUT IN BATH ROOMS (NON- SKID)	385	% SFT	27,747.06	106,826.18

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
3	**DADO & SKIRTING**				
i)	**GLAZED TILES ON DADO & SKIRTING 6" THICK IN ROOMS & CORRIDORS**				
	Glazed tiles dado 1/4" thick laid in pigment over cement sand mortar 3/4" thick including finishing. Item No 38 Page No 45	465.25	% SFT	28299.3	131,662.49
ii)	**Do- but in bath rooms upto 7-0" height**	1529.50	% SFT	28299.3	432,837.79
iii)	**DO- BUT 2'-0" height IN Kitchen**	188.00	% SFT	28299.3	53,202.68
4	**WOOD WORK**				
a)	**PANELLED DOOR**				
	First Class Deodar Wood Wrought ,Joinery in doors & Windows etc fixed in position including chowkhats hold fasts, hinges,iron tower bolts, chock cleats, handles and chords with hooks etc, Dodar Panelled or Panelled and Glazed or fully glazed 2" thick Item No 7 (a) Page 58.	80.00	PSft	1336.59	106,927.20
b)	**HOLLOW CORE FLUSH DOOR**				
	Providing & Fixing in Position door Windows & ventilators for Ist Class Deodar wood frames 1-1/2" thick and teak wood ply shutters of First Class deodar wood skeleton (Solid) stiled and ply wood Stiled and rail core of Partal wood and teak ply wood (3ply) on both sides including hold fasts, hinges, Aldrops, Iron Tower Bolts handles Cleats with cords etc Complete. Item No 51 Page No 51	367.50	SFT	1245.96	457,890.30
c)	**WOODEN ARCHIVES**				
	Providing and Fixing with sunk iron screws wooden Archives approved design /shape having width not less than 2-1/2 inches as directed by Engineer Incharge. (Item No 60 Page No 66)	577.00	RFT	49.97	28,832.69
5	**PAINT**				
(i)	**CEILING DESTEMPER**				
	Distempering three coats page no 54 item no 24 c	3387.75	% SFT	1079.65	36,575.84
ii)	**INTERNAL WALL PAINTING**				
	Preparing the surface and painting with matt finish Enamel including rubbing the surface with bathy (silicon carbide rubbing brick) filling the voids with zink / chalk / plaster of paris mixture, applying first coat premix, making the surface smooth and then painting 3 coats with matt finish of approved make etc. complete (new surface). Page No. 55, Item No. 36A+36-b. (3 Coats)	8292.50	% SFT	3,444.38	285,625.21
iii)	**EXTERNAL WALL PAINTING**				
	Preparing the Surface and painting with Weather Coat i/c Rubbing the surface with rubbing brick/sand paper, filling the voids with chalk /plaster of Paris and then paintining with weather coat of approved make (3 Coats) Page No 56 Item no 38-a & B	4738.75	% SFT	2567.95	121,688.73
iv)	**PAINT OVER IRON SURFACE**				
	Preparing surfaces & Painting Guard bars Gates, iron bars, gratins, railings including standard braces three coats Item No 5(d) Page No 70	1845.63	% SFT	1270.83	23,454.82
v)	**PAINT OVER WOODEN SURFACE**				
	French Polish Complete on new works. Item No 7(a) Page No71	2421.50	% SFT	3841.75	93,027.98
vi)	**SOLINGUM PAINT**				
	Solingum Painting Two Coats Applied Hot Item No 12 Page No 71.	1857.00	% SFT	869	16,137.33
	TOTAL COST IN PKR FIRST FLOOR BASED ON CSR				**3,296,274.78**

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SUMMARY OF COST					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**S/RATE 2012**	**AMOUNT**
	ADDITIONAL COST DUE TO ADDENDA I,II&III				
1	**CEMENT**				
	Adding Cost of Difference of Ordinary Port Land Cement Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	350.00	BAGS	325	113,750.00
2	**SAND**				
	Adding Cost of Difference of Fine Sand Aggregate as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	2000.00	CFT	4.75	9,500.00
3	**CRUSH**				
	Adding Cost of Difference of Coarse Aggregate (Crushed Stone) as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	3500.00	CFT	10.66	37,310.00
4	**WOOD**				
	Adding Cost of Difference of Deodar Wood Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	100.51	CFT	5500	552,805.00
	ADDITIONAL COST DUE TO ADDENDA I,II&III FIRST FLOOR				**713,365.00**

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(C)	**SECOND FLOOR**				
1	**RENDERING (PLASTER)**				
i)	**Internal Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 11-B	3387.75	% SFT	2,496.76	84,583.99
b)	**Cement Plaster 1:6 upto 12' height (Internal)**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 13-c	8292.50	% SFT	2,590.50	214,817.21
ii)	**External Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
i)	3/4" thick Plaster (ONLY FOR Block masonary work) Page No. 52, Item No. 11-d	4738.75	% SFT	3,191.76	151,249.53
2	**FLOORING**				
i)	**FLOORING BASE CONC. 1:3 :6**				
a)	Cement Concrete plain including placing, compacting, finishing and curing complete including screening and washing at stone aggregate with out shuttering. (Ref. Item No 5 h, Page No16 1:3:6 Conc. Plain	846.94	% CFT	12,595.00	106,671.78
b)	Do 1:2:4 Concrete	86.46	% CFT	14,429.25	12,475.53
(ii)	**GLAZED FLOOR TILES (PORCELEAN)**				
a)	Laying floor of approved colour glazed tiles 1/4" thick in white cement and pigment on a bed of 3/4" thick Cement mortar 1:2 Item No 25 Page No 43	2997.75	% SFT	27,747.06	831,787.49
b)	BUT IN BATH ROOMS (NON SKID)	385	% SFT	27,747.06	106,826.18
3	**DADO & SKIRTING**				
i)	**GLAZED TILES ON DADO & SKIRTING 6" THICK IN ROOMS & CORRIDORS**				
	Glazed tiles dado 1/4" thick laid in pigment over cement sand mortar 3/4" thick including finishing. Item No 38 Page No 45	465.25	% SFT	28299.3	131,662.49
ii)	**GLAZED TILES ON DADO & SKIRTING**				
	Do- But in Bath Rooms upto 7-0" height	1529.50	% SFT	28299.3	432,837.79
iii)	**IN Kitchen UPTO 2'-0"**	188.00	% SFT	28299.3	53,202.68
4	**WOOD WORK**				
a)	**PANELLED DOOR**				
	First Class Deodar Wood Wrought ,Joinery in doors & Windows etc fixed in position including chowkhats hold fasts, hinges,iron tower bolts, chock cleats, handles and chords with hooks etc, Dodar Panelled or Panelled and Glazed or fully glazed 2" thick Item No 7 (a) Page 58.	80.00	PSft	1336.59	106,927.20
b)	**HOLLOW CORE FLUSH DOOR**				
	Providing & Fixing in Position door Windows & ventilators for Ist Class Deodar wood frames 1-1/2" thick and teak wood ply shutters of First Class deodar wood skeleton (Solid) stiled and ply wood Stiled and rail core of Partal wood and teak ply wood (3ply) on both sides including hold fasts, hinges, Aldrops, Iron Tower Bolts handles Cleats with cords etc Complete. Item No 51 Page No 51	367.50	SFT	1245.96	457,890.30
C	**WOODEN ARCHIVES**				
	Providing and Fixing with sunk iron screws wooden Archives approved design /shape having width not less than 2-1/2 inches as directed by Engineer Incharge. (Item No 60 Page No 66)	577.00	RFT	49.97	28,832.69
5	**PAINT**				
(i)	**CEILING DESTEMPER**				
	Distempering three coats page no 54 item no 24 c	3387.75	% SFT	1079.65	36,575.84
ii)	**INTERNAL WALL PAINTING**				
	Preparing the surface and painting with matt finish Enamel including rubbing the surface with bathy (silicon carbide rubbing brick) filling the voids with zink / chalk / plaster of paris mixture, applying first coat premix, making the surface smooth and then painting 3 coats with matt finish of approved make etc. complete (new surface). Page No. 55, Item No. 36A+36-b. (3 Coats)	8292.50	% SFT	3,444.38	285,625.21

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(C)	**SECOND FLOOR**				
5	**PAINT (CONTD.)**				
iii)	**EXTERNAL WALL PAINTING**				
	Preparing the Surface and painting with Weather Coat i/c Rubbing the surface with rubbing brick/sand paper, filling the voids with chalk /plaster of Paris and then paintining with weather coat of approved make (3 Coats) Page No 56 Item no 38-a & B	4738.75	% SFT	2567.95	121,688.73
iv)	**PAINT OVER IRON SURFACE**				
	Preparing surfaces & Painting Guard bars Gates, iron bars, gratins, railings including standard braces three coats Item No 5(d) Page No 70	1845.63	% SFT	1270.83	23,454.82
v)	**PAINT OVER WOODEN SURFACE**				
	French Polish Complete on new works. Item No 7(a) Page No71	2421.50	% SFT	3841.75	93,027.98
vi)	**SOLINGUM PAINT**				
	Solingum Painting Two Coats Applied Hot Item No 12 Page No 71.	1857.00	% SFT	869	16,137.33
6	**EXTRA LABOUR FOR CONC.**				
	Extra labour for laying Concrete plain or reinforced 20'-0" to 40'-0"	900.00	% CFT	1210	10,890.00
	TOTAL COST IN PKR SECOND FLOOR BASED ON CSR				**3,307,164.78**
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(C)	**SECOND FLOOR**				
	ADDITIONAL COST DUE TO ADDENDA I,II&III				
1	**CEMENT**				
	Adding Cost of Difference of Ordinary Port Land Cement Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	350.00	BAGS	325	113,750.00
2	**SAND**				
	Adding Cost of Difference of Fine Sand Aggregate as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	2500.00	CFT	4.75	11,875.00
3	**CRUSH**				
	Adding Cost of Difference of Coarse Aggregate (Crushed Stone) as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	3000.00	CFT	10.66	31,980.00
4	**WOOD**				
	Adding Cost of Difference of Deodar Wood Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	100.51	CFT	5500	552,805.00
	ADDITIONAL COST DUE TO ADDENDA I,II&III SECOND FLOOR				**710,410.00**

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(C)	**THIRD FLOOR**				
1	**RENDERING (PLASTER)**				
i)	**Internal Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 11-B	3387.75	% SFT	2,496.76	84,583.99
b)	**Cement Plaster 1:6 upto 12' height (Internal)**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 13-c	3553.75	% SFT	2,590.50	92,059.89
ii)	**External Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
i)	3/4" thick Plaster (ONLY FOR Block masonary work) Page No. 52, Item No. 11-d	8292.50	% SFT	3,191.76	264,676.70
2	**FLOORING**				
i)	**FLOORING BASE CONC. 1:3 :6**				
a)	Cement Concrete plain including placing, compacting, finishing and curing complete including screening and washing at stone aggregate with out shuttering. (Ref. Item No 5 h, Page No16 1:3:6 Conc. Plain	846.94	% CFT	12,595.00	106,671.78
b)	Do 1:2:4 Concrete	86.46	% CFT	14,429.25	12,475.53
(ii)	**GLAZED FLOOR TILES**				
a)	Laying floor of approved colour glazed tiles 1/4" thick in white cement and pigment on a bed of 3/4" thick Cement mortar 1:2 Item No 25 Page No 43	2997.75	% SFT	27,747.06	831,787.49
b)	BUT IN BATH ROOMS	385	% SFT	27,747.06	106,826.18
3	**DADO & SKIRTING**				
i)	**GLAZED TILES ON DADO & SKIRTING 6" THICK IN ROOMS & CORRIDORS**				
	Glazed tiles dado 1/4" thick laid in pigment over cement sand mortar 3/4" thick including finishing. Item No 38 Page No 45	465.25	% SFT	28299.3	131,662.49
ii)	**GLAZED TILES ON DADO & SKIRTING 7'-0" height IN bath ROOMS**				
	Do- but in bath rooms upto 7-0" height	1529.50	% SFT	28299.3	432,837.79
iii)	**GLAZED TILES ON DADO & SKIRTING 2'-0" height IN Kitchen**	188.00	% SFT	28299.3	53,202.68
4	**WOOD WORK**				
(i)	First Class Deodar Wood Wrought ,Joinery in doors & Windows etc fixed in position including chowkhats hold fasts, hinges,iron tower bolts, chock cleats, handles and chords with hooks etc, Dodar Panelled or Panelled and Glazed or fully glazed 2" thick Item No 7 (a) Page 58.	80.00	PSft	1336.59	106,927.20
ii)	Providing & Fixing in Position door Windows & ventilators for Ist Class Deodar wood frames 1-1/2" thick and teak wood ply shutters of First Class deodar wood skeleton (Solid) stiled and ply wood Stiled and rail core of Partal wood and teak ply wood (3ply) on both sides including hold fasts, hinges, Aldrops, Iron Tower Bolts handles Cleats with cords etc Complete. Item No 51 Page No 51	367.50	SFT	1245.96	457,890.30
iii)	Providing and Fixing with sunk iron screws wooden Archives approved design /shape having width not less than 2-1/2 inches as directed by Engineer Incharge. (Item No 60 Page No 66)	577.00	RFT	49.97	28,832.69
5	**PAINT**				
(i)	**CEILING DESTEMPER**				
	Distempering three coats page no 54 item no 24 c	3387.75	% SFT	1079.65	36,575.84
ii)	**INTERNAL WALL PAINTING**				
	Preparing the surface and painting with matt finish Enamel including rubbing the surface with bathy (silicon carbide rubbing brick) filling the voids with zink / chalk / plaster of paris mixture, applying first coat premix, making the surface smooth and then painting 3 coats with matt finish of approved make etc. complete (new surface). Page No. 55, Item No. 36A+36-b. (3 Coats)	8292.50	% SFT	3,444.38	285,625.21

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
iii)	**EXTERNAL WALL PAINTING**				
	Preparing the Surface and painting with Weather Coat i/c Rubbing the surface with rubbing brick/sand paper, filling the voids with chalk /plaster of Paris and then paintining with weather coat of approved make (3 Coats) Page No 56 Item no 38-a & B	4738.75	% SFT	2567.95	121,688.73
iv)	**PAINT OVER IRON SURFACE**				
	Preparing surfaces & Painting Guard bars Gates, iron bars, gratins, railings including standard braces three coats Item No 5(d) Page No 70	1845.63	% SFT	1270.83	23,454.82
v)	**PAINT OVER WOODEN SURFACE**				
	French Polish Complete on new works. Item No 7(a) Page No71	2421.50	% SFT	3841.75	93,027.98
vi)	**SOLINGUM PAINT**				
	Solingum Painting Two Coats Applied Hot Item No 12 Page No 71.	1857.00	% SFT	869	16,137.33
6	**EXTRA LABOUR**				
a	Extra Labour for Block masonary Item No 30 Page No 19	13031.25	% SFT	1191.09	155,213.92
b	Extra labour for lifting of Steel above first floor for every additional floor	302.95	CWT	302.5	91,642.38
c	Extra Labour for Concrete plain or reinforced (a) 20'-0" ~ 40'-0"	3875.00	% CFT	1210.03	46,888.66
	TOTAL COST IN PKR THIRD FLOOR BASED ON CSR				**3,580,689.58**

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(C)	**THIRD FLOOR**				
	ADDITIONAL COST DUE TO ADDENDA I,II&III THIRD FLOOR				
1	**CEMENT**				
	Adding Cost of Difference of Ordinary Port Land Cement Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	350.00	BAGS	325	113,750.00
2	**SAND**				
	Adding Cost of Difference of Fine Sand Aggregate as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	2000.00	CFT	4.75	9,500.00
4	**CRUSH**				
	Adding Cost of Difference of Coarse Aggregate (Crushed Stone) as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	2550.00	CFT	10.66	27,183.00
5	**WOOD**				
	Adding Cost of Difference of Deodar Wood Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	100.51	CFT	5500	552,805.00
	ADDITIONAL COST DUE TO ADDENDA I,II&III THIRD FLOOR				**703,238.00**
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
	(FOURTH FLOOR)				
1	**RENDERING (PLASTER)**				
i)	**Internal Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 11-B	332.00	% SFT	2,496.76	8,289.24
	DO- BUT OHT	288.00	% SFT	2,496.76	7,190.67
b)	**Cement Plaster 1:6 upto 12' height (Internal)**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 13-c	2530.00	% SFT	2,590.50	65,539.65
	DO- BUT OHT	676.00	% SFT	2,590.50	17,511.78
ii)	**External Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
i)	3/4" thick Plaster (ONLY FOR Block masonary work) Page No. 52, Item No. 11-d	2558.00	% SFT	3,191.76	81,645.22
	DO- BUT OHT	676.00	% SFT	3,191.76	21,576.30
2	**FLOORING**				
i)	**FLOORING BASE CONC. 1:3 :6**				
a)	Cement Concrete plain including placing, compacting, finishing and curing complete including screening and washing at stone aggregate with out shuttering. (Ref. Item No 5 h, Page No16 1:3:6 Conc. Plain	83.00	% CFT	12,595.00	10,453.85
b)	Do 1:2:4 Concrete	72.00	% CFT	14,429.25	10,389.06
(ii)	**GLAZED FLOOR TILES**				
a)	Laying floor of approved colour glazed tiles 1/4" thick in white cement and pigment on a bed of 3/4" thick Cement mortar 1:2 Item No 25 Page No 43	332.00	% SFT	27,747.06	92,120.24
3	**DADO & SKIRTING**				
i)	**GLAZED TILES ON DADO & SKIRTING 6" THICK IN ROOMS & CORRIDORS**				
	Glazed tiles dado 1/4" thick laid in pigment over cement sand mortar 3/4" thick including finishing. Item No 38 Page No 45	46.00	% SFT	28299.3	13,017.68

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
	supplying and fixing in position iron /steel grill of 3/4"x1/4" size flat iron of approved design including painting 3 coats etc. (weight not to be less than 3.7 lbs /sft of finished grill) Item No 26 Page No93	56.00	Psft	180.5	10,108.00
4	**WOOD WORK**				
(i)	First Class Deodar Wood Wrought ,Joinery in doors & Windows etc fixed in position including chowkhats hold fasts, hinges,iron tower bolts, chock cleats, handles and chords with hooks etc, Dodar Panelled or Panelled and Glazed or fully glazed 2" thick Item No 7 (a) Page 58.	49.00	PSft	1336.59	65,492.91
5	**PAINT**				
(i)	**CEILING DESTEMPER**				
	Distempering three coats page no 54 item no 24 c	332.00	% SFT	1079.65	3,584.44
ii)	**INTERNAL WALL PAINTING**				
	Preparing the surface and painting with matt finish Enamel including rubbing the surface with bathy (silicon carbide rubbing brick) filling the voids with zink / chalk / plaster of paris mixture, applying first coat premix, making the surface smooth and then painting 3 coats with matt finish of approved make etc. complete (new surface). Page No. 55, Item No. 36A+36-b. (3 Coats)	2530.00	% SFT	3,444.38	87,142.81
iii)	**EXTERNAL WALL PAINTING**				
	Preparing the Surface and painting with Weather Coat i/c Rubbing the surface with rubbing brick/sand paper, filling the voids with chalk /plaster of Paris and then paintining with weather coat of approved make (3 Coats) Page No 56 Item no 38-a & B	2558.00	% SFT	2567.95	65,688.16
iv)	**PAINT OVER IRON SURFACE**				
	Preparing surfaces & Painting Guard bars Gates, iron bars, gratins, railings including standard braces three coats Item No 5(d) Page No 70	112.00	% SFT	1270.83	1,423.33
v)	**PAINT OVER WOODEN SURFACE**				
	French Polish Complete on new works. Item No 7(a) Page No71	98.00	% SFT	3841.75	3,764.92
vi)	**SOLINGUM PAINT**				
	Solingum Painting Two Coats Applied Hot Item No 12 Page No 71.	63.00	% SFT	869	547.47
6	EXTRA LABOUR				
a	Extra Labour for Block masonary Item No 30 Page No 19	4225.25	% SFT	1191.09	50,326.53
b	Extra labour for lifting of Steel above first floor for every additional floor	310.25	CWT	302.5	93,850.63
c	Extra Labour for Concrete plain or reinforced (a) 20'-0" ~ 40'-0"	3875.00	% CFT	1210.03	46,888.66
	TOTAL COST IN PKR FOURTH FLOOR BASED ON CSR				**756,551.54**

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
	ADDITIONAL COST DUE TO ADDENDA I,II&III				
1	**CEMENT**				
	Adding Cost of Difference of Ordinary Port Land Cement Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	150.00	BAGS	325	48,750.00
2	**SAND**				
	Adding Cost of Difference of Fine Sand Aggregate as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	650.00	CFT	4.75	3,087.50
3	**CRUSH**				
	Adding Cost of Difference of Coarse Aggregate (Crushed Stone) as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	800.00	CFT	10.66	8,528.00
4	**WOOD**				
	Adding Cost of Difference of Deodar Wood Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	8.50	CFT	5500	46,750.00
	ADDITIONAL COST DUE TO ADDENDA I,II&III FOURTH FLOOR				**107,115.50**
A	**MAIN BUILDING**				
	SECTION B UNDER GROUND WATER TANK 14500 GLNS (ONE TANK QTY.)				
1	**TERMITE PROOFING**				
	Providing anti-termite treatment by spraying / sprinkling / spreading Neptachler 0.5% Emulsion as an overall pre-construction treatment in slab type construction under the slab and attached perches or entrances etc. complete in all respect as per directions of the Engineer-in-Charge (Page No. 108, Item No. 92)	1329.75	SFT	9.74	12,951.77
2	**STONE SOLING**				
	Stone pitching including sub-base with hammer dressed stone on surface laid in courses including carriage of materials chains. (Page No. 32, Item No. 23) 6" THICK	185.63	%Cft	5,377.63	9,982.23
3	**LEAN CONCRETE**				
i)	Cement concrete plain including placing compacting, finishing and curing complete (including screining and washing at stone aggregate without shuttering (Page No. 16, Item No. 5-i) 1:4:8 Concrete				
a)	Under Footing	371	% CFT	11,288.75	41,909.48
4	**POLY ETHYLENE SHEET**				
	Providing and laying single per layer of polyethylene sheet 0.13 mm thick for water proofing as per specification and instruction of Engineer Incharge (Page No. 38, Item No. 38).	371	SFT	10.70	3,972.38
5	**FORM WORK**				
	Erection and Removal of Centering for RCC or Plain Cement Concrete of Class ii Partal Wood Vertical Item No (ii) Page 18	0.00	%SFT	3,127.41	0.00
6	**DAMP PROOF COURSE**				
(i)	**VERTICAL DPC**				
	Verticle DPC of 3/4" thick CSM plaster 1:2 with Bitumen at 20 LBs per %Sft Item No70 Page No 107	828.00	% SFT	2,760.99	22,861.00
7	**RENDERING (PLASTER)**				
i)	**Internal Plaster**				
a)	**Cement Plaster 1:4 upto 12' height**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 11-B	266.00	% SFT	2,496.76	6,641.38
b)	**Cement Plaster 1:6 upto 12' height (Internal)**				
	1/2" thick Plaster (for ceiling and wall) Page No. 52, Item No. 13-c	594.00	% SFT	2,590.50	15,387.57

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SUMMARY OF COST					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**S/RATE 2012**	**AMOUNT**
ii)	**External Plaster (in two coats)**				
a)	**Cement Plaster 1:4 upto 12' height**				
i)	3/4" thick Plaster (ONLY FOR Block masonary work) Page No. 52, Item No. 11-d	828.00	% SFT	3,191.76	26,427.77
8	**FLOORING**				
i)	**FLOORING BASE CONC. 1:3 :6**				
a)	Cement Concrete plain including placing, compacting, finishing and curing complete including screening and washing at stone aggregate with out shuttering. (Ref. Item No 5 h, Page No16 1:3:6 Conc. Plain	66.50	% CFT	12,595.00	8,375.68
b)	Do 1:2:4 Concrete	96.00	% CFT	14,429.25	13,852.08
9	ADD EXTRA FOR USING SR CEMENT	350.00	BAGS	40	14,000.00
	TOTAL COST IN PKR BASED ON CSR FOR ONE TANK				**176,361.33**
	TOTAL COST IN PKR BASED ON CSR FOR TWO TANKS				**352,722.65**
	ADDITIONAL COST DUE TO ADDENDA I,II&III				
1	**CEMENT**				
	Adding Cost of Difference of Ordinary Port Land Cement Cost as per notification dated 1st Dec 2021 letter No Case No IV/2(IV)-SO Rates Addendum & Corrigendum No-2	65.00	BAGS	325	21,125.00
2	**SAND**				
	Adding Cost of Difference of Fine Sand Aggregate as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	300.00	CFT	4.75	1,425.00
3	**CRUSH**				
	Adding Cost of Difference of Coarse Aggregate (Crushed Stone) as per notification dated Case No iv/2 (iv/SO (Rates)/2009 Addendum & Corrigendum No 3 Dated 17th Feb 2022	500.00	CFT	10.66	5,330.00
	ADDITIONAL COST DUE TO ADDENDA I,II&III UNDER GROUND TANK 14000GLS ONE TANK				**27,880.00**
	COST FOR TWO TANKS				**55,760.00**

C	**ROADS &,PATH**				
C-1	**ROADS**				
1	**SECTION C-1 EARTH WORKS**				
a	**CLEARIN&GRUBBING**				
	Clearing and grubbing the site by cutting, uprooting and removing all rubbish and shrubs including disposal to (outside limits) designated places. ITEM NO 1 PAGE 1 VOL-III PART-V1 ROADS & HIGH WAYS CSR 2012	43216	%SFT	97.07	4,194,977.12
b	**COMPACTION OF NGL**				
	Compaction of Natural Ground upto a depth of 20cm (8"inch) below the natural ground level compacted upto 90% density modified AASHTO. ITEM NO-2 PAGE NO 1 CSR 2012 VOL-III PART VI	43216	%SFT	177.56	7,673,432.96
2	**PRE - CAST CURB BLOCK**				
	Providing & fixing Precast Edge Block 3750 PSI Industrial Made Size 6 inches thick x 12 inches long x 18 inches high including the cost of Cartage, excavation, form Work for haunching, 1450 PSI lean concrete, 2250 PSI concrete for haunching, 1:4 cement sand mortor.ITEM NO 14 PAGE NO 16 VOL-III PART VI CSR 2012	1700.00	RFT	297.01	504,917.00

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SUMMARY OF COST					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**S/RATE 2012**	**AMOUNT**
3	**CC PAVER**				
I	**NATURAL COLOUR**				
	Providing & fixing cement paving blocks flooring having size of 197 x 97 x 60 (mm) of city /quddra / cobble shape with natural colours , having strength b/w 5000 PSI to 8500 PSI i/c filling the joints with hill sand and laying in specified manner/ pattern and design etc complete ITEM NO 68 CH 8 PAGE NO 76 CSR 2022	25472.00	SFT	203.91	5,193,995.52
II	**PIGMENTED**				
i)	Providing & fixing cement paving blocks flooring having size of 197 x 97 x 60 (mm) of city /quddra / cobble shape with natural colours , having strength b/w 5000 PSI to 8500 PSI i/c filling the joints with hill sand and laying in specified manner/ pattern and design etc complete ITEM NO 69 CH 8 PAGE NO 76 CSR 2022	6,368	SFT	224.80	1,431,526.40
	TOTAL AMOUNT OF ROADS				**18,998,849.00**
C-2	**PATH**				
1	**STONE SOLING UNDER FOOTING & FLOOR**				
	Stone filling dry hand packed as filling behind retaining walls or in ITEM NO 16 CH 6 CSR 2022	728	Cft	65.23	47,487.44
	CONCRETE WORK IN FOUNDATION				
2	**LEAN CONCRETE**				
	Cement concrete brick or stone ballast 1 1/2" to 2" gauge. (b) Ratio 1 : 4 : 8 ITEM NO 4(b) CH-4 CSR 2022				
a)	Under Footing	240	CFT	292.43	70,183.20
3	**PLASTER RENDERING**				
i)	**Internal Plaster**				
a)	**Cement Plaster 1:4 ON WALLS**				
i)	Cement plaster 1:4 upto 12' height upto 20 ft. (6.10 metre) height. (b) 3/4" thick .ITEM NO 11(c) CH-9 CSR 2022	5096.00	SFT	54.37	277,069.52
4	EXTRA FOR USING SULPHATE CEMENT	200.00	BAGS	50.00	10,000.00
5	EXTRA FOR WATER PROOFING AGENT (PUDLO)	50.00	KG	220.00	11,000.00
6	**CC PAVER**				
I	**NATURAL COLOUR**				
	Providing & fixing cement paving blocks flooring having size of 197 x 97 x 60 (mm) of city /quddra / cobble shape with natural colours , having strength b/w 5000 PSI to 8500 PSI i/c filling the joints with hill sand and laying in specified manner/ pattern and design etc complete ITEM NO 68 CH 8 PAGE NO 76 CSR 2022	8000.00	SFT	203.91	1,631,280.00
II	**PIGMENTED**				
i)	Providing & fixing cement paving blocks flooring having size of 197 x 97 x 60 (mm) of city /quddra / cobble shape with natural colours , having strength b/w 5000 PSI to 8500 PSI i/c filling the joints with hill sand and laying in specified manner/ pattern and design etc complete ITEM NO 69 CH 8 PAGE NO 76 CSR 2022	2,000	SFT	224.80	449,600.00
	TOTAL AMOUNT OF PATHS				**2,496,620.16**

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SUMMARY OF COST

S.NO	DESCRIPTION	QTY	UNIT	S/RATE 2012	AMOUNT
D	**RAIN WATER DISPOSAL**				
1	**Excavation**				
a	**Excavation for Pipe line in trenches and pits in hard soils including trimming and dressing sides to true algnment and shape levelling of beds of trench to correct level and grades cutting joint holes and disposal of surplus earth within one chain as directed by Engineer Incharges. Providing fence guards, lights, flag and temporary crossings for non vehicular traffic where ever required lift upto 5'-0" and lead upto one chain. Item No 3 Ch-II Page 61**	15,001.00	% 0 CFT	3,900.00	**58,503.90**
b	**Excavation for Pipe line in trenches and pits in soft rock by hammering and chieseling including trimming and dressing sides to true algnment and shape levelling of beds of trench to correct level and grades cutting joint holes and disposal of surplus earth within one chain as directed by Engineer Incharges. Providing fence guards, lights, flag and temporary crossings for non vehicular traffic where ever required lift upto 5'-0" and lead upto one chain. Item No 3 Ch-II Page 61**	2,890.00	% 0 CFT	10,770.00	**31,125.30**
2	**Providing and laying UPVC pipe of Class B , fixing in trench and jointing with Solvent cement including testing with water to a head of 200 ft. Item No 4 Page No23 Chapter II.**				
a	**6" (150)mm**	640.00	Rft	259.00	**165,760.00**
b	**8" (200)mm**	250.00	Rft	397.00	**99,250.00**
3	**Constructing Man Hole or Inspection Chamber Internal size 2'-0"x2'-0"x3'-6" with walls of Block Masonary in Cement sand Mortar and 1:3 CSM Plater, 1/2" thick inside and 1" thick out side over benching ad channel including fixing CI Man Hole cover 1-1/2'x1-1/2 ' of 1.75 CWT (88.9)Kg embedded in plain CC complete as per Standard specification and drawing. Item No 1 Page 46 Chapter II.**	20.00	No	14,768.00	**295,360.00**
	Total Amount				**649,999.20**
	SAY				**650,000.00**

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ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
A	**MAIN BUILDING**				
	SECTION A-1 CIVIL WORKS				
(a)	**GROUND FLOOR**				
1	**EXCAVATION FOR FOUNDATION**				
a	Earth-work excavation by using Excavator and dumper lead upto 100-ft. from the building line as per direction of Engineer Incharge IN ORDINARY SOIL	17,347	Cft		
b	Earth-work excavation by Excavator and loader lead upto 100-ft. from the building line as per direction of Engineer Incharge IN GRAVEL/CONGLOMERATE	3,500	Cft		
2	**BACK FILLING**				
a)	**USING EXCAVATED AVAILABLE EARTH AT SITE**				
	Filling, watering and ramming earth in foundation, under floor with s earth from foundation excavation etc. as per specification	22,303	Cft		
b	**EARTH FILLING FROM BROUGHT OUT SIDE OF THE SITE**				
	Supply, place and compact in layers of 6" thick compacted thickness to 95% Modified Proctor's Relative Dry Density, approved selected earth brought from outside ANY LEAD to soil groups GM, SW, and ML as per ASTM D2487-85 (as amended) (classification of soil for engineering purpose) including cost of laboratory and field tests, spreading , leveling, watering and compaction etc; complete in all respect as per drawing and specifications and as instructed by the ENGINEER INCHARGE.	5647.5	CFT		
3	**BLOCK MASONARY**				
a)	**SOLID**				
i)	**6 " OR BELOW THICKNESS**				
	Providing and laying Cement Concrete solid Machine made block Type B minimum compressive Strength 1000 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 CSM CEMENT SAND MORTAR in ground floor Super Structure including raking out joints and curing etc. complete. Izhar, Banu Mukhtar Envicrete or equivalent.	1756.75	Cft		
b)	**HOLLOW BLOCK 6"THICK**				
	Providing and laying CC Hollow Machine made block minimum compressive Strength 725 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 in ground floor including raking out joints and curing etc. complete.	1695.46	CFT		

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ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
4	**STRUCTURAL CONCRETE**				
a)	**UP TO PLINTH LEVEL**				
	Providing and laying Ready mix reinforced cement concrete Grade M20 having Compressive Cyliderical strength 20 MPa (3000 PSI) strength at 28 days including all kinds of formwork, and necessary framing for support, hoisting, placing, compacting, finishing, curing complete in all respect as shown on the drawing and as per specifications. (Submission & approval of Mix Design is mandatory if concrete is to be produced at site), as per specification.				
I)	**COLUMN FOOTING**	2710.97	CFT		
(II)	**COLUMN PEDESTAL**	447.9	CFT		
(III)	**PLINTH BEAM**	981.282	CFT		
IV)	**WALLS UPTO PLINTH**	245	CFT		
V)	**RAMP**	75	CFT		
b)	**UPTO GROUND FLOOR ROOF LEVEL**				
I)	**COLUMN**	726.50	CFT		
(II)	**BEAMS**	700.23	CFT		
(III)	**SLAB & PROJECTIONS**	1825	CFT		
(IV)	**STAIR STEPS & LANDINGS**	102.88	CFT		
(V)	**LIFT WALLS**	168	CFT		
IV)	**LINTOL**	264	CFT		
5	**Steel Reinforcement**				
	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and under ground tanks and in projections for future extension 166 / 114/ 22) .				
a)	UPTO PLINTH LEVEL	255.5	CWT		

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ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
b)	UPTO GROUND FLOOR LEVEL	328.5	CWT		
6	**MS SECURITY GRILLS**				
	Providing and fixing in position iron steel grill of angle iron and square bar of required size 3/4"x1/4" size flat iron/3/4" X3/4" SQ BAR of approved design including welding all sides and painting 3 coats etc. (weight not to be less than 3.7 lbs /sft of finished grill)	922.82	Psft		
7	**ALUMINUM WINDOWS /VENTILATORS**				
a)	**SLIDING**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Sliding Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) &Aluminum fly screen including handles, stoppers & locking arrangement etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass & net.	462.00	Psft		
b)	**FIXED PANEL**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Fixed Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass .	50.00	Psft		
c)	**FREE STANDING GLASS PARTITION**				
	Providing & fixing 1/2"thick Tempered Glass partition in Bath Room with 2'-0" single leaf swing door including Aluminum bottom & top frame as per drawing.	2	Each		
8	**STAIR CASE HAND RAIL**				
	Providing and fixing MS Square Pipe Railing 38mm (1-1/2") x38mm size 16 SWG comprising of verticle posts and horizontal bracng of the same size as per design including cost of fabrication, welding fitting embedding in walls and floors as required as per detail and design shown on drawing including all labour and materials tools and plants required.	76	RFT		
9	**MARBLE ON TREAD**				
	Providing and fixing 1"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 1'-0" width including grinding, polishing, 3/4" chamfer nosing including three no carbondum strips and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	20	Each		
10	**MARBLE ON RISER**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 0'-6" width including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	21	Each		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
11	**MARBLE ON LANDING**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)1-'0" long and 1'-0" width ON LANDING including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	48	SFT		
12	**MARBLE SKIRTING 6" HIGH**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) skirting including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	32	RFT		
13	**MARBLE TILE ON FAÇADE**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) on lift facade including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	171	SFT		
14	**PATTA PLASTER 6" WIDE AND 2-0" TH.**				
	Providing & laying 1:4 CSM Patta Plaster 4" WIDE & av. 1-1/2" thick in two layers around windows as per shown on drawing as per direction of Engineer.	404	RFT		
15	**REAR SIDE HOLLOW PIPE GRILL**				
	Providing, fabricating & Laying Hollow Cold drawn section 4"x2" 18 SWG welding, grinding, painting three coats in approved shade including one coat anti corrosive primer as per drawing.	144	SFT		
16	**WARD ROBE**				
	Providing and install wardrobe comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the Engineer.	168	SFT		
17	**KITCHEN COUNTER TOP**				
	Provide and fix counter top as per detail consisting of 3/4" thick chemically pre polished granite of approved sample with round edges, sealing the edges with imported epoxy filling resting on RCC slab, cutting the slab for sink etc.complete in all respect as per drawing, specifications and as instructed by the Engineer.	88	SFT		

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ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
18	**KITCHEN CABINET FLOOR MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the Engineer.	44	RFT		
19	**KITCHEN CABINET WALL MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, complete in all respect as per drawing and specifications and as instructed by the Engineer.	32	RFT		
20	**VANITY TOP**				
	Provide and fix Vanity top as per detail consisting of 3/4" thick chemically pre polished granite of approved sample with round edges, sealing the edges with imported epoxy filling resting on RCC slab, cutting the slab for sink/ Basin etc.complete in all respect as per drawing, specifications and as instructed by the Engineer. Base Rate Rs. 800/sft)	48	SFT		
20	**FALSE CEILING**				
	Provide and install in position 1/2" thick gypsum board (Thermec or approved equivalent) false ceiling (revealed edges) with G.I framework of approved section including all acessories, G.I hanging system with approved fiber tape on joints, cutting out openings for all lights fixtures, linear grills and diffusers including wooden/gypsum light pelmet as shown and providing 1"x1"x16-18 SWG 'U' channel or angle for protection of edges where ever required etc including matt enamel paint(ICI/BERGER), after installation in the reqd number of coats, complete in all respect as per drawing, specifications and as instructed by the Engineer.	402	SFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE ABSTRACT OF COST COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
15	**Pantry Cabinets**				
	Providing and install Wooden Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the architect.	24	SFT		
	TOTAL AMOUNT				
A	**MAIN BUILDING**				
	SECTION A-2 CIVIL WORKS				
(b)	**FIRST FLOOR**				
1	**STRUCTURAL CONCRETE**				
	Providing and laying reinforced cement concrete Grade M20 having Compressive Cyliderical strength 20 MPa (2900 PSI) at 28 days including all kinds of formwork, and necessary framing for support, hoisting, placing, compacting, finishing, curing complete in all respect as shown on the drawing and as.per specifications. (Submission & approval of Mix Design is mandatory as per specification.				
(I)	Columns in super structure	717	CFT		
(II)	Beams	700	CFT		
(III)	Slabs / projection etc	1,825	CFT		
(IV)	Staircase steps, Landing waist etc	103	CFT		
(V)	WALLS	168	CFT		
(VI)	LINTOL OVER DOORS & WINDOWS	362	CFT		
2	**Steel Reinforcement**				
	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and under ground tanks and in projections for future extension 166 / 114/ 22) .	310	CWT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
3	**BLOCK MASONARY**				
a)	**SOLID**				
i)	**6 " OR BELOW THICKNESS**				
	Providing and laying Cement Concrete solidMachine made block Type B minimum compressive Strength 1000 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 CSM CEMENT SAND MORTAR in ground floor Super Structure including raking out joints and curing etc. complete. Izhar, Banu Mukhtar Envicrete or equivalent.	1756.75	Cft		
b)	**HOLLOW BLOCK 6"THICK**				
	Providing and laying CC Hollow Machine made block minimum compressive Strength 725 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 in ground floor including raking out joints and curing etc. complete.	1695.45	CFT		
4	**MS SECURITY GRILLS**				
	Providing and fixing in position iron steel grill of angle iron and square bar of required size 3/4"x1/4" size flat iron/3/4" X3/4" SQ BAR of approved design including welding all sides and painting 3 coats etc. (weight not to be less than 3.7 lbs /sft of finished grill)	922.85	Psft		
5	**ALUMINUM WINDOWS /VENTILATORS**				
a)	**SLIDING**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Sliding Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) &Aluminum fly screen including handles, stoppers & locking arrangement etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass & net.	462.00	Psft		
b)	**FIXED PANEL**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Fixed Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass .	50.00	Psft		
c)	**FREE STANDING GLASS PARTITION**				
	Providing & fixing 1/2"thick Tempered Glass partition in Bath Room with 2'-0" single leaf swing door including Aluminum bottom & top frame as per drawing.	2	Each		
6	**STAIR CASE HAND RAIL**				
	Providing and fixing MS Square Pipe Railing 38mm (1-1/2") x38mm size 16 SWG comprising of verticle posts and horizontal bracng of the same size as per design including cost of fabrication, welding fitting embedding in walls and floors as required as per detail and design shown on drawing including all labour and materials tools and plants required.	64	RFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
7	**MARBLE ON TREAD**				
	Providing and fixing 1"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 1'-0" width including grinding, polishing, 3/4" chamfer nosing including three no carbondum strips and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	20	Each		
8	**MARBLE ON RISER**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 0'-6" width including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	21	Each		
9	**MARBLE ON LANDING**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)1-'0" long and 1'-0" width ON LANDING including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	48	SFT		
10	**MARBLE SKIRTING 6" HIGH**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) skirting including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	32	RFT		
11	**MARBLE TILE ON FAÇADE**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) on lift facade including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	192	SFT		
12	**PATTA PLASTER 6" WIDE AND 2-0" TH.**				
	Providing & laying 1:4 CSM Patta Plaster 4" WIDE & av. 1-1/2" thick in two layers around windows as per shown on drawing as per direction of Engineer.	171	RFT		
13	**REAR SIDE HOLLOW PIPE GRILL**				
	Providing, fabricating & Laying Hollow Cold drawn section 4"x2" 18 SWG welding, grinding, painting three coats in approved shade including one coat anti corrosive primer as per drawing.	144	SFT		
14	**KITCHEN CABINET FLOOR MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the Engineer.	44	RFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
15	**KITCHEN CABINET WALL MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, complete in all respect as per drawing and specifications and as instructed by the Engineer.	32	RFT		
16	**VANITY TOP**				
	Provide and fix Vanity top as per detail consisting of 3/4" thick chemically pre polished granite of approved sample with round edges, sealing the edges with imported epoxy filling resting on RCC slab, cutting the slab for sink/ Basin etc.complete in all respect as per drawing, specifications and as instructed by the Engineer. Base Rate Rs. 800/sft)	48	SFT		
17	**FALSE CEILING**				
	Provide and install in position 1/2" thick gypsum board (Thermec or approved equivalent) false ceiling (revealed edges) with G.I framework of approved section including all acessories, G.I hanging system with approved fiber tape on joints, cutting out openings for all lights fixtures, linear grills and diffusers including wooden/gypsum light pelmet as shown and providing 1"x1"x16-18 SWG 'U' channel or angle for protection of edges where ever required etc including matt enamel paint(ICI/BERGER), after installation in the reqd number of coats, complete in all respect as per drawing, specifications and as instructed by the Engineer.	48	SFT		
18	**Pantry Cabinets**				
	Providing and install Wooden Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the architect.	48	SFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
	TOTAL AMOUNT FOR NON SCH. ITEM FIRST FLOOR				
A	**MAIN BUILDING**				
	SECTION A-2 CIVIL WORKS				
(C)	**SECOND FLOOR**				
1	**STRUCTURAL CONCRETE**				
	Providing and laying reinforced cement concrete Grade M20 having Compressive cube strength 20 MPa (2900 PSI) Cube strength at 28 days nominal mix ratio 1:1-1/2: 3 (cement, fine & coarse aggregates) including all kinds of formwork, and necessary framing for support, hoisting, placing, compacting, finishing, curing complete in all respect as shown on the drawing and as.per specifications. (Submission & approval of Mix Design is mandatory as per specification.				
(I)	Columns in super structure	717	CFT		
(II)	Beams	700	CFT		
(III)	Slabs / projection etc	1,825	CFT		
(IV)	Staircase steps, Landing waist etc	103	CFT		
(V)	WALLS	168	CFT		
(VI)	LINTOL OVER DOORS & WINDOWS	362	CFT		
2	**Steel Reinforcement**				
	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and under ground tanks and in projections for future extension 166 / 114/ 22) .	310	CWT		
3	**BLOCK MASONARY**				
a)	**SOLID**				
i)	**6 " OR BELOW THICKNESS**				
	Providing and laying Cement Concrete solidMachine made block Type B minimum compressive Strength 1000 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 CSM CEMENT SAND MORTAR in ground floor Super Structure including raking out joints and curing etc. complete. Izhar, Banu Mukhtar Envicrete or equivalent.	1756.75	Cft		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
b)	**HOLLOW BLOCK 6"THICK**				
	Providing and laying CC Hollow Machine made block minimum compressive Strength 725 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 in ground floor including raking out joints and curing etc. complete.	1695.45	CFT		
4	**MS SECURITY GRILLS**				
	Providing and fixing in position iron steel grill of angle iron and square bar of required size 3/4"x1/4" size flat iron/3/4" X3/4" SQ BAR of approved design including welding all sides and painting 3 coats etc. (weight not to be less than 3.7 lbs /sft of finished grill)	922.85	Psft		
5	**ALUMINUM WINDOWS /VENTILATORS**				
a)	**SLIDING**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Sliding Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) &Aluminum fly screen including handles, stoppers & locking arrangement etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass & net.	462.00	Psft		
b)	**FIXED PANEL**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Fixed Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass .	50.00	Psft		
c)	**FREE STANDING GLASS PARTITION**				
	Providing & fixing 1/2"thick Tempered Glass partition in Bath Room with 2'-0" single leaf swing door including Aluminum bottom & top frame as per drawing.	2	Each		
6	**STAIR CASE HAND RAIL**				
	Providing and fixing MS Square Pipe Railing 38mm (1-1/2") x38mm size 16 SWG comprising of verticle posts and horizontal bracng of the same size as per design including cost of fabrication, welding fitting embedding in walls and floors as required as per detail and design shown on drawing including all labour and materials tools and plants required.	21	RFT		
7	**MARBLE ON TREAD**				
	Providing and fixing 1"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 1'-0" width including grinding, polishing, 3/4" chamfer nosing including three no carbondum strips and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	20	Each		
8	**MARBLE ON RISER**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 0'-6" width including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	21	Each		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
9	**MARBLE ON LANDING**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)1-'0" long and 1'-0" width ON LANDING including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	48	SFT		
10	**MARBLE SKIRTING 6" HIGH**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) skirting including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	32	RFT		
11	**MARBLE TILE ON FAÇADE**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) on lift facade including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	171	SFT		
12	**PATTA PLASTER 6" WIDE AND 2-0" TH.**				
	Providing & laying 1:4 CSM Patta Plaster 4" WIDE & av. 1-1/2" thick in two layers around windows as per shown on drawing as per direction of Engineer.	56	RFT		
13	**REAR SIDE HOLLOW PIPE GRILL**				
	Providing, fabricating & Laying Hollow Cold drawn section 4"x2" 18 SWG welding, grinding, painting three coats in approved shade including one coat anti corrosive primer as per drawing.	144	SFT		
14	**KITCHEN CABINET FLOOR MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the Engineer.	44	RFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE

ABSTRACT OF COST

COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES

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S.NO	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
15	**KITCHEN CABINET WALL MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, complete in all respect as per drawing and specifications and as instructed by the Engineer.	32	RFT		
16	**FREE STANDING GLASS PARTITION**				
	Providing & fixing 1/2"thick Tempered Glass partition in Bath Room with 2'-0" single leaf swing door including Aluminum bottom & top frame as per drawing.	96	SFT		
17	**VANITY TOP**				
	Provide and fix Vanity top as per detail consisting of 3/4" thick chemically pre polished granite of approved sample with round edges, sealing the edges with imported epoxy filling resting on RCC slab, cutting the slab for sink/ Basin etc.complete in all respect as per drawing, specifications and as instructed by the Engineer. Base Rate Rs. 800/sft)	48	SFT		
18	**FALSE CEILING**				
	Provide and install in position 1/2" thick gypsum board (Thermec or approved equivalent) false ceiling (revealed edges) with G.I framework of approved section including all acessories, G.I hanging system with approved fiber tape on joints, cutting out openings for all lights fixtures, linear grills and diffusers including wooden/gypsum light pelmet as shown and providing 1"x1"x16-18 SWG 'U' channel or angle for protection of edges where ever required etc including matt enamel paint(ICI/BERGER), after installation in the reqd number of coats, complete in all respect as per drawing, specifications and as instructed by the Engineer.	48	SFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
19	**Pantry Cabinets**				
	Providing and install Wooden Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the architect.	48	SFT		
	TOTAL AMOUNT FOR NON SCH. ITEM FIRST FLOOR				
A	**MAIN BUILDING**				
	SECTION A-2 CIVIL WORKS				
(D)	**THIRD FLOOR**				
1	**STRUCTURAL CONCRETE**				
	Providing and laying reinforced cement concrete Grade M20 having Compressive cube strength 20 MPa (2900 PSI) Cube strength at 28 days nominal mix ratio 1:1-1/2: 3 (cement, fine & coarse aggregates) including all kinds of formwork, and necessary framing for support, hoisting, placing, compacting, finishing, curing complete in all respect as shown on the drawing and as.per specifications. (Submission & approval of Mix Design is mandatory as per specification.				
(I)	Columns in super structure	717	CFT		
(II)	Beams	700	CFT		
(III)	Slabs / projection etc	103	CFT		
(IV)	Staircase steps, Landing waist etc	168	CFT		
(V)	WALLS	103	CFT		
(VI)	LINTOL OVER DOORS & WINDOWS	362	CFT		
2	**Steel Reinforcement**				
	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and under ground tanks and in projections for future extension 166 / 114/ 22) .	310	CWT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
3	**BLOCK MASONARY**				
a)	**SOLID**				
i)	**6 " OR BELOW THICKNESS**				
	Providing and laying Cement Concrete solidMachine made block Type B minimum compressive Strength 1000 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 CSM CEMENT SAND MORTAR in ground floor Super Structure including raking out joints and curing etc. complete. Izhar, Banu Mukhtar Envicrete or equivalent.	1756.75	Cft		
b)	**HOLLOW BLOCK 6"THICK**				
	Providing and laying CC Hollow Machine made block minimum compressive Strength 725 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 in ground floor including raking out joints and curing etc. complete.	1695.45	CFT		
4	**MS SECURITY GRILLS**				
	Providing and fixing in position iron steel grill of angle iron and square bar of required size 3/4"x1/4" size flat iron/3/4" X3/4" SQ BAR of approved design including welding all sides and painting 3 coats etc. (weight not to be less than 3.7 lbs /sft of finished grill)	922.85	Psft		
5	**ALUMINUM WINDOWS /VENTILATORS**				
a)	**SLIDING**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Sliding Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) &Aluminum fly screen including handles, stoppers & locking arrangement etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass & net.	462.00	Psft		
b)	**FIXED PANEL**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Fixed Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass .	50.00	Psft		
c)	**FREE STANDING GLASS PARTITION**				
	Providing & fixing 1/2"thick Tempered Glass partition in Bath Room with 2'-0" single leaf swing door including Aluminum bottom & top frame as per drawing.	2	Each		
6	**STAIR CASE HAND RAIL**				
	Providing and fixing 50mm dia 16SWG Stainless steel 304 pipe fixed at wall with coupling as per detail and design shown on drawing including all labour and material required.	64	RFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE

ABSTRACT OF COST

COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES

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S.NO	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
7	**MARBLE ON TREAD**				
	Providing and fixing 1"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 1'-0" width including grinding, polishing, 3/4" chamfer nosing including three no carbondum strips and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	20	Each		
8	**MARBLE ON RISER**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)4-'0" long and 0'-6" width including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	21	Each		
9	**MARBLE ON LANDING**				
	Providing and fixing 3/4"thick lasbella Marble (Tavera,or equivalent)1-'0" long and 1'-0" width ON LANDING including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	64	SFT		
10	**MARBLE SKIRTING 6" HIGH**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) skirting including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	32	RFT		
11	**MARBLE TILE ON FAÇADE**				
	Providing and fixing 1/2"thick lasbella Marble (Tavera,or equivalent) on lift facade including grinding, polishing, and fixing over 3/4"thick base 1:6CSM complete as per drawing and specification.	171	SFT		
11	**WARD ROBE**				
	Providing and install wardrobe comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the Engineer.	88	SFT		
12	**KITCHEN COUNTER TOP**				
	Provide and fix counter top as per detail consisting of 3/4" thick chemically pre polished granite of approved sample with round edges, sealing the edges with imported epoxy filling resting on RCC slab, cutting the slab for sink etc.complete in all respect as per drawing, specifications and as instructed by the Engineer. Base Rate Rs. 800/sft)	44	SFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
13	**KITCHEN CABINET FLOOR MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the Engineer.	44	RFT		
14	**KITCHEN CABINET WALL MOUNTED**				
	Providing and install Wooden Kitchen Floor Mounted Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, complete in all respect as per drawing and specifications and as instructed by the Engineer.	32	RFT		
15	**FREE STANDING GLASS PARTITION**				
	Providing & fixing 1/2"thick Tempered Glass partition in Bath Room with 2'-0" single leaf swing door including Aluminum bottom & top frame as per drawing.	96	SFT		
16	**VANITY TOP**				
	Provide and fix Vanity top as per detail consisting of 3/4" thick chemically pre polished granite of approved sample with round edges, sealing the edges with imported epoxy filling resting on RCC slab, cutting the slab for sink/ Basin etc.complete in all respect as per drawing, specifications and as instructed by the Engineer. Base Rate Rs. 800/sft)	48	SFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
17	**FALSE CEILING**				
	Provide and install in position 1/2" thick gypsum board (Thermec or approved equivalent) false ceiling (revealed edges) with G.I framework of approved section including all acessories, G.I hanging system with approved fiber tape on joints, cutting out openings for all lights fixtures, linear grills and diffusers including wooden/gypsum light pelmet as shown and providing 1"x1"x16-18 SWG 'U' channel or angle for protection of edges where ever required etc including matt enamel paint(ICI/BERGER), after installation in the reqd number of coats, complete in all respect as per drawing, specifications and as instructed by the Engineer.	402	SFT		
18	**Pantry Cabinets**				
	Providing and install Wooden Cabinet comprising of Meranti wood frame, Meranti wood lipping, 3/4" laminated M.D.F (Alnoor or equivalent) of approved quality including wastage, cutting of openings, fixtures / hardware, polishing on lipping, including the cost of 4" thick 1:3:6 C.C Bed etc. complete in all respect as per drawing and specifications and as instructed by the architect.	48	SFT		
19	**PATTA PLASTER 4" WIDE AND 1-1/2" TH.**				
	Providing & laying 1:4 CSM Patta Plaster 4" WIDE & av. 1-1/2" thick in two layers around windows as per shown on drawing as per direction of Engineer.	556	RFT		
20	**REAR SIDE HOLLOW PIPE GRILL**				
	Providing, fabricating & Laying Hollow Cold drawn section 4"x2" 18 SWG welding, grinding, painting three coats in approved shade including one coat anti corrosive primer as per drawing.	144	SFT		
	TOTAL AMOUNT FOR THIRD FLOOR				

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE

ABSTRACT OF COST

COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES

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S.NO	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
A	**MAIN BUILDING**				
	SECTION A-2 CIVIL WORKS				
(E)	**FOURTH /ROOF FLOOR**				
1	**STRUCTURAL CONCRETE**				
	Providing and laying reinforced cement concrete Grade M20 having Compressive cube strength 20 MPa (2900 PSI) Cube strength at 28 days nominal mix ratio 1:1-1/2: 3 (cement, fine & coarse aggregates) including all kinds of formwork, and necessary framing for support, hoisting, placing, compacting, finishing, curing complete in all respect as shown on the drawing and as.per specifications. (Submission & approval of Mix Design is mandatory as per specification.				
(I)	Columns in super structure	277	CFT		
(II)	Beams	62	CFT		
(III)	Slabs / projection etc	157	CFT		
(IV)	Staircase steps, Landing waist etc	112	CFT		
(V)	WALLS	112	CFT		
	OVER HEAD WATER TANK				
(I)	Columns in super structure	38	CFT		
(II)	Beams	86	CFT		
(III)	Bottom Slab	205	CFT		
(IV)	TOP SLAB	180	CFT		
(V)	WALLS	369	CFT		
2	**Steel Reinforcement**				
	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and under ground tanks and in projections for future extension 166 / 114/ 22) .	74.06	CWT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
3	**BLOCK MASONARY**				
a)	**SOLID**				
i)	**6 " OR BELOW THICKNESS**				
	Providing and laying Cement Concrete solidMachine made block Type B minimum compressive Strength 1000 PSI at 28 days masonry wall 6" and below in thickness set in 1:6 CSM CEMENT SAND MORTAR in ground floor Super Structure including raking out joints and curing etc. complete. Izhar, Banu Mukhtar Envicrete or equivalent.	2124.88	Cft		
4	**ALUMINUM WINDOWS /VENTILATORS**				
a)	**SLIDING**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Sliding Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) &Aluminum fly screen including handles, stoppers & locking arrangement etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass & net.	50.00	Psft		
b)	**FIXED PANEL**				
	Supplying and fixing in position Anodized or Powder Coated Bronze Aluminum Fixed Glazed Aluminum Windows & Ventilators deluxe Section fitted with 5mm thick tinted glazing (Ghani, ganj Glass or equivalent) etc. complete Deluxe Model Aluminum thickness minmum 1.6mm by Alcop,khas, lucky, Pakistan Cable, Chawla or as approved by the Engineer Incharge. this cost in inclusive of Glass .	50.00	Psft		
5	**ROOF TREATMENT**				
	Provide and laying roof treatment of following items (For payment screed area will be measured)				
a)	Providing and applying adhesive coat ZSAC-10 / 15 of ZAHABIA chemical or equivalent complete as per manufacturer's specifications and instruction, and approval of Engineer Incharge.	4914	SQFT		
b)	Providing & laying Concrete 1:2:4 screed in required slope minimum 2-1/2" thick (Average) laid in Panel using 5mm thick glass strip , including curing, making ridges, valleys, chamfered edges, hacking of existing surface for bond where necessary etc.	4914	SQFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE

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S.NO	DESCRIPTION	QTY	UNIT	RATE	AMOUNT
6	**ROOF THERMAL INSULATION**				
	Providing & fixing Terra , Roof Insulation Composite Tile size 300mm x300mmx50mm Manufactured by Matrix or equivalent: Light weight thermal insulation to be made with fibre reinforced cement concrete wearing surface minmum compressive strength 3000 Psi fixed with tile bond on evenly prepared roof surface. Tile base to comprise of light weight aerated - cellular concrete with expanded polystyrene (EPS) inset average density 1500 Kg/m3 and minimum thickness .Tiles to be grouted with minmum 5mm space. Colour as per approved by Engineer Incharge.	4322	SQFT		
7	**STAIR CASE DOOR**				
	Providing, Supplying & fixing MS Door 3'-6"x7'-0"comprising MS section and MS including prime coat of anticorrosive paint with three coat Sysnthetic Enamel paint in approved shade.	49	SQFT		
8	**PATTA PLASTER 4" WIDE AND 1-1/2" TH.**				
	Providing & laying 1:4 CSM Patta Plaster 4" WIDE & av. 1-1/2" thick in two layers around windows as per shown on drawing as per direction of Engineer.	552	RFT		
9	**MAN HOLE COVER**				
	Providing and fixing in position heavy duty M.S Manhole covers with frame size 24"x24" from "CME" (min weight 30 Kg) or approved equivalent make. Complete in all respect as per drawing, specifications and directed by Engineer – in – charge.	1	EACH		
	TOTAL AMOUNT FOR ROOF				
A	**MAIN BUILDING**				
	SECTION A-2 CIVIL WORKS				
	UNDER GROUND WATER TANK 14500 GLS QTY FOR SINGLE TANK				
1	**EXCAVATION FOR FOUNDATION**				
a	Earth-work excavation by using Excavator and dumper lead upto 100-ft. from the building line as per direction of Engineer Incharge IN ORDINARY SOIL	4,455	Cft		
b	Earth-work excavation by Excavator and loader lead upto 100-ft. from the building line as per direction of Engineer Incharge IN GRAVEL/CONGLOMERATE	550	Cft		
2	**BACK FILLING**				
a)	**USING EXCAVATED AVAILABLE EARTH AT SITE**				
	Filling, watering and ramming earth in foundation, under floor with s earth from foundation excavation etc. as per specification	2,930	Cft		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
3	**STRUCTURAL CONCRETE**				
	Providing and laying reinforced cement concrete Grade M20 having Compressive cube strength 20 MPa (2900 PSI) Cube strength at 28 days nominal mix ratio 1:1-1/2: 3 (cement, fine & coarse aggregates) including all kinds of formwork, and necessary framing for support, hoisting, placing, compacting, finishing, curing complete in all respect as shown on the drawing and as.per specifications. (Submission & approval of Mix Design is mandatory as per specification.				
(I)	RAFT FOOTING	234	CFT		
(II)	WALLS	529	CFT		
(III)	Slabs / projection etc	227	CFT		
4	**Steel Reinforcement**				
	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and under ground tanks and in projections for future extension 166 / 114/ 22) .	30	CWT		
5	**MAN HOLE COVER**				
	Providing and fixing in position heavy duty M.S Manhole covers with frame size 24"x24" from “CME” (min weight 50 Kg) or approved equivalent make. Complete in all respect as per drawing, specifications and directed by Engineer – in – charge.	1	EACH		
6	**GI RUNGS**				
	Providing and fixing in position 5/8” dia G.I Rungs duly powder coated, fixed prior the concreting of walls. Complete in all respect as per drawing, specifications and directed by Engineer – in – charge.	8	EACH		
7	PVC WATER STOPPER				
	Providing and fixing in position PVC water bar fixed prior the concrete of wall from M/S “FOSROC”, “PLYBIT” or approved equivalent make, complete with proper fixing and jointing. Complete in all respect as per drawing, specifications and directed by Engineer – in – charge	60	RFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
	TOTAL AMOUNT FOR SINGLE TANK				
	TOTAL AMOUNT FOR TWO TANK				
C	**ROADS &,PATH**				
C-1	**ROADS**				
1	**SECTION C-1 EARTH WORKS**				
1	**STRIPPING**				
	Stripping & removal of Top soil 300mm thick transporting and depositing & spreading where as per direction of the Engineer .	43216	CFT		
2	**PREPARATION OF SUB-GRADE**				
I	**GRANULAR BACK FILLING 300mm thick**				
	Preparing sub grade USING GRANULAR BACK FILLING ITEM NO 107d NHA SPEC.	31,840	Cft		
3	**PREPARATION OF BASE COARSE**				
	Preparing Water Bound MacAdam with Coarse Aggregate Class B NHA SPEC	23880.00	Cft		
	TOTAL AMOUNT OF NON SCHEDULE ITEM				
C	**ROADS &,PATH**				
C-2	**PATHS**				
1	**SECTION C-1 EARTH WORKS**				
1	**STRIPPING**				
	Stripping & removal of Top soil 300mm thick transporting and depositing & spreading where as per direction of the Engineer .	4368	CFT		
2	**PREPARATION OF SUB-GRADE**				
I	**GRANULAR BACK FILLING 300mm thick**				
	Preparing sub grade USING GRANULAR BACK FILLING ITEM NO 107d NHA SPEC.	4,368	Cft		
3	**STRUCTURAL CONCRETE**				
	Providing and laying reinforced cement concrete Grade M20 having Compressive cube strength 20 MPa (2900 PSI) Cube strength at 28 days nominal mix ratio 1:1-1/2: 3 (cement, fine & coarse aggregates) including all kinds of formwork, and necessary framing for support, hoisting, placing, compacting, finishing, curing complete in all respect as shown on the drawing and as.per specifications. (Submission & approval of Mix Design is mandatory as per specification.				
(I)	FOOTING	728	CFT		
(II)	WALLS	1,456	CFT		

32 NOS FACULTY APARTMENT IBA STAFF TOWN KARACHI UNIVERSITY ENCLAVE					
ABSTRACT OF COST					
COST BASED ON NON SCHEDULED ITEMS ON PREVAILING MARKET RATES					
S.NO	**DESCRIPTION**	**QTY**	**UNIT**	**RATE**	**AMOUNT**
4	**Steel Reinforcement**				
	Providing and laying hard grade ribbed deformed (minimum yield point 60,000 psi) reinforcement bars with & including the cost of straightening, cutting, bending, binding, wastage, and such overlaps as are not shown in the drawings, placing in position on cement concrete 1:2:4 precast or m.s. chairs, tying with binding wire, cost of chairs and wires etc. in all kinds of RCC work in foundation, basement, plinth and ground floor of building including septic tanks and under ground tanks and in projections for future extension 166 / 114/ 22) .	40	CWT		
	TOTAL FOR NON-SCHEDULE ITEMS				
D	**HORTICULTURE**				
1	**SECTION C-1 EARTH WORKS**				
1	**STRIPPING**				
	Rough dressing of the area for lawn including picking stones, pebbles, stubble, grass roots and other injurious matters and breaking of clods complete including disposal of rubbish within 3 chains (92 m).	4368	CFT		
2	**SWEET EARTH**				
	Spreading approved garden soil (sweet earth) in uniform thickness including mixing and breaking clods and dressing fine for grassing including disposal of rubbish within 3 chains (92 m) complete .	5500	CFT		
3	**MANURE**				
	Supplying,Stacking and spreading well decayed cowdung manure from approved source including all leads and lifts.	1500	CFT		
4	**GRASS**				
	Supplying live (local) grass in slabs with earth intact including all lead and lifts.	8000	SFT		
5	**GRASSING**				
	Grassing fine by dribbling grass roots 3" apart including watering, weeding till such time the grass is set and becomes green and is fit for mowing	24000	SFT		
	TOTAL FOR HORTICULTURE				

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S.#	DESCRIPTION	UNIT	TOTAL QTY.	RATE IN PKR	AMOUNT
			A	B	C = B X A
SECTION - A: **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **WIRING / WIRING ACCESSORIES ETC.** **Make - Ref. List of approved Manufacturers**					
1	Wiring of light circuit from DB to switch, between switches or first light point / directly controlled from DB with single core PVC insulated 2 x 1C - 2.5 sq.mm + 1 x 2.5 sq.mm wires in 25 mm dia PVC conduit complete in all respect.	Nos.	128		
2	Wiring from switch to first light point with 2 x 1C - 1.5 sq.mm + 1 x 1.5 sq.mm wires in 25 mm dia PVC conduit complete in all respect.	Nos.	1408		
3	Same as above but from point to point.	Nos.	1746		
4	Wiring of power circuit from DB to first power socket with 2 x 1C-2.5 sq.mm + 1x 2.5 Sq.mm PVC wires in 25 mm dia PVC conduit complete in all respect.	Nos.	256		
5	same as above but outlet to outlet	Nos.	256		
6	Wiring of power circuit from DB to AC - Isolator point and outdoor with 2 x 1C-4 sq.mm + 1x 4 Sq.mm PVC wires in 25 mm dia PVC conduit complete in all respect.	Nos.	192		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION - B: **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **SWITCHES, SOCKETS, OUTLET & ACCESSORIES** **Make - Ref. List of approved Manufacturers**					
1	**Following Switches etc. complete in all respect.**				
a	1 - Gang. (1-way)	Nos.	64		
b	2 - Gang. (1-way)	Nos.	160		
c	3 - Gang . (1-way)	Nos.	224		
d	4 - Gang . (1-way)	Nos.	32		
e	Fan dimmers	Nos.	192		
f	1 - Gang TV Outlet	Nos.	32		
g	Bell Button	Nos.	32		
h	Door bell	Nos.	32		
2	**Following Sockets complete in all respects**				
a	13A Duplex Type - Flat pin	Nos.	5		
b	13 A Simplex type - Flat Pin	Nos.	20		
c	13 A International Switch socket outlet	Nos.	448		
d	13A Isolator switch for A.C Weather Proof	Nos.	192		
e	15A 3-pin socket	Nos.	64		
3	**Following sizes M.S Back box for switchs and sockets**				
a	3 x 3 M.S Back Box	Nos.	1273		
4	**Weather proof 10A switches with M.S back box complete in all respect.**				
a	1 - Gang .(1-way)	Nos.	2		
5	**Weather proof socket outlet (IP-54) including sheet steel Back box or plastic box.**				
a	13 Amp - International Switch Socket.	Nos.	2		

S.#	DESCRIPTION	UNIT	TOTAL QTY.	RATE IN PKR	AMOUNT
			A	B	C = B X A
6	**Pull box as per drawing/requirement with M.S powder coated paint (With Cover)**				
a	Pull box powder coated - 18''x8''x4'' with cover	Nos.	32		
b	4"x4"	Nos.	5		
c	6''x6''	Nos.	5		
d	12''x12''	Nos.	5		
e	18"x18"	Nos.	5		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION- C : **INSTALLATION, TESTING & COMMISSIONING** **UN-INTERRUPTED POWER SUPPLY** **Make - Ref. List of approved Manufacturers**					
1	**Following size of UPS (10 Minutes backup) for emergency as per drawing/specs with dry battery complete in all respect.**				
a	10 KVA. (3-Phase in 1-Phase out).	Nos.	4		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION- D : **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **LIGHT FIXTURES & FANS** **Make - Ref. List of approved Manufacturers**					
1	**Following LED light fixtures complete in all repsect.**				
a	LED Down Light Round Surface Type - 6500K - 13watt	Nos.	2240		
b	LED Down Light Round Surface Type - 3000K - 13watt	Nos.	256		
c	LED Mirror Light 2feet - 3000K	Nos.	96		
d	LED Down Light Round Surface Type - 4000K - min. 13watt	Nos.	112		
2	**Following Fans with complete accessories and hanging arrangements etc. complete in all respect.**				
a	Exhaust Fan 18"	Nos.	128		
b	Ceiling Fan 56" - max. 60 Watt	Nos.	330		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION- E : **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **MAIN. SUB-MAIN CABLES, CONDUIT & CABLE TRAY** **Make - Ref. List of approved Manufacturers**					
1	**Following size multicore Cu/PVC/PVC/XLPE, including lugs, glands, termination kits, etc. complete in all respect as shown on drawing. Cables if layed in cable tray trafoil arrangements shall be made**				
a	3.5C-95 Sqm Cu./pvc/pvc + 1C-50Sq.mm Cu./PVC as ECC from LT Panel to SMDB-A in 100mm dia Class-D conduit.	Rm	10		
b	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A01 (Ground Floor) in 100mm dia Class-D conduit.	Rm	15		
c	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A02 (Ground Floor) in 38mm dia Class-D conduit.	Rm	15		
d	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A11 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
e	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A12 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
f	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A21 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
g	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A22 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
h	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A31 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		
i	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-A to DB-Apt A32 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		

S.#	DESCRIPTION	UNIT	TOTAL QTY.	RATE IN PKR	AMOUNT
			A	B	C = B X A
j	4C-6 Sqm Cu./pvc/pvc + 1C-6Sq.mm Cu./PVC as ECC from SMDB-A to DB-Elevator 38mm dia Class-D conduit.	Rm	42		
k	3.5C-240 Sqm Cu./pvc/pvc + 2x1C-70Sq.mm Cu./PVC as ECC from LT Panel to SMDB-B in 100mm+50mm dia Class-D conduit.	Rm	40		
l	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B01 (Ground Floor) in 100mm dia Class-D conduit.	Rm	15		
m	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B02 (Ground Floor) in 38mm dia Class-D conduit.	Rm	15		
n	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B11 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
o	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B12 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
p	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B21 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
q	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B22 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
r	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B31 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		
s	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt B32 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		
t	4C-6 Sqm Cu./pvc/pvc + 1C-6Sq.mm Cu./PVC as ECC from SMDB-B to DB-Elevator 38mm dia Class-D conduit.	Rm	42		
u	3.5C-95 Sqm Cu./pvc/pvc + 1C-50Sq.mm Cu./PVC as ECC from SMDB-B to SMDB-E in 75mm dia Class-D conduit.	Rm	40		
v	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-E to DB-Apt E01 (Ground Floor) in 100mm dia Class-D conduit.	Rm	15		
	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-E to DB-Apt E02 (Ground Floor) in 100mm dia Class-D conduit.	Rm	15		
w	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt E11 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
x	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt E12 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
y	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt E21 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
z	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt E22 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
aa	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt E31 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		
ab	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-B to DB-Apt E32 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		
ac	4C-6 Sqm Cu./pvc/pvc + 1C-6Sq.mm Cu./PVC as ECC from SMDB-E to DB-Elevator 38mm dia Class-D conduit.	Rm	42		
ad	3.5C-95 Sqm Cu./pvc/pvc + 1C-50Sq.mm Cu./PVC as ECC from LT Panel to SMDB-F in 75mm dia Class-D conduit.	Rm	50		
ae	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F01 (Ground Floor) in 100mm dia Class-D conduit.	Rm	15		
	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F02 (Ground Floor) in 100mm dia Class-D conduit.	Rm	15		
af	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F11 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
ag	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F12 (First Floor) in 38mm dia Class-D conduit.	Rm	22		
ah	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F21 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
ai	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F22 (Second Floor) in 38mm dia Class-D conduit.	Rm	29		
aj	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F31 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		
ak	4C-10 Sqm Cu./pvc/pvc + 1C-10Sq.mm Cu./PVC as ECC from SMDB-F to DB-Apt F32 (Second Floor) in 38mm dia Class-D conduit.	Rm	36		
al	4C-6 Sqm Cu./pvc/pvc + 1C-6Sq.mm Cu./PVC as ECC from SMDB-F to DB-Elevator 38mm dia Class-D conduit.	Rm	42		
am	3x1C-6 Sq.mm Cu./PVC in 25mm dia pvc conduit from SMDB to DB-UPS-01	Rm	60		
an	5x1C-4 Sq.mm Cu./PVC in 25mm dia pvc conduit from DB-UPS to IT LOAD.	Rm	60		

S.#	DESCRIPTION	UNIT	TOTAL QTY.	RATE IN PKR	AMOUNT
			A	B	C = B X A
2	**Following sizes of PVC conduits complete in all respect**				
a	50 mm dia.	Rm	5		
b	38 mm dia.	Rm	5		
c	32 mm dia.	Rm	5		
d	25 mm dia.	Rm	320		
e	20 mm dia.	Rm	5		
3	**Following sizes of Class- D PVC conduits complete in all respect**				
a	75 mm dia.	Rm	5		
b	50 mm dia.	Rm	5		
c	38 mm dia.	Rm	5		
d	32 mm dia.	Rm	5		
4	**Following sizes of Core Cutting complete in all respect.**				
a	Core Cutting 4'' Dia	Nos.	2		
b	Core Cutting 6'' Dia	Nos.	2		
c	Core Cutting 8'' Dia	Nos.	2		
d	Core Cutting 10'' Dia	Nos.	2		
5	**Galvanized Cable Tray including Cover of 16 SWG M.S. sheet steel (perforated) having 02 coats of Zinc Chromate paint with cover and hanging arrangement from ceiling / wall as per drawing / site conditions, complete in all respect to the entire satisfaction to Client / Consultant.**				
	CABLE TRAY				
a	100mm x 75mm 16 SWG	Rm	10		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION - F: **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **SWITCHBOARDS / DISTRIBUTION BOARDS** **Make - Ref. List of approved Manufacturers**					
1	**Supply & Installation of the following distribution boards as per detail shown on drawing complete in all respect.**				
a	Main LT Panel	Nos.	1		
b	SMDB-A	Nos.	1		
c	SMDB-B	Nos.	1		
d	SMDB-E	Nos.	1		
e	SMDB-F	Nos.	1		

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S.#	DESCRIPTION	UNIT	TOTAL QTY.	RATE IN PKR	AMOUNT
			A	B	C = B X A
f	DB-Apartments	Nos.	32		
g	DB-Elevator	Nos.	4		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION - G: **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **EARTHING SYSTEM** **Make - Ref. List of approved Manufacturers**					
1	**Following size single core PVC insulated cable in 38mm Class-D PVC Conduit from earth electrode to ECP complete in all respects. Earth Test Report to be submitted by contractor to client.**				
	70 sq. mm	Rm.	80		
	35 sq. mm	Rm.	20		
2	3 Meter long 20mm dia steel rod copper claded, including inspection pit, test bar, chemical, etc. Earth resistance should be less than 1 ohm.	Nos.	8		
3	Bare copper strip of following size earth connecting point (ECP) with proper mounting arrangements including cover as per drawing complete in all respects.				
	200 mm x 50 mm x 10 mm	Nos.	8		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION - H: **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **WIRING & ACCESSORIES FOR DATA, CCTV and WiFi system** **Make - Ref. List of approved Manufacturers**					
	Supply, installation, Testing and Commissioning of following including flexible conduits from points to device complete in all respects as per drawings / specs.				
1	RJ-45 including I/O with face plate (Simplex) accessories complete in all respect.	Nos.	50		
4	Cat-6 UTP cable in already laid 25mm dia pvc conduit from each Wi-Fi Point to Data rack in First Floor.	Rm	800		
5	RG-6 Cable in already laid 25mm dia pvc conduit from TV point to TJB in each floor complet to all respect.	Rm	450		
6	RG-6 and Cat-6 connector strip.	Nos.	32		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
SECTION - I: **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **A.C DRAINAINGE** **Make - Ref. List of approved Manufacturers**					
1	**Supply, installation, Testing and commissioning of uPVC including all accessories as per site condition.**				
a	25mm dia uPVC conduit.	Rm	119		
b	20mm dia uPVC Conduit	Rm	25		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				

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S.#	DESCRIPTION	UNIT	TOTAL QTY.	RATE IN PKR	AMOUNT
			A	B	C = B X A
	SECTION - I : **SUPPLY, INSTALLATION, TESTING & COMMISSIONING** **SOIL, WASTE AND VENT PIPING** **Make - Ref. List of approved Manufacturers**				
	Supply, install and commission Soil & Waste piping uPVC Non Pressure pipes & fittings confirming to BSS 3505/BSS 3506 PSI 3051-91 ASTM D 1785-94 DIN 8061-8062 standards, including all special accessories, and hangers as per drawings & specifications for drainage systems.				
1	75mm dia I.D	Rm	110		
2	100mm dia I.D	Rm	350		
3	32mm Dia VENT PIPE	Rm	34		
4	50mm Dia Vent Pipe	Rm	79		
5	75mm Dia Vent Pipe	Rm	21		
	Supply & Installation of UPVC floor drain with SS Cover of the following size with all consumable of approved make .				
6	75mm	Nos.	36		
	Supply & Installation of floor clean out of following sizes including all consumable as per approved make.				
7	100mm Diameter	Nos	12		
	Supply installation of Cowel Vent of the following sizes as per specification and approved make.				
8	75mm dia	Nos	2		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
	SECTION - I : **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING** **SANITARY FIXTURES AND FITTINGS WITH ALL CONSUMABLE AND ACCESSORIES WITH COMPETE IN ALL RESPECTS** **Make - Ref. List of approved Manufacturers**				
1	Water Closet Western Floor Mounted with Flush tank operated.	Nos	96		
2	Bathroom vanity with sink	Nos	96		
3	Basin Mixer Single Lever	Nos	96		
4	Wall mounted mixer with shower	Nos	96		
5	Muslim shower	Nos	96		
6	Double Bibcock	Nos	96		
7	Stop Cock	Nos	288		
8	Floor Trap (Stainless steel).	Nos	110		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				
	SECTION - J: **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING** **SEWER PIPE NETWORK AND MANHOLES** **Make - Ref. List of approved Manufacturers**				
	Soil & Waste piping UPVC Non Pressure pipes & fittings confirming to BSS 3505/BSS 3506 PSI 3051-91 ASTM D 1785-94 DIN 8061-8062 standards, including all special accessories,EXCAVATION IN ANY SOIL, LAYING & JOINTING PIPE, BACK FILLING, COMPACTION as per drawings & specifications for drainage systems.				
1	150mm I.D Diameter	Rm	137		
2	Making of Manhole 900mm x 900mm internal size with block masony 200mm thick wall water proof plaster from both sides, including, excavation, back filling, RCC ring and Cover 600mm dia with benching complete. Maximum depth upto invert level 1800mm. complete as per drawing & design.	Nos	12		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				

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S.#	DESCRIPTION	UNIT	TOTAL QTY.	RATE IN PKR	AMOUNT
			A	B	C = B X A
SECTION - K : **SUPPLY, INSTALLATION, TESTING AND COMMISSIONING** **WATER, GAS AND FIRE SUPPRESSION PIPING** **Make - Ref. List of approved Manufacturers**					
	Poly Propylene Random PPR (PN 20) piping for Cold Water Supply system complete in all respects with all fittings & accessories as per drawings and specifications confirming to DIN 8077-78 and fitting DIN 16962.				
1	20mm Diameter (20mm ID)	Rm	30		
2	25mm Diameter (25mm ID)	Rm	1400		
3	32mm Diameter (32mm ID)	Rm	20		
4	38mm Diameter (40mm ID)	Rm	20		
5	50mm Diameter (50mm ID)	Rm	1600		
6	63mm Diameter (63mm ID)	Rm	10		
	Poly Propylene Random PPR (PN 20) piping for Hot Water Supply system complete in all respects with all fittings & accessories as per drawings and specifications confirming to DIN 8077-78 and fitting DIN 16962. including pressure testing, AS PER MAKE, MODEL, BRAND AS PER APPROVED MANUFACTURER'S LIST				
7	20mm Diameter	Rm	30		
8	25mm Diameter	Rm	1280		
9	32mm Diameter	Rm	40		
10	38mm Diameter	Rm	35		
11	50mm Diameter	Rm	50		
	TOTAL AMOUNT OF NON - SCHEDULED BASED ITEM				