K/W-4

HUBBALLI DHARWAD SMART CITY LIMITED

HUBBALLI

TENDERS FOR THE WORK OF

Rehabilitation Nehru Stadium including Operation and Maintenance for five years for Hubballi Dharwad Smart City Limited

Volume I – Bid Document

Indent No: UDD/2017-18/OW/WORK_INDENT509

TENDER Notification No : HDSCL/SCP Tender/MD/2018-19

Address for communication:
Hubballi Dharwad Smart City Limited,
IT Park, "B" Block, IV floor,
Opp Indira Glass House,
Hubballi – 580029
Ph: 0836 – 2355331
Email : sohdsmartcity@gmail.com

BID DATA SHEET

Sl. No.	Item	Description
1	Name of work	**Rehabilitation Nehru Stadium including Operation and Maintenance for five years for Hubballi Dharwad Smart City Limited**.
2	Employer	Managing Director, Hubballi Dharwad Smart City Limited, Hubballi.
3	Availability of tender Documents	www.eproc.karnataka.gov.in
4	NIT Issued on	04.08.2018
5	Tender document will be available on e-portal from	13.08.2018
6	Last date and time for Submission of Pre-bid Queries	25.08.2018 at 16:00 hrs Email ID : sohdsmartcity@gmail.com
7	Pre-Bid meeting time, date & Venue	28.08.2018 at 11:00 hrs at the office of Hubballi Dharwad Smart City Limited., Hubballi.
8	Bid due date	12.10.2018 at 16:00 hrs
9	Technical bid opening	15.10.2018 at 16:30 hrs
10	Price bid opening	Will be informed later
11	Posting of responses to queries (on website)	www.eproc.karnataka.gov.in
12	EMD amount	Rs 11,49,000 (Rupees eleven lakh forty nine thousand only) valid 45 days beyond the validity of bid.
13	Time for completion	12 months (including monsoon) and five years for O&M.
14	Bid validity	Bid must remain valid up to **180** (**One Hundred & Eighty**) days from the last date of submission of bid extendable upon request by authority.
15	Performance bank guarantee	5% of the award amount.
16	Additional Performance Security	For Seriously unbalanced rates as per GCC 43
17	Method of Selection	The Selection of Contractor shall be through two stage with the 1st Stage consisting of Technical Criteria evaluation. And in 2nd stage the price bid of only technically qualified bidder will be opened. And L1 Bidder will be selected based on Grand Total Price (Capex Price + Opex Price with NPV).

Sl. No.	Item	Description
18	Currency	Currency in which the bidders may quote the price and will receive payment is in Indian Rupees only.
19	Name and Address for Correspondence/ Site Visit	Special Officer, Hubballi Dharwad Smart City Limited, Hubballi Contact no.0836-2355331 sohdsmartcity@gmail.com

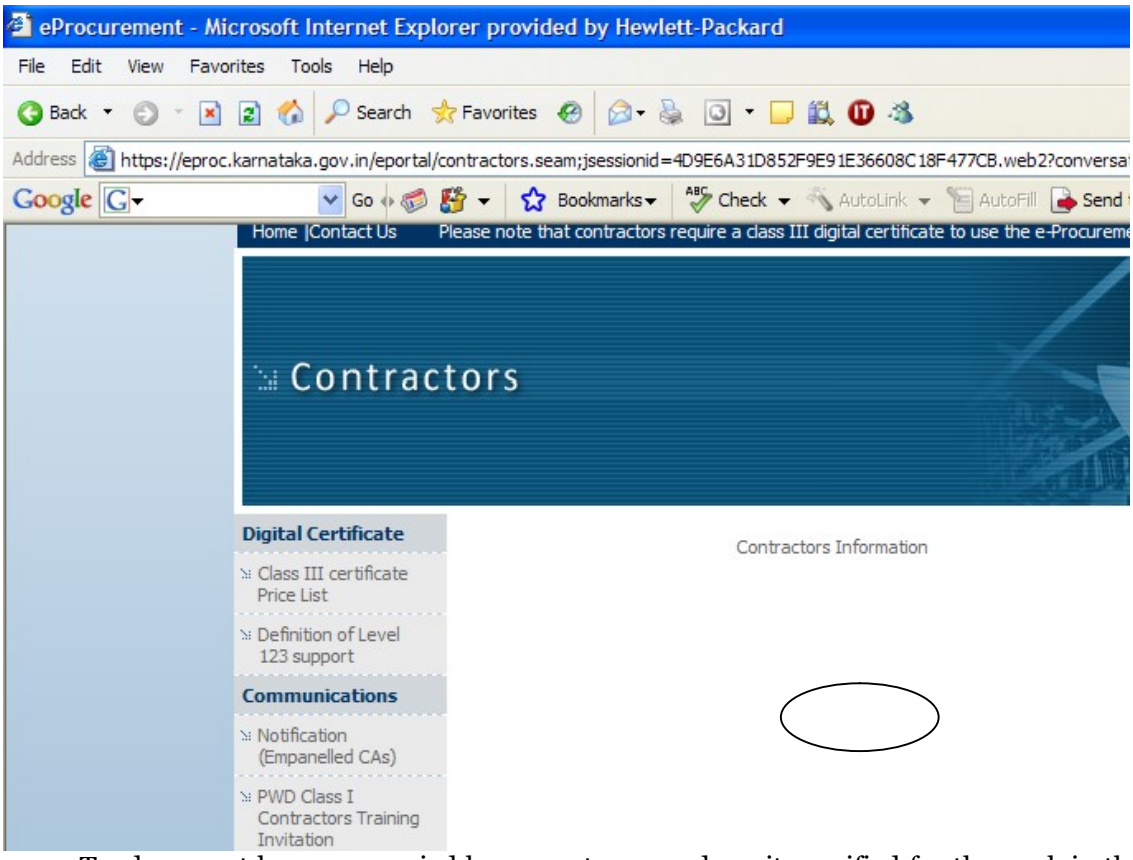
C O N T E N T S

SECTION 1: INVITATION FOR TENDERS (IFT)

Tender Notification No: **HDSCL/SCP Tender/MD/2018-19 DATED: 04.08.2018**

1. **The Managing director Hubballi Dharwad Smart City Limited, Hubballi,** invites tenders from eligible tenderers, for the construction of works detailed in the Table below. The tenderers may submit tenders for any or all of the works given in the Table. **Two Cover Tender procedure as per Rule28 of the KTPP Act shall be followed. The Tenders are required to submit two separate bid (Technical and Financial) covers, one containing the Earnest money deposit and the details of their capability to undertake the tender (as detailed in ITT Clause 3 and 6), which will be opened first and the Financial Bid (Second Cover) containing the price tender which will be opened only if the Tenderer is found to be qualified to execute the tendered work. The Tenderers are advised to note the minimum qualification criteria specified in Clause 3 of the Instructions to Tenderers to qualify for award of the contract.**
2. **Tender documents may be downloaded from Government of Karnataka E-Procurement website https://eproc.karnataka.gov.in/eportal/index.seam under login for Contractors:**

After login to Contractors, Please scroll down to the right side bottom to see List of Tenders, Please click there to find the details of NIT and download copy of the tender. The tender can be downloaded in the portal as per prescribed date and time published in the portal. Only Interested Contractors who wish to participate should remit online tender processing fee, after registering in the portal. The tender processing fee /transaction fee is non-refundable.



3. Tenders must be accompanied by earnest money deposit specified for the work in the Table below. **Earnest Money deposit which will be paid online through e-Procurement portal.** Earnest money deposit will have to be in any one of the forms as specified in the E procurement portal and shall have to be valid for 45 days **beyond** the validity of the tender.
4. **Tenders must be electronically submitted (on-line through internet) within the date and time published in e-procurement portal. First Cover (Technical Bid) of the Tenders will be opened after prescribed time and date in the e-procurement portal, in the presence of the Tenderers who wish to attend at the OFFICE OF MANAGING DIRECTOR, HUBBALLI DHARWAD SMART CITRY LIMITED, Hubballi**
5. **Other details can be seen in the tender documents.**

TABLE

Sl. No	Name of work	Amount put to Tender (Rs.)	Earnest Money Deposit (Rs. in lakhs)	Class of Contractor	Period of completion
1	Rehabilitation Nehru Stadium under Hubballi Dharwad Smart City Limited, Hubballi	**11,48,95,716**	11.49	Class-I Civil	12 Calendar months (Including Monsoon) and five years for O&M.

SECTION 2: INSTRUCTIONS TO TENDERERS (ITT)

Table of Clauses

A General

1. Scope of Tender

1.1 **The Managing director Hubballi Dharwad Smart City Limited, Hubballi** invites tenders Following Two Cover tender procedure, from eligible Tenderers, for the construction of works (as defined in these documents and referred to as "the works") detailed in the Table given in the Invitation for Tenders (IFT). The Tenderers may submit tenders for any or all of the works detailed in the table given in IFT.

2. Eligible Tenderers

2.1 Tenderers shall not be under a declaration of ineligibility for corrupt and fraudulent practices issued by the Government of Karnataka

2.2 **Tenders from Joint ventures are not acceptable.**

3. Qualification of the Tenderer:

3.1 All Tenderers shall provide the requested information accurately and in sufficient detail in Section 3: Qualification information.

3.2 To qualify for award of this contract, each tenderer in its name should have in the last five years i.e.,2013-14 to 2017-18

(a) Achieved in at least two financial years a minimum annual financial turnover of Rs. **2298 lakhs**.

(b) satisfactorily completed (at least 90% of the contract value), as prime contractor, at least one similar work such as Construction and/or Operation of Cricket Stadium, Sports Academy, Sports Stadium project of value not less **Rs. 575 Lakhs**

(c) Executed in any one year in last five years the following minimum quantities of work

Sl. No.	As per Estimate	Unit	Quantity executed
1	Earthwork	Cum	**3700**
2	Cement Concrete	Cum	**1800**
3	Steel	M.T	**200**
4	BBM	Cum	**600**

(d) The tenderer or his identified sub-contractor should possess required valid electrical license for executing electrification works and should have executed similar electrical works such as Building/ Electrical External/ Layout lighting / Panel installation and commissioning totaling **Rs 47 Lakhs in any one year in last five years.**

(e) The tenderer or his identified sub-contractor should have carried out at least one work of "Designing, supplying, fabricating, assembling and erection of tensile fabric roofing with supporting structure and foundations" costing at least **Rs 102 Lakhs of at least 3450 sqm area of Tensile Roofing in any one year in last five years.**

3.3 Each tenderer should further demonstrate:

a) availability by owning at least 50% of the required key and critical equipment for this work and the remaining 50% can be deployed on lease /hire basis for all works provided, the relevant documents (Applicants shall indicate the make, year of manufacture, capacity and working conditions of each of the equipments along with RC issued by R.T.O. / Sale deed/purchase invoice, hire/lease agreements) shall be

furnished.

Sr.No	Machinery	Own	Hire
		Nos required	
1	Excavator- 04 No. (50Cum/day)	01 Nos. Own and 03 Nos Own/Hire	
2	Tipper- 02 Nos (5.5 Cum/trip)	01 Nos.	01 Nos.
3	Transit Mixer Machine-02 Nos	02 Nos owned / hired	
4	Vibrator-Pin/Plate-08 Nos.	04 Nos	04 Nos

b) liquid assets and or availability of credit facilities of no less than **Rs. 288 Lakhs** (Credit lines/ letters of credit / certificates from banks for meeting the fund requirement etc.

3.4 To qualify for a package of contracts made up of this and other contracts for which tenders are invited in this IFT, the Tenderer must demonstrate having experience and resources to meet the aggregate of the qualifying criteria for the individual contracts.

3.5 Sub-contractors' experience and resources shall not be taken into account in determining the Tenderer's compliance with the qualifying criteria except to the extent stated in 3.2 (d) and (e) above.

3.6 Tenderers who meet the above specified minimum qualifying criteria, will only be qualified, if their available tender capacity is more than the total tender value. The available tender capacity will be calculated as under:

Assessed available tender capacity = (A*N*1.50 - B)

Where,

A = Maximum value of civil engineering works executed in any one year during the last five years (2013-14 to 2017-18) *(updated to 2017-18 price level)* taking into account the completed as well as works in progress.
N = Number of years prescribed for completion of the works for which tenders are invited -12 months or 1 Year.
B = Value, at *2017-18 price* level, of existing commitments and on-going works to be completed during the next 1 year

Note: *The statements showing the value of existing commitments and on-going works as well as the stipulated completion period, remaining period for each of the works listed should be countersigned by the Employer in charge, not below the rank of an Executive Engineer or equivalent.*

3.4 Even though the Tenderers meet the above criteria, they are subject to be disqualified if they have:

- made misleading or false representations in the forms, statements and attachments submitted in proof of the qualification requirements; and/or
- record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completion, litigation history, or financial failures etc.; and/or
- Participated in the previous Tender for the same work and had quoted unreasonably high tender prices and could not furnish rational justification.

4. One Tender per Tenderer:

4.1 Each tenderer shall submit only one tender for one work. A tenderer who submits or participates in more than one Tender (other than as a sub-contractor or in cases of alternatives that have been permitted or requested) will cause all the proposals with

the Tenderer's participation to be disqualified.

5. Cost of Tendering:

5.1 The tenderer shall bear all costs associated with the preparation and submission of his tender, and the Employer will in no case be responsible and liable for those costs.

6. Site visit:

6.1 The Tenderer at his own responsibility and risk is encouraged to visit and examine the Site of Works and its surroundings and obtain all information that may be necessary for preparing the Tender and entering into a contract for construction of the Works. The cost of visiting the Site shall be at the Tenderer's own expense**.**

B. Tender documents

7. Content of Tender documents

The Contractor should go through the Tender Document and submit the response /commercial /technical through e-procurement portal online after downloading the tender document within the stipulated time.

8. Clarification of Tender Documents

8.1 A prospective tenderer requiring any clarification of the tender documents may notify the Employer in writing or by cable (hereinafter "cable" includes telex and facsimile) at the Employer's address indicated in the invitation to tender. The Employer will respond to any request for clarification which he receives earlier than 15 days prior to the deadline for submission of tenders. Copies of the Employer's response will be forwarded to all purchasers of the tender documents, including a description of the enquiry but without identifying its source.

8.2 Pre-tender meeting:

8.2.1 The tenderer or his authorized representative is invited to attend a pre-tender meeting which will take place at the office of the Employer as mentioned in the e-procurement portal.

8.2.2 The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage

8.2.3 The tenderer is requested to submit any questions in writing or by cable to reach the Employer not later than 24 hours before the meeting.

8.2.4 Minutes of the meeting, including the text of the questions raised (without identifying the source of enquiry) and the responses given will be transmitted on e-portal only. Any modification of the tender documents listed in Sub-Clause 7.1 which may become necessary as a result of the pre-tender meeting shall be made by the Employer exclusively through the issue of an Addendum pursuant to Clause 9 and not through the minutes of the pre-tender meeting.

8.2.5 Non-attendance at the pre-tender meeting will not be a cause for disqualification of a tenderer.

9. Amendment of Tender documents

9.1 Before the deadline for submission of tenders, the Employer may modify the tender documents by issuing addenda.

9.2 Any addendum thus issued shall be part of the tender documents and shall be posted online in the e-procurement portal which Contractors should download.

9.3 To give prospective Tenderers reasonable time in which to take an addendum into account in preparing their tenders, the Employer shall extend as necessary the deadline for submission of tenders on line through e-procurement portal, in accordance with Sub-Clause 16.2 below.

C. Preparation of Tenders

10. Documents comprising the Tender

10.1 The tender submitted by the Tenderer shall be in two covers and shall contain the documents as follows:

10.1.1 Technical Bid (First Cover): (THORUGH E-PORTAL)

(a) Earnest Money Deposit; on line payment through e-Procurement platform and in the form as specified in the e-procurement portal. Challan / Receipt to be uploaded.

(b) Qualification Information as per formats given in Section 3;

(c) General eligibility criteria.

10.1.2 Financial Bid (Second Cover): (THORUGH E-PORTAL)

(a) Priced Bill of Quantities (Section 9); online through e-procurement portal, no hardcopy of commercials should be attached or disclosed.

and any other materials required to be completed and submitted by Tenderers in accordance with these instructions. The documents listed under Sections 3, 4, 6 and 9 shall be filled in without exception.

10.2 Tenderers submitting tenders together with other contracts stated in the IFT to form a package will so indicate in the tender together with any discounts offered for the award of more than one contract.

11. Tender prices

11.1 The contract shall be for the whole works as described in Sub-Clause 1.1, based on the priced Bill of Quantities submitted by the Tenderer.

11.2 The Tenderer shall fill in rates and prices for each item of Work described in the Bill of Quantities in the E-procurement portal.

Items for which no rate or price is entered by the Tenderer will not be paid for by the Employer when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities. **Corrections, if any, shall be made online only before the submission of the bid.**

Tenderer will be selected based on total Tender Price (Capex Price + Opex Price with NPV) inclusive of applicable taxes.

Since the payments to the Contractor shall be made over several years, the Net Present Value (NPV) method will be used for evaluation of the Commercial bids, so as to bring all tenderers to a common denomination for determination of lowest bidder. The Bidder shall quote their O&M rates as per their own assessment. However, the Authority will calculate the NPV of the quoted amount as per the formula below for the purpose of evaluation. The Net Present Value of a contract is equal to the sum of the present values of all the cash flows associated with it. The formula for calculating NPV of a Commercial bid is illustrated below:

$$P = C + [(O1) / (1+r)] + [(O2 / (1+r)^2] + [(O3) / (1+r)^3] + [(O4) / (1+r)^4]$$

Where: P= Final Price

C = Total Capex Price,

O1 = Opex Price for Year 2,

O2 = Opex Price for Year 3,

O3 = Opex Price for Year 4,

O4 = Opex Price for Year 5,

r = Rate of Interest / Discounting Rate at 10%

In order to equitably compare different O&M charges for different years, NPV (Net Present Value) would be used at Discounting Rate (r) to bring the O&M cost at the same footing in the assessment of total Tender Price.
Bidder shall quote O&M support cost for all the 5 years. However, the rate and amount quoted for 1st year maintenance (DLP) will not be considered for financial evaluation.

11.3 All duties, taxes, and other levies payable by the contractor under the contract, or for any other cause, shall be included in the rates, prices and total Tender Price submitted by the Tenderer.

11.4 The rates and prices quoted by the Tenderer shall be subject to adjustment during the performance of the Contract in accordance with the provisions of Clause of the Conditions of Contract

12. Tender validity

12.1 Tenders shall remain valid for a period not less than **180 days** after the deadline date for tender submission specified in Clause 16. A tender valid for a shorter period shall be rejected by the Employer as non-responsive.

12.2 In exceptional circumstances, prior to expiry of the original time limit, the Employer may request that the Tenderers may extend the period of validity for a specified additional period. The request and the Tenderers' responses shall be made in writing or by cable. A Tenderer may refuse the request without forfeiting his earnest money deposit. A Tenderer agreeing to the request will not be required or permitted to modify his tender, but will be required to extend the validity of his earnest money deposit for a period of the extension, and in compliance with Clause 13 in all respects.

13. Earnest money deposit

13.1 Earnest Money Deposit/ Bid security

The supplier/contractor can pay the Earnest Money Deposit (EMD) in the e-Procurement portal using any of the following payment modes:

1 Credit Card
2 Direct Debit
3 National Electronic Fund Transfer (NEFT)
4 Over the Counter (OTC)

OTC payment procedure

If a contractor/supplier chooses to make payment of EMD/tender processing fees Over The Counter (OTC) in any of the designated Axis Bank branches listed in the e-Procurement web-site (www.eproc.karnataka.gov.in), the contractor/supplier will need to log into e-Procurement system, access the tender for which bid is being created and then select the OTC option under the payment section and print the Challan shown in that section. The printed challan will have the unique bid reference number and the amount to be remitted. Along with the challan, contractor can choose to make the payment either in the form of cash or in the form of Demand Draft. Cheque payments will not be accepted. The contractor is requested to specifically inform the bank officer to input the unique bid reference number printed in the challan in the banking software. Upon successful receipt of the payment, the bank will provide a 16-digit reference number acknowledging the receipt of payment. This 16-digit reference number has to be inputted by contractor in the payment section of its bid as payment confirmation before the bid is submitted (i.e.) as a pre-requisite for bid submission.

NEFT payment procedure

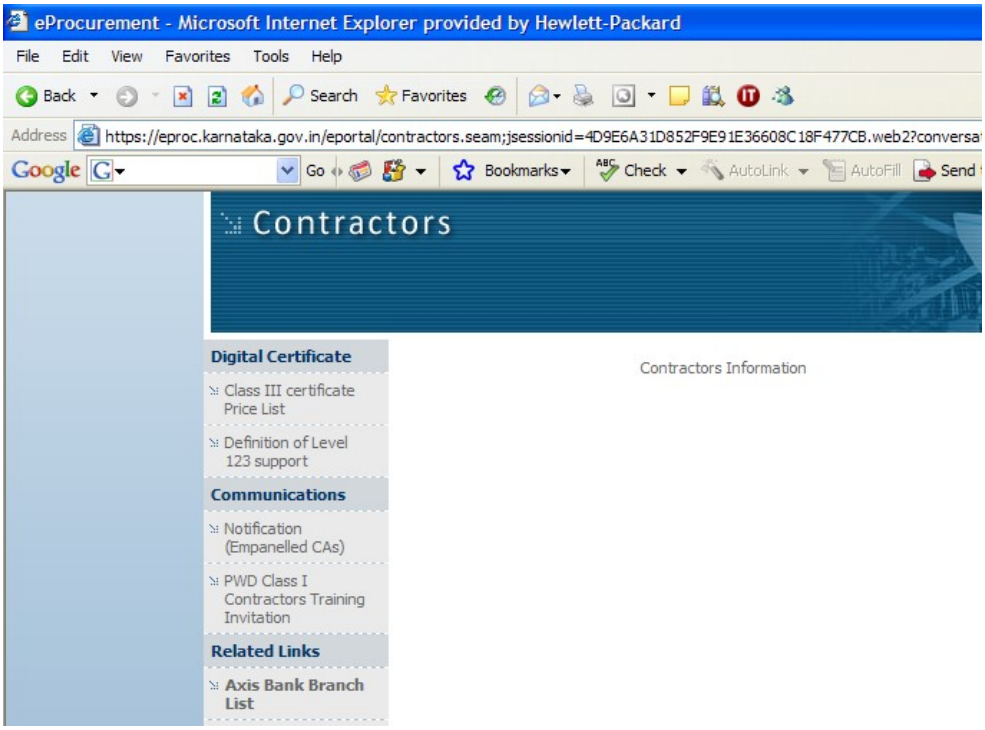
If a contractor/supplier chooses to make payment of EMD/tender processing fees using Reserve Bank of India's (RBI) National Electronic Fund Transfer (NEFT) system, the contractor/supplier will need to log into e-Procurement system, access the tender for which bid is being created and then select the NEFT option under the payment section and print the Challan shown in that section. The printed challan will have the unique bid reference number, account details of Government of Karnataka and the amount to be remitted. The contractor has to submit the printed challan to its bank-branch (NEFT-enabled) and request for an account-to-account transfer, wherein the money will get transferred from the contractors' bank account to GoK's bank account. The contractor should ensure that NEFT transfer instructions are executed and the funds are wired to the Government of Karnataka's principal account before the last date for bid submission and preferably 24 hours before the last date for bid submission. If the contractor's bank transfers/wires the money after the last date for bid submission, the contractor's bid will be liable for rejection. Upon executing the transfer, the contractor's bank will provide a reference number generated by NEFT software as confirmation of transfer, which has to be inputted by contractor in the payment section of its bid as payment confirmation before the bid is submitted (i.e.) as a pre-requisite for bid submission. Also, the account number from which the funds were transferred have to be inputted in the e-Procurement system as part of its bid.

The supplier/contractor’s bid will be evaluated only on confirmation of receipt of the payment (EMD) in the Government of Karnataka central pooling a/c held at Axis Bank

EMD amount will have to be submitted by the supplier/contractor taking into account the following conditions:

a. EMD will be accepted only in the form of electronic cash (and not through Demand Draft or Bank Guarantee) and will be maintained in the Govt.’s central pooling account at Axis Bank until the contract is closed.

b. The entire EMD amount for a particular tender has to be paid in a single transaction
For details on e-Payment services refer to e-procurement portal for more details on the process.



Refund of EMD
Based on the instructions of Tender Accepting Authority (TAA) the EMD amount of the unsuccessful bidders will be refunded to the respective Bank a/c's of the supplier/contractor registered in the e-Procurement system.

13.2 Instruments having fixed validity issued as earnest money deposit for the tender shall be valid for 45 days beyond the validity of the tender- NA-

13.3 Any tender not accompanied by an acceptable earnest money deposit and not secured as indicated in Sub-Clauses 13.1 and 13.2 above shall be rejected by the Employer as non-responsive.

13.4 The earnest money deposit of unsuccessful Tenderers will be returned within 30 days of the end of the tender validity period specified in Sub-Clause 12.1.

13.5 The earnest money deposit of the successful Tenderer will be discharged when the Tenderer has signed the Agreement and furnished the required Performance Security.

13.6 The earnest money deposit may be forfeited:

(a) if the Tenderer withdraws the Tender after tender opening during the period of tender validity;

(b) if the Tenderer does not accept the correction of the Tender Price, pursuant to Clause 24; or

(c) in the case of a successful Tenderer, if the Tenderer fails within the specified time limit to

(i) sign the Agreement; or

(ii) furnish the required Security deposit

(d) if the documents submitted by the Tenderer found to be misleading/forged or fake

14. Format and signing of Tender

Bid shall be signed by the authorized person digitally.

D. Submission of Tenders

15. Tenderer shall submit the Bid electronically before the submission date and time notified in e-procurement portal.

16. Deadline for submission of the Tenders

16.1 In online e-procurement system, tenderer shall not be able to submit the bid after the bid submission time and date as the icon or the task in the e-procurement portal will not be available.

16.2 The Employer may extend the deadline for submission of tenders by issuing an amendment in accordance with Clause 5, in which case all rights and obligations of the Employer and the Tenderers previously subject to the original deadline will then be subject to the new deadline.

17. Late Tenders

17.1 In online e-procurement system, you shall not be able to submit the bid after the bid submission time and date as the icon or the task in the e-procurement portal will not be available.

18. Modification and Withdrawal of Tenders

Tender has all the time to modify and correct or upload any relevant document in the portal till Bid submission date and time, as published in the e-procurement portal.

E- Tender opening and evaluation

19. Opening of Technical Bid (First Cover) of all Tenders and evaluation to determine qualified Tenderers:

19.1 The Employer will open online **Technical Bid** (First Cover) of all the Tenders received through e-procurement portal, in the presence of the Tenderers or their representatives who choose to attend at the date, time and the venue specified in the e-procurement portal. In the event of the specified date of Tender opening being declared a holiday for the Employer, the Tenders will be opened at the appointed time and location on the next working day.

19.2 Not Applicable

19.3 The Tenderers names, the presence or absence of earnest money deposit (amount, format and validity), the submission of qualification information and such other information as the Employer may consider appropriate will be announced by the Employer at the opening.

19.4 The Employer shall prepare minutes of the Tender opening, including the information disclosed to those present in accordance with Sub-Clause 19.3

19.5 NA

19.6 The Employer will evaluate and determine whether each tender (a) meets the eligibility criteria defined in ITT Clause 2; (b) is accompanied by the required earnest money deposit as per stipulations in ITT Clause and (c) meets the minimum qualification criteria stipulated in ITT Clause 3. The Employer will draw out a list of qualified Tenderers.

20. Opening of Financial Bid (Second Cover) of qualified Tenderers and evaluation:

20.1 The Employer will inform all the Qualified Tenderers the time, date and venue fixed for the opening of the Financial Bid (Second Cover) containing the priced Tenders. The Employer will open online Financial Bid (Second Cover's) of Qualified Tenderers at the date, time and the venue specified in the e-procurement portal, in the presence of the Tenders or their representatives who choose to attend. In the event of the specified date of Financial Bid (Second Cover) opening being declared a holiday for the Employer, the Financial Bid (Second Cover's) will be opened at the appointed time and location on the next working day.

20.2 Not Applicable

20.3 The Tenderer's names, the Tender prices, the total amount of each Tender, and such other details as the Employer may consider appropriate, will be announced by the Employer at the opening.

20.4 The employer shall prepare minutes of the tender opening including the information disclosed to those present in accordance with the sub clause 20.3

21. Process to be confidential

21.1 Information relating to the examination, clarification, evaluation, and comparison of Tenders and recommendations for the award of a contract shall not be disclosed to Tenderers or any other persons not officially concerned with such process until the award to the successful Tenderer has been announced. Any effort by a Tenderer to influence the Employer's processing of Tenders or award decisions may result in the rejection of his Tender.

22 Clarification of Tenders

22.1 To assist in the examination, evaluation, and comparison of Tenders, the Employer may, at his discretion, ask any Tenderer for clarification of his Tender, including breakdowns of unit rates. The request for clarification and the response shall be in writing or by cable, but no change in the price or substance of the Tender shall be sought, offered, or permitted.

22.2 Subject to sub-clause 22.1, no Tenderer shall contact the Employer on any matter relating to its Tender from the time of the Tender opening to the time the contract is awarded. If the Tenderer wishes to bring additional information to the notice of the Employer, it should do so in writing.

22.3 Any effort by the Tenderer to influence the Employer in the Employer's Tender evaluation, Tender comparison or contract award decisions may result in the rejection of the Tenderers' Tender.

23. Examination of Tenders and determination of responsiveness

23.1 Prior to the detailed evaluation of Tenders, the Employer will determine whether each Tender; (a) has digitally signed; and; (b) is substantially responsive to the requirements of the Tender documents.

23.2 A substantially responsive Tender is one which conforms to all the terms, conditions, and specifications of the Tender documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with the Tender documents, the Employer's rights or the Tenderer's obligations under the Contract; or (c) whose rectification would affect unfairly the competitive position of other Tenderers presenting substantially responsive Tenders.

23.3 If a Tender is not substantially responsive, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the nonconforming deviation or reservation.

24. Correction of errors

The Tenderer can do Modification/corrections/changes to their bids till the last time and date of submission of bid in e-Procurement Portal only

25. Evaluation and comparison of Tenders

25.1 The Employer will evaluate and compare only the Tenders determined to be substantially responsive in accordance with Clause 23.

25.2 The Employer reserves the right to accept or reject any variation, deviation, or alternative offer. Variations, deviations, and alternative offers and other factors which are in excess of the requirements of the Tender documents or otherwise result in unsolicited benefits for the Employer shall not be taken into account in Tender evaluation.

25.4 The estimated effect of the price adjustment conditions under Clause 41 of the Conditions of Contract, during the implementation of the Contract, will not be taken into account in tender Evaluation

25.5 If the tender of the successful tenderer is seriously unbalanced in relation to the Employer's estimate of the cost of the work to be performed under the contract, the Employer may require the Tenderer to produce detailed price analysis 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 Employer may require that the amount of the performance security set forth in Clause 29 be increased at the expense of the successful Tenderer to a level sufficient to protect the Employer against financial loss in the event of default of the successful under the contract.

F. Award of Contract

26. Award criteria

26.1 Subject to Clause 27, the Employer will award the Contract to the Tenderer whose Tender has been determined to be substantially responsive to the Tender documents and who has offered the lowest evaluated Tender Price, provided that such Tenderer has been determined to be (a) eligible in accordance with the provisions of Clause 2, and (b) qualified in accordance with the provisions of Clause 3.

Tenderer will be selected based on total Tender Price (Capex Price + Opex Price with NPV) inclusive of applicable taxes.

Since the payments to the Contractor shall be made over several years, the Net Present Value (NPV) method will be used for evaluation of the Commercial bids, so as to bring all tenderers to a common denomination for determination of lowest bidder. The Bidder shall quote their O&M rates as per their own assessment. However, the Authority will calculate the NPV of the quoted amount as per the formula below for the purpose of evaluation. The Net Present Value of a contract is equal to the sum of the present values of all the cash flows associated with it. The formula for calculating NPV of a Commercial bid is illustrated below:

$P = C + [(O1) / (1+r)] + [(O2 / (1+r)^2] + [(O3) / (1+r)^3] + [(O4) / (1+r)^4]$
Where: P= Final Price
C = Total Capex Price,
O1 = Opex Price for Year 2,
O2 = Opex Price for Year 3,
O3 = Opex Price for Year 4,
O4 = Opex Price for Year 5

r = Rate of Interest / Discounting Rate at 10%

In order to equitably compare different O&M charges for different years, NPV (Net Present Value) would be used at Discounting Rate (r) to bring the O&M cost at the same footing in the assessment of total Tender Price.

Bidder shall quote O&M support cost for all the 5 years. However the rate and amount quoted for 1st year maintenance (DLP) will not be considered for financial evaluation.

27. Employer's right to accept any Tender and to reject any or all Tenders

27.1 Notwithstanding Clause 26, the Employer reserves the right to accept or reject any Tender, and to cancel the Tender process and reject all Tenders, at any time prior to the award of Contract, without thereby incurring any liability to the affected Tenderer or Tenderers or any obligation to inform the affected Tenderer or Tenderers of the grounds for the Employer's action.

28. Notification of award and signing of Agreement

28.1 The Tenderer whose Tender has been accepted will be notified of the award by the Employer prior to expiration of the Tender validity period by, e-mail or facsimile or e-procurement portal or through letter. This letter (hereinafter and in the *Conditions of Contract* called the "Letter of Acceptance") will state the sum that the Employer will pay the Contractor in consideration of the execution, completion, and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").

28.2 The notification of award will constitute the formation of the Contract, subject only to the furnishing of Security deposit in accordance with the provisions of Clause 29.

28.3 The Agreement will incorporate all agreements between the Employer and the successful Tenderer. It will be kept ready for signature of the successful Tenderer in the office of Employer within 30 days following the notification of award along with the Letter of Acceptance. Within 20 days of receipt, the successful Tenderer will sign the Agreement and deliver it to the Employer.

28.4 Upon the furnishing by the successful Tenderer of the Performance Security, the Employer will promptly notify the other Tenderers that their Tenders have been unsuccessful.

29. Security deposit

29.1 Within 20 days of receipt of the Letter of Acceptance, the successful Tenderer shall deliver to the Employer a Security deposit in any of the forms given below for an amount equivalent to 5% of the Contract price plus Additional Security for Unbalanced Tenders* in accordance with Clause 25.5 of the ITT and clause 43 of the conditions of contract. **

-Deleted, or

-A bank guarantee in the form given in Section 10; or

-Deleted

*(Unbalanced Tender is defined as a tender where the tender premium is negative beyond 10%, Additional Security shall be collected for all Tenders whose Tender Premium is negative beyond 10%, and no Additional Security shall be collected for all tenders whose Tender Premium is upto Minus 10%. Additional Security shall be collected only to the extent of negative premium beyond minus 10%).

** Modified clause inserted vide circular no; ನಅಇ 410 ಸಮಸ 2017 Dated: 20.02.2018

29.2 If the security deposit is provided by the successful Tenderer in the form of a Bank Guarantee, it shall be issued either by a Nationalized/Scheduled bank.

29.3 The security deposit if furnished in demand draft can, if requested, be converted to interest bearing securities at the cost of the contractor.

29.4 Failure of the successful Tenderer to comply with the requirements of Sub-Clause 29.1 shall constitute sufficient grounds for cancellation of the award and forfeiture of the Earnest money deposit.

30 Advance Payment and Security:

30.1 The Employer will provide an advance payment on the contract price as stipulated in the Conditions of Contract, subject to the maximum amount as stated in the Contract Data.

31. Corrupt or Fraudulent practices

31.1 The Government of Karnataka (GOK) requires that the Tenderers/Suppliers/Contractors, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy, GOK:

(a) will reject a proposal for award if it determines that the Tenderer recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question;

(b) will declare a firm ineligible, either indefinitely or for a stated period of time, to be awarded a GOK contract if it at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing, a GOK contract.

31.2 Furthermore, Tenderers shall be aware of the provision stated in sub-clause 50.2 of the Conditions of Contract.

SECTION 3: QUALIFICATION INFORMATION

The information to be filled in by the Tenderer hereunder will be used for purposes of computing Tender capacity as provided for in Clause 3 of the Instructions to Tenderers. This information will not be incorporated in the Contract.

1.1 Constitution or legal status of Tenderer [Attach copy]

Place of Registration _____ (Attach Copy)

Principal place of business: _____

1.2 Total value of works executed and payments received in the last five years in Rs. Lakhs (certificate by Charted Accountant to be attached)

2017-18
2016-17
2015-16
2014-15
2013-14

1.3 Work performed as Prime Contractor (in the same name) on works of similar nature over during the five years specified in 1.2 above.

Project Name	Name of Employer	Description of Work	Contract Number	Value of contract Rs Lakhs	Date of issue of Work	Specified period of completion	Actual date of completion	Remarks explaining reasons for delay in completion of work
1	2	3	4	5	6	7	8	9

Note: The statements showing the value of existing commitments and on-going works as well as the stipulated completion period, remaining period for each of the works listed should be countersigned by the Employer in charge, not below the rank of an Executive Engineer or equivalent.

1.4 Quantities of work executed as prime contractor (in the same name) during the last five years specified in 1.2 above:

Year	Name of Work	Name of Employer	Quantity of work performed (As per Section 3 Qualification of the Tenderer Clause 3.2 (c))	Remarks (Indicate contract reference)
1	2	3	4	5
2013-14				
2014-15				
2015-16				
2016-17				
2017-18				

1.5 Information on works for which Tenders have been submitted and works which are yet to be completed as on the date of this Tender.

(A) Existing commitments and on-going works:

Description of Work	Place & State	Contract No. & Date	Name & Date Address of Employer	Value of Contract (Rs. Lakhs)	Stipulated period of completion	Value of works remaining to be completed (Rs. Lakhs)	Anticipated date of completion
1	2	3	4	5	6	7	8

(B) Works for which Tenders already submitted:

Description of Work	Place & State	Name & Date Address of Employer	Estimated value of works (Rs. Lakhs)	Stipulated period of completion	Date when decision is expected	Remarks if any
1	2	3	4	5	6	7

1.6 The following items of equipment are considered essential for successfully carrying out the works. The tenderer should furnish all the information listed below.

Item of Equipment	Requirement No. Capacity	Owned	Owned and available Number/Capacity Age/Condition	Remarks
(as specified in clause 3.3)				

1.7 Reports on the financial standing of the tenderer, such as profit and loss statements and auditor's reports for the last five years;

1.8 Qualification and experience of the key technical and management personnel in permanent employment with the tenderer and those that are proposed to be deployed on this contract, if awarded.

Position*	Qualifications	Years of experience (general)	Years of experience in the proposed position
Project Manager-1Nos	Graduate in Civil Engineering	10 years	3years
Site Engineer civil -1 Nos	Graduate in Civil Engineering	5 years	3years
Site Engineer (Ele) -1 Nos	Graduate in Electrical Engineering	5 years	3 years

1.9 Name, address, and telephone, telex, and fax numbers of the Tenderers' bankers who may provide references if contacted by the Employer.

1.10 Evidence of access to financial resources to meet the qualification requirement specified in ITT Clause3.3 (b): Cash in hand, Letter of Credit etc. List them below and attach certificate from the Banker in the suggested format as under:

1.11 Deleted

1.12 Information on litigations in which the Tenderer is involved:

Other Party (ies)	Employer	Details of dispute	Amount involved	Remarks showing present status
1	2	3	4	5

1.13 The proposed methodology and program of construction, backed with equipment planning and deployment, duly supported with broad calculations and quality control procedures proposed to be adopted, justifying their capability of execution and completion of the work as per technical specifications within the stipulated period of completion as per milestones.

SECTION 4: FORMS OF TENDER, LETTER OF ACCEPTANCE, NOTICE TO PROCEED WITH THE WORK AND AGREEMENT FORM

Form of Tender

Description of the Works ----------

Tender

To :
Address :

GENTLEMEN,

We offer to execute the Works described above in accordance with the Conditions of Contract accompanying this Tender for the Contract Price of

This Tender and your written acceptance of it shall constitute a binding contract between us. We understand that you are not bound to accept the lowest or any tender you receive.

The advance payment required is Rs Lakhs
We undertake that, in competing for (and, if the award is made to us, in executing) the above contract, we will strictly observe the laws against fraud and corruption in force in India namely "Prevention of Corruption Act 1988".

We hereby confirm that this Tender complies with the Tender validity and Earnest money deposit required by the Tender documents.

We attach herewith our current income-tax clearance certificate.

Authorized Signature:

Name & Title of Signatory:
_____

Name of Tenderer _____

Address: _____

_____

Letter of Acceptance
(letterhead paper of the Employer)

_____[date]

To:

_____

_____
[name and address of the Contractor]

Dear Sirs,

This is to notify you that your Tender dated _____ for execution of the ---------- for the Contract Price of Rupees ( ) [amount in words and figures], as corrected and modified in accordance with the Instructions to Tenderers is hereby accepted by our Agency.

You are hereby requested to furnish Security deposit plus additional security for unbalanced tenders in terms of Clause 25.5 of ITT, in the form detailed in Clause 29.1 of ITT for an amount of Rs.————— within 20 days of the receipt of this letter of acceptance valid up to 30 days from the date of expiry of Defects Liability Period i.e. up to 24 months from the date of Agreement (12 months for working period + 12 months for Defective liability period + 1 month and 5 years of O&M) and sign the contract, failing which action as stated in Para 29.4 of ITT will be taken.

Yours faithfully,

Authorized Signature

Name and Title of Signatory

Name of Agency

Issue of Notice to proceed with the work
(letterhead of the Employer)

————— (date)

To

————————————— (name and address of the Contractor)

—————————————

—————————————

Dear Sirs:

Pursuant to your furnishing the requisite security deposit as stipulated in ITT Clause 29.1 and signing of the contract agreement for the construction of ---------- at Tender Price of Rs.————, you are hereby instructed to proceed with the execution of the said works in accordance with the contract documents.

Yours faithfully,

Agreement Form

Agreement

This agreement, made the _____day of _____20_____, between .....(hereinafter called "the Employer") of the one part and _____ _____ _____ _____ [name and address of contractor] (hereinafter called "the Contractor") of the other part.

Whereas the Employer is desirous that the Contractor execute ---------- i.e. (hereinafter called "the Works") and the Employer has accepted the Tender by the Contractor for the execution and completion of such Works and the remedying of any defects therein at a contract price of Rupees.....

NOW THIS AGREEMENT WITNESSETH as follows:

1. In this Agreement, words and expression shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this Agreement.
2. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all aspects with the provisions of the Contract.
3. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying the defects wherein 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.
4. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz:
   i) Letter of Acceptance;
   ii) Notice to proceed with the works;
   iii) Contractor's Tender;
   iv) Contract Data;
   v) Conditions of contract (including Special Conditions of Contract);
   vi) Specifications;
   vii) Drawings;
   viii) Bill of Quantities; and
   ix) Any other document listed in the Contract Data as forming part of the contract.

In witness whereof the parties thereto have caused this Agreement to be executed the day and year first before written.

The Common Seal of _____ was hereunto affixed in the presence of:
Signed, Sealed and Delivered by the said _____ in the presence of:
Binding Signature of Employer _____
Binding Signature of Contractor _____

SECTION 5: CONDITIONS OF CONTRACT

Table of Contents

E Finishing of Contract

45. Completion
46. Taking Over
47. Final account
48. As built drawings and/or Operating and Maintenance Manuals
49. Termination
50 Payment upon termination
51. Property
52. Release from performance

F Special Conditions of Contract

Conditions of Contract

A. General

1. Definitions

1.1 Terms which are defined in the Contract Data are not also defined in the Conditions of Contract but keep their defined meanings. Bold letters are used to identify defined terms.

Bill of Quantities means the priced and completed Bill of Quantities forming part of the Tender.
Compensation events are those defined in Clause 38 hereunder.
The **Completion Date** is the date of completion of the Works as certified by the Employer in accordance with Sub Clause 46.1.
The **Contract** is the contract between the Employer and the Contractor to execute, complete and maintain the Works. It consists of the documents listed in Clause 2.2 below.
The **Contract Data** defines the documents and other information which comprise the Contract.
The **Contractor** is a person or corporate body whose Tender to carry out the Works has been accepted by the Employer.
The **Contractor's Tender** is the completed Tender document submitted by the Contractor to the Employer.
The **Contract price** is the price stated in the Letter of Acceptance and thereafter as adjusted in accordance with the provisions of the Contract.
Days are calendar days; **months** are calendar months.
A **Defect** is any part of the Works not completed in accordance with the Contract.
The **Defects liability period** is the period named in the Contract Data and calculated from the Completion Date.
The **Employer** is the party who will employ the Contractor to carry out the Works.
Equipment is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works.
The **Initial Contract price** is the Contract Price listed in the Employer's Letter of Acceptance.
The **Intended Completion Date** is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is specified in the Contract Data. The Intended Completion Date may be revised only by the Employer by issuing an extension of time.
Materials are all supplies, including consumables, used by the contractor for incorporation in the Works.
Plant is any integral part of the Works which is to have a mechanical, electrical, electronic or chemical or biological function.
The **Site** is the area defined as such in the Contract Data.
Specification means the Specification of the Works included in the Contract and any modification or addition made or approved by the Employer.
The **Start Date** is given in the Contract Data. It is the date when the Contractor shall commence execution of the works. It does not necessarily coincide with any of the Site Possession Dates.
A **Variation** is an instruction given by the Employer which varies the Works.
The **Works** are what the Contract requires the Contractor to construct, install, and turn over to the Employer, as defined in the Contract Data.

2. Interpretation

2.1 In interpreting these Conditions of Contract, singular also means plural, male also means female or neuter, and the other way around. Headings have no significance. Words have their normal meaning under the language of the Contract unless

specifically defined. The Employer will provide instructions clarifying queries about the Conditions of Contract.

2.2 The documents forming the Contract shall be interpreted in the following order of priority:

(1) Agreement
(2) Letter of Acceptance, notice to proceed with the works
(3) Contractor's Tender
(4) Contract Data
(5) Conditions of Contract
(6) Specifications
(7) Drawings
(8) Bill of quantities and
(9) Any other document listed in the Contract Data as forming part of the Contract.

3. Law governing contract

3.1 The law governing the Contract is the Laws of India supplanted by the Karnataka Local Acts.

4. Employer's decisions

4.1 Except where otherwise specifically stated, the Employer will decide contractual matters between the Employer and the Contractor.

5. Delegation

5.1 The Employer may delegate any of his duties and responsibilities to other people after notifying the Contractor and may cancel any delegation after notifying the Contractor.

6. Communications

6.1 Communications between parties which are referred to in the conditions are effective only when in writing. A notice shall be effective only when it is delivered (in terms of Indian Contract Act).

7. Sub contracting

7.1 The Contractor may subcontract with the approval of the Employer but may not assign the Contract without the approval of the Employer in writing. Subcontracting does not alter the Contractor's obligations.

8. Other Contractors

8.1 The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and the Employer.

9. Personnel

9.1 The Contractor shall employ the technical personnel (of number and qualifications) as may be stipulated by GOK from time to time during the execution of the work. The technical staff so employed shall be available at site as may be stipulated by the Employer.

9.2 If the Employer asks the Contractor to remove a person who is a member of the Contractor's staff or his work force stating the reasons, the Contractor shall ensure that the person leaves the Site within seven days and has no further connection with the work in the Contract.

10. Employer's and Contractor's risks

10.1 The Employer carries the risks which this Contract states are Employer's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.

11. Employer's risks

11.1 The Employer is responsible for the excepted risks which are:

(a) rebellion, riot commotion or disorder unless solely restricted to employees of the Contractor or his Sub-Contractors arising from the conduct of the Works; or

(b) a cause due solely to the design of the Works, other than the Contractor's design; or

(c) any operation of the forces of nature (in so far 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 such loss or damage

12. Contractor's risks

12.1 All risks of loss of or damage to physical property and of personal injury and death which arise during and in consequence of the performance of the Contract other than the excepted risks are the responsibility of the Contractor.

13. Insurance:

13.1 The Contractor shall prior to commencing the works, effect and thereafter maintain insurances , in the joint names of the Employer and the Contractor, (cover from the first working day after the Start Date to the end of Defects Liability Period), in the amounts stated in the Contract Data :

(a) for loss of or damage to the Works, Plants and Materials and the Contractor's equipment;

(b) for liability of both Parties for loss, damage, death and injury to third parties or their property arising out of the Contractor's performance of the Contract including the Contractor's liability for damage to the Employer's property other than the Works and

(c) for liability of both Parties and of any Employer's representative for death and injury to the Contractor's personnel except to the extent that liability arises from the negligence of the Employer, any Employer's representative or their Employees.

13.2 Policies and certificates for insurance shall be delivered by the Contractor to the Employer for his approval before the Start Date. All such insurance shall provide for compensation to be payable to rectify the loss or damage incurred. All payments received from insurers relating to loss or damage shall be held jointly by the Parties and used for the repair of the loss or damage or as compensation for loss or damage that is not to be repaired.

13.3 If the Contractor fails to effect or keep in force any of the insurances referred to in the previous sub-clauses or fails to provide satisfactory evidence, policies or receipts, the Employer may without prejudice to any other right or remedy, effect insurance for the cover relevant to such default and pay the premiums due and recover the same as a deduction from any other monies due to the Contractor. If no payments is due, the payment of the premiums shall be a debt due.

13.4 Alterations to the terms of insurance shall not be made without the approval of the Employer.

13.5 Both Parties shall comply with any conditions of the insurance policies.

14. Site Investigation Reports:

14.1 The Contractor, in preparing the tender, shall rely on any site investigation reports

referred to in the Contract data, supplemented by any information available to the Tenderer.

15. Queries about the Contract Data

15.1 The Employer will clarify queries on the Contract Data.

16. Contractor to construct the Works

16.1 The Contractor shall construct the Works in accordance with the Specification and Drawings.

17. The Works to be completed by the Intended Completion Date

17.1 The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the program submitted by the Contractor, as updated with the approval of the Employer, and complete them by the Intended Completion Date.

18. Approval by the Employer:

18.1 The Contractor shall submit Specification and drawings showing the proposed Temporary Works to the Employer, who is to approve them if they comply with the Specifications and Drawings.

18.2 The Contractor shall be responsible for the design of Temporary Works

18.3 The Employer's approval shall not alter the Contractor's responsibility for design of the Temporary Works.

18.4 The Contractor shall obtain approval of third parties to the design of third parties to the design of the temporary Works where required.

18.5 All Drawings prepared by the Contractor for the execution of the temporary or permanent Works, are subject to prior approval by the Employer before their use.

19. Safety

19.1 The Contractor shall be responsible for the safety of all activities on the Site.

20. Discoveries

20.1 Anything of historical or other interest or of significant value unexpectedly discovered on the Site is the property of the Employer. The Contractor is to notify the Employer of such discoveries and carry out the Employer's instructions for dealing with them.

21. Possession of the Site

21.1 The Employer shall give possession of all parts of the Site to the Contractor. If possession of a part is not given by the date stated in the Contract Data the Employer is deemed to have delayed the start of the relevant activities and this will be Compensation Event.

22. Access to the Site

22.1 The Contractor shall allow the Employer and any person authorized by the Employer access to the Site, to any place where work in connection with the Contract is being carried out or is intended to be carried out and to any place where materials or plant are being manufactured / fabricated / assembled for the works.

23. Instructions

23.1 The Contractor shall carry out all instructions of the Employer which comply with the applicable laws where the Site is located.

24. Procedure for resolution of Disputes (Not Applicable):

24.1 If the Contractor is not satisfied with the decision taken by the Employer, the dispute shall be referred by either party to Arbitration within 30 days of the notification of the Employer's decision.

24.2 If neither party refers the dispute to Arbitration within the above 30 days, the

Employer's decision will be final and binding.

24.3 The Arbitration shall be conducted in accordance with the arbitration procedure stated in the Special Conditions of Contract.

B. Time Control

25. Program

25.1 Within the time stated in the Contract Data the Contractor shall submit to the Employer for approval a Program showing the general methods, arrangements, order, and timing for all the activities in the Works.

25.2 The Employer's approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the Employer again at any time. A revised Program is to show the effect of Variations and Compensation Events.

26. Extension of the Intended Completion Date

26.1 The Employer shall extend the Intended Completion Date if a Compensation Event occurs or a Variation is issued which makes it impossible for Completion to be achieved by the Intended Completion Date.

26.2 The Employer shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Employer for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information.

27. Delays ordered by the Employer

27.1 The Employer may instruct the Contractor to delay the start or progress of any activity within the Works.

28. Management meetings

28.1 The Employer may require the Contractor to attend a management meeting. The business of a management meeting shall be to review the progress achieved and the plans for remaining work.

28.2 The responsibility of the parties for actions to be taken is to be decided by the Employer either at the management meeting or after the management meeting and stated in writing to be distributed to all who attended the meeting.

C. Quality Control

29. Identifying defects

29.1 The Employer shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Employer may instruct the Contractor to search for a Defect and to uncover and test any work that the Employer considers may have a Defect

30. Tests

30.1 If the Employer instructs the Contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect the test shall be a Compensation Event.

31. Correction of defects

31.1 The Employer shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion and is defined in the Contract Data. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.

31.2 Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Employer's notice.

32. Uncorrected defects

32.1 If the Contractor has not corrected a Defect within the time specified in the Employer's notice, the Employer will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

D.Cost Control

33. Bill of Quantities (BOQ)

33.1 The BOQ shall contain items for the construction, installation, testing, and commissioning work to be done by the Contractor.

33.2 The BOQ is used to calculate the Contract Price. The Contractor is paid for the quantity of the work done at the rate in the BOQ for each item

34. Variations

34.1 The Employer shall have power to order the Contractor to do any or all of the following as considered necessary or advisable during the progress of the work by him

(a) Increase or decrease of any item of work included in the Bill of Quantities (BOQ);
(b) Omit any item of work;
(c) Change the character or quality or kind of any item of work;
(d) Change the levels, lines, positions and dimensions of any part of the work;
(e) Execute additional items of work of any kind necessary for the completion of the works; and
(f) Change in any specified sequence, methods or timing of construction of any part of the work.

34.2 The Contractor shall be bound to carry out the work in accordance with any instructions in this connection, which may be given to him in writing by the Employer and such alteration shall not vitiate or invalidate the contract.

34.3 Variations shall not be made by the Contractor without an order in writing by the Employer, provided that no order in writing shall be required for increase or decrease in the quantity of an item appearing in the BOQ so long as the work executed conforms to the approved drawings.

34.4 The Contractor shall promptly request in writing to the Employer to confirm verbal orders and the officer issuing oral instructions shall confirm it in writing within 30 days, failing which the work shall be carried out as though there is no variation. In case variation is approved it shall be accompanied by BOQ failing which the contractor shall be responsible for deviation if any. Further approval of Govt has to be obtained for the variation exceeding 5 %.

35. Payments for Variations

35.1 Payment for increase in the quantities of an item in the BOQ up to 25% of that provided in the Bill of Quantities shall be made at the rates quoted by the Contractor.

35.2 For quantities in excess of 125% of the tendered quantity of an item as given in the BOQ, the Contractor shall be paid at the rate entered in or derived from in the Schedule of Rates (applicable for the area of the work and current at the time of award of contract) plus or minus the overall percentage of the original tendered rates over the current Schedule of Rates prevalent at the time of award of contract.

35.3 If there is no rate for the additional, substituted or altered item of the work in the BOQ, efforts would be made to derive the rates from those given in the BOQ or the Schedule of Rates (applicable for the area of the work and current at the time of award of contract) and if found feasible the payment would be made at the derived rate for the item plus or minus the overall percentage of the original tendered rates over the current Schedule of Rates prevalent at the time of award of contract

35.4 If the rates for additional, substituted or altered item of work cannot be determined either as at 35.1 or 35.2 or 35.3 above, the Contractor shall be requested to submit his quotation for the items supported by analysis of the rate or rates claimed, within 7

days.

35.5 If the Contractor's quotation is determined unreasonable, the Employer may order the Variation and make a change to the Contract Price which shall be based on Employer's own forecast of the effects of the Variation on the Contractor's costs.

35.6 If the Employer decides that the urgency of varying the work would prevent a quotation being given and considered without delaying the work, no quotation shall be given and the Variation shall be treated as a Compensation Event.

35.7 Under no circumstances the Contractor shall suspend the work on the plea of non-settlement of rates for items falling under this Clause.

36. Submission of bills for payment

36.1 The Contractor shall submit to the Employer monthly bills of the value of the work completed less the cumulative amount paid previously.

36.2 The Employer shall check the Contractor's bill and determine the value of the work executed which shall comprise of (i) value of the quantities of the items in the BOQ completed and (ii) valuation of Variations and Compensation Events.

36.3 The Employer may exclude any item paid in a previous bill or reduce the proportion of any item previously paid in the light of later information.

37. Payments

37.1 Payments shall be adjusted for deductions for advance payments, other than recoveries in terms of the contract and taxes, at source, as applicable under the law. The Employer shall pay the Contractor within 60 days of submission of bill. The contractor shall be liable to pay liquidated damages for shortfall in progress.
For progress beyond the agreed programme payment is subject to availability of the grants.

37.2 Items of works for which no rate or price has been entered in will not be paid for by the employer and shall be deemed covered by other rates and prices in the Contract.

38. Compensation events

38.1 The following are Compensation events unless they are caused by the Contractor:

(a) The Employer does not give access to a part of the Site by the Site Possession Date stated in the Contract Data.
(b) The Employer orders a delay or does not issue drawings, specifications or instructions required for execution of works on time.
(c) The Employer instructs the Contractor to uncover or to carry out additional tests upon work which is then found to have no Defects.
(d) The Employer gives an instruction for dealing with an unforeseen condition, caused by the Employer, or additional work required for safety or other reasons.
(e) The effect on the Contractor of any of the Employer's Risks.
(f) The Employer unreasonably delays issuing a Certificate of Completion.
(g) Other Compensation Events listed in the Contract Data or mentioned in the Contract.

38.2 If a Compensation Event would cause additional cost or would prevent the work being completed before the Intended Completion Date, the Contract Price shall be increased and/or the Intended Completion Date is extended. The Employer shall decide whether and by how much the Contract Price shall be increased and whether and by how much the Intended Completion Date shall be extended.

38.3 As soon as information demonstrating the effect of each Compensation event upon the Contractor's forecast cost has been provided by the Contractor, it is to be assessed by the Employer and the Contract Price shall be adjusted accordingly. If the Contractor's forecast is deemed unreasonable, the Employer shall adjust the Contract Price based on Employer's own forecast. The Employer will assume that the Contractor will react competently and promptly to the event.

38.4 The Contractor shall not be entitled to compensation to the extent that the Employer's interests are adversely affected by the Contractor not having given early

warning or not having cooperated with the Employer.

39. Tax

39.1 The rates quoted by the Contractor shall be deemed to be inclusive of the sales tax , labour welfare cess and other taxes that the Contractor will have to pay for the performance of this Contract. The Employer will perform such duties in regard to the deduction of such taxes at source as per applicable law.

40. **Price Adjustment: (Refer GOK Order No.FD 59 Pro.Cell 2004, Bangalore Dated 26th November 2004** AND **Government order No. FD 3 PCL 2008, Bangalore, Dated :21-11-2008)**

As per Government order No. FD 3 PCL 2008, Bangalore dated 21.11.2008;

"If the period of execution is more than 6 months but less than or equal to 12 months for work costing more than Rs.50.00 Lakhs, star rates in respect of specified materials (Cement, Steel and Bitumen) only shall be payable to the contractor based on the all India average wholesale price index for the said materials. The star rates adjustment shall be as per the increase or decrease in the index as applied to the said materials between the last date for receiving bids and the date of execution as per the approved programme of works submitted by the contractor at the time of execution of agreement which shall mandatorily be a part of the agreement"

40.1 Contract price shall be adjusted for increase or decrease in rates and prices of labour, materials, fuels and lubricants in accordance with the following principles and procedures and as per formulae given in the Contract Data.

(a) The price Adjustment shall apply for the work done from the date of commencement up to the end of original period of completion or extensions granted by the Employer and shall not apply to work carried out beyond the stipulated period of completion for reasons attributable to the Contractor;
(b) Price Adjustment shall be admissible from the date of opening of tenders (original or extended)
(c) The price adjustment shall be determined during each quarter from the formulae given in Contract Data.
(d) Following expressions and meanings are assigned to the work done during the quarter:

R = Total value of work done during the quarter. It will **exclude** value for works executed under variations for which price adjustment (if any) will be worked out separately based on the terms mutually agreed.

40.2 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 included in the contract shall be deemed to include amounts to cover the contingency of such other rise or fall in costs.

41. Liquidated damages

41.1 The Contractor shall pay liquidated damages to the Employer at the rate per day stated in the Contract Data for each day that the Completion Date is later than the Intended Completion Date (for the whole of the works or the milestone as stated in the Contract Data). The total amount of liquidated damages shall not exceed the amount defined in the Contract Data. The Employer may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages does not affect the Contractor's liabilities.

41.2 If the Intended Completion Date is extended after liquidated damages have been paid, the Employer shall correct any overpayment of liquidated damages by the

Contractor by adjusting the next payment of bill.

42. Advance Payments:

42.1 The Employer shall make payment to the Contractor of the amounts stated in the Contract Data by the date stated in the Contract Data, against provision by the Contractor of an unconditional bank guarantee in a form acceptable to the Employer issued by a Nationalized/Scheduled Bank in amounts equal to the advance payment. The guarantee shall remain effective until the advance payment has been repaid, but the amount of the guarantee shall be progressively reduced by the amounts repaid by the Contractor. Interest will not be charged on the advance payment.

42.2 The Contractor is to use the advance payment only to pay for Mobilization expenses required specifically for execution of the Works. The Contractor shall demonstrate that advance payment has been used in this way by supplying copies of invoices or other documents to the Employer.

42.3 The advance payment shall be repaid by deducting proportionate amounts from payments otherwise due to the Contractor, following the schedule of completed percentages of the Works on a payment basis. No account shall be taken of the advance payment or its repayment in assessing valuation of the work done, variations, price adjustments, compensation events or liquidated damages.

43. Securities:

The Security deposit (including additional security for unbalanced tenders) shall be provided to the Employer no later than the date specified in the Letter of Acceptance and shall be issued in an amount and form and type of instrument acceptable to the Employer. The Security deposit shall be valid until a date 30 days from the date of expiry of Defects Liability Period and the additional security for unbalanced tenders shall be valid until a date 30 days from the date of issue of the certificate of completion.

44. Cost of Repairs:

44.1 Loss or damage to the Works or Materials to be incorporated in the Works between the Start Date and the end of the Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions.

E. Finishing the Contract

45. Completion

45.1 The Contractor shall request the Employer to issue a Certificate of Completion of the Works and the Employer will do so upon deciding that the Work is completed.

46. Taking over

46.1 The Employer shall take over the Site and the Works within seven days of issuing a certificate of Completion.

47. Final account

47.1 The Contractor shall supply to the Employer a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Employer shall issue a Defect Liability Certificate and certify any final payment that is due to the Contractor within 90 days of receiving the Contractor's account if it is correct and complete. If it is not, the Employer shall issue within 90 days a schedule that states the scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the

Employer shall decide on the amount payable to the Contractor and make payment within 60 days of receiving the Contractor's revised account.

48. As built drawings and /or Operating and Maintenance Manuals

48.1 If "as built" Drawings and/or operating and maintenance manuals are required, the Contractor shall supply them by the dates stated in the Contract Data.

48.2 If the Contractor does not supply the Drawings by the dates stated in the Contract Data, or they do not receive the Employer's approval, the Employer shall withhold the amount stated in the Contract Data from payments due to the Contractor.

49. Termination

49.1 The Employer may terminate the Contract if the other party causes a fundamental breach of the Contract.

49.2 Fundamental breaches of Contract include, but shall not be limited to the following:

(a) the Contractor stops work for 45 days when no stoppage of work is shown on the current Program and the stoppage has not been authorized by the Employer;

(b) **deleted**

(c) The Contractor becomes bankrupt or goes into liquidation other than for a reconstruction or amalgamation;

(d) **deleted**

(e) the Employer gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Employer;

(f) the Contractor does not maintain a security which is required;

(g) the Contractor has delayed the completion of works by the number of days for which the maximum amount of liquidated damages can be paid as defined in the Contract data; and

(h) if the Contractor, in the judgment of the Employer has engaged in corrupt or fraudulent practices in competing for or in the executing the Contract.
For the purpose of this paragraph : "corrupt practice" means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution. "Fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Borrower, and includes collusive practice among Tenderers (prior to or after Tender submission) designed to establish Tender prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition."

49.3 When either party to the Contract gives notice of a breach of contract to the Employer for a cause other than those listed under Sub Clause 49.2 above, the Employer shall decide whether the breach is fundamental or not.

49.4 Notwithstanding the above, the Employer may terminate the Contract for convenience.

49.5 If the Contract is terminated the Contractor shall stop work immediately, make the Site safe and secure and leave the Site as soon as reasonably possible.

50. Payment upon Termination

50.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Employer shall prepare bill for the value of the work done less advance payments received up to the date of the bill, less other recoveries due in terms of the contract, less taxes due to be deducted at source as per applicable law and less the percentage to apply to the work not completed as indicated in the Contract Data. Additional Liquidated Damages shall not apply. If the total amount due to the Employer exceeds any payment due to the Contractor the difference shall be a debt payable to the Employer.

50.2 If the Contract is terminated at the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Employer shall prepare bill for the value of the work done, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works and less advance payments received up to the date of the certificate, less other recoveries due in terms of the contract, and less taxes due to be deducted at source as per applicable law and make payment accordingly.

51. Property

51.1 All materials on the Site, Plant, Equipment, Temporary Works and Works are deemed to be the property of the Employer, if the Contract is terminated because of a Contractor’s default.

52. Release from performance

52.1 If the Contract is frustrated by any event entirely outside the control of either the Employer or the Contractor the Employer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which commitment was made

F. Special Conditions of Contract

1. Labour:

The Contractor shall, unless otherwise provided in the Contract, make his own arrangements for the engagement of all staff and labour, local or other, and for their payment, housing, feeding and transport.

The Contractor shall, if required by the Employer, deliver to the Employer a return in detail, in such form and at such intervals as the Employer may prescribe, showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such other information as the Employer may require.

2. Compliance with labour regulations:

During continuance of the contract, the Contractor and his sub contractors shall abide at all times by all existing labour enactments and rules made there under, regulations, notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules), regulations, bye laws that may be passed or notification that may be issued under any labour law in future either by the State or the Central Government or the local authority. The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by the competent authority on account of contravention of any of the provisions of any Act or rules made there under, regulations or notifications including amendments. If the Employer is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/bye laws/Acts/Rules/regulations including amendments, if any, on the part of the Contractor, Employer shall have the right to deduct any money due to the Contractor including his amount of security deposit. The Employer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer.

The employees of the Contractor and the Sub-Contractor in no case shall be treated as the employees of the Employer at any point of time.

3 Protection of Environment:

The contractor shall take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation. During continuance of the contract, the contractor and his sub-contractors shall abide at all times by all existing enactments on environmental protection and rules made there under, regulations, notifications and bye-laws of the State or Central Government, or local authorities and any other law, bye-law, regulations that may be passed or notification that may be issued in this respect in future by the State or Central Government or the local authority.

Monitoring Requirement & Specifications

No	Monitoring Requirements	Specification	Responsible agency
1	Noise levels at the construction sites (only during construction period)	Monitoring at all locations hourly basis for 24 hour period. Once every season of the year during construction period.	Contractor
2	Disposal of construction debris	Periodic inspection at haul roads and sites for construction debris for safe collection and disposal to identified land fill sites.	Contractor

No	Monitoring Requirements	Specification	Responsible agency
3	Traffic and Transportation	Measures for diverting the traffic during construction across roads within the ULB	PC in consultation with ULB and local police department
4	Domestic sewage and refuse management at the labour camps and construction sites	Check for adequacy of sanitation arrangements at the labour camps	Contractor
5	Water Pollution	Check for: • Blockage of flowing water which may lead to stagnation of water • Soil erosion due to construction activities leading to contamination and siltation of water bodies • Water contamination due to use of fuel and lubricants at the construction sites.	Contractor
6	Procurement of construction material	Check that procurement of construction materials should be only from permitted sites and quarries.	Contractor, PC

Location of Noise monitoring shall be wherever the contractor decides to locate the equipment yard and at sensitive locations such as school, hospitals, dispensary etc. In case of noise levels causing disturbance to the sensitive receptors, management measures as suggested in the EMP shall be carried out.

The implementation of Mitigation Measures is the responsibilities of the Contractor/PC/ULB. However, it may be noted that implementation of all the measures is full responsibility of Contractor. The PC/ULB would be responsible only for monitoring/supervision/guidance, etc.

4. Arbitration (Clause 24)

4.1 All disputes arising out of or in connection with this contract, not settled by amicable settlement, shall be finally referred to the Deputy Commissioner (DC) of the district. Upon such reference the DC shall attempt to amicably resolve the dispute within (60) days. If the dispute is not settled the first appeal shall be referred lie with the Secretary Urban Development Department (UDD), Govt. of Karnataka (GoK) who shall be the sole arbitrator, who will conduct the proceedings in accordance with procedures prescribed under Arbitration and Conciliation Act 1996, of India and / or its latest amendments if any. The decision of Secretary, UDD shall be binding on either party. If the dispute is not amiably settled within 60 (Sixty) days from the date of reference to Secretary, UDD or 120(One Hundred and Twenty) days from the first reference to the Board, either party may refer the dispute to the Court of Law.

41. Liquidated damages refer GCC 41,

Sub Clause 41.1

Please substitute last sentence with the following

"Time is an essence of the contract and payment or deduction of liquidated damages shall not relieve the contractor from his obligations to complete the work as per agreed construction program and milestones or from any of the contractor's obligations and liabilities under the contract"

Liquidated damages once levied as per contract data for delay of achievement of a milestone cannot be refunded even if the subsequent mile stone is achieved in time or

the entire work is completed by the intended completion date, unless the extension of time is granted for that particular milestone.

5. Death of Contractor. Refer GCC 36, the following is added

In case of the death of a contractor after executing the agreement/ commencement of the work, his legal heir, if an eligible registered contractor and willing, can execute and complete the work at the accepted tender rate irrespective of the cost of the work.

6. Establishment of Field laboratory (Clause 30)

The contractor shall establish the field testing laboratory within two weeks from the date of agreement as per the details provided in Section 6: Specification

7. Additional security for unbalanced tenders (Refer GCC 43)

Unbalanced tender is the one where the bidder quotes less than 25% of Engineers estimated cost for any one item/several items. In such a case, the additional security for Unbalanced tender shall be submitted by the bidder along with security deposit for performance security. The amount of additional security as per GCC 43 will be difference between the Engineer's estimated cost and amount quoted less than 25% of Engineer's estimated cost of all such items in BOQ.

The additional security to be provided in the form of a Bank Guarantee and it shall be issued either by a Nationalized/Scheduled bank encashable at Hubli. The Bank Guarantee shall be valid till the completion of the construction period and an additional period of 45 days.

8. The successful bidder has to Operate and Maintain the project for period of 5 years including 1 year of defect liability period. In the defect liability period also the successful bidder has to maintain the project at his own cost.

9. Operation and Maintenance (O&M) of the project:

9.1

A. Item provision and Rates:

For the O&M period, maintenance items are made available in the Schedule-C from 1st year to 5th year (including DLP) separately for quoting the competitive rates by the bidder.

The quantities provided for the yearly maintenance is arrived based on percentage of the main work BOQ. The quantities are tentative in nature and vary as per the site conditions. The bidder has to work out the rates for each year, item wise and quote the rates accordingly. If the bidder does not quote or quotes rupees "zero" against the item, then contractor shall execute all such items of work at his own cost.

Maintenance BOQ items are available under the following headings;

1. Operation & Maintenance for 1st Year (DLP)#
2. Operation & Maintenance for 2nd Year
3. Operation & Maintenance for 3rd Year
4. Operation & Maintenance for 4th Year
5. Operation & Maintenance for 5th Year

Note:

1st year O&M (DLP) items are only for rate purpose and the same will not be considered for financial evaluation.

- Annual 4% escalation on rates for the base year of 2018-19 for each item has been considered to arrive at the O&M cost for each year during O&M period.

B. Defect liability period (1 year) after completion of construction activities:

During the Defect liability period (DLP) of 1 year, contractor shall maintain the project area at his own cost. Payment will not be made from HDSCL towards the maintenance. Works involved during the DLP which may not be limited to the following:

i. Drain Maintenance: Maintenance of drains in full operation condition by cleaning, clearing, removal of silt, debris, etc., from grit chambers and it's pipe, drains, culverts, weep holes, utility chambers (Power/OFC/Cross duct), manhole covers, etc., wherever required, including disposal of silts/sediments, excess material from site with all leads and lifts, including materials, equipments, machineries, labour, complete in all respect as directed by the Engineer in charge of work and as per latest MORT&H/ KRBS Specifications.
ii. Maintenance of landscaping/horticulture/trees/plants as per the requirement of the species (Watering, cleaning of weed, trimming, etc.,) inclusive of material, tools, equipments, machineries, labor, complete and as per the directions of Engineer-In-Charge of work.
iii. Rectification of any structures such as Drain cover slabs, utility chamber cover slabs, paver blocks on footpath/utility corridor area, bollards, hand railings, sign boards, kerb stones, etc., which are damaged/ dislodged/ distressed/ wear & tear due to construction defects as per the direction of Engineer in charge of work.
iv. Manpower, equipment/machineries, materials, consumables, etc., complete for the above works shall be at contractors cost.
v. For the above purpose, the contractor shall retain key personnel at site who shall be always available as bidder representative in dealing with employer during DLP and O&M period.
vi. If the contractor fails to carry out the works as specified in the contract, the same maybe got done by the employer at risk and cost of bidder and the amount recovered out of work bills/security deposit and/or performance security amount with employer.
vii. However, for any additional works to be executed in the project area / damage observed in the project area which has been created by a third party with un intentional/ intentional incidents which is not part of the routine maintenance as listed above., such items of rectification/ restoration works is required to be executed by the contractor as per the quoted rates for 1st year O&M as in Schedule "C". The quantities are tentative in nature and can vary based on the site conditions; the contractor will identify such requirements and inform the SPV of such requirements immediately upon occurrence of such incidents. Based on the intimation by contractor, a joint inspection needs to be arranged by the contractor with the SPV team for finalization of such works including the items and the quantities that is required to be executed. Based on the written confirmation of the SPV, the woks shall be executed. The payment for all such works/quantities will be made as per the rates quoted/rationalized during the bidding stage/agreement.

C. Routine & Repair Maintenance (4 years) after DLP:

During the Operation & Maintenance period for next 4 years after completion of DLP, contractor shall maintain the project area with item wise rate quoted/rationalized. Works involved during the O&M which may not be limited to the following:

i. Drain Maintenance: Maintenance of drains in full operation condition by cleaning, clearing, removal of silt, debris, etc., from grit chambers and it's pipe, drains, culverts, weep holes, utility chambers (Power/OFC/Cross duct),

manhole covers, etc., wherever required, including disposal of silts/sediments, excess material from site with all leads and lifts, including materials, equipments, machineries, labour, complete in all respect as directed by the Engineer in charge of work and as per latest MORT&H/ KRBS Specifications.

ii. Maintenance of landscaping/horticulture/trees/plants as per the requirement of the species (Watering, cleaning of weed, trimming, replacing of dead plants, etc.,) inclusive of material, tools, equipments, machineries, labor, complete and as per the directions of Engineer-In-Charge of work.

iii. Rectification of any structures such as Drain cover slabs, utility chamber cover slabs, paver blocks on footpath/utility corridor area, bollards, hand railings, sign boards, kerb stones, etc., which are damaged/dislodged/distressed/wear & tear due to construction defects as per the direction of Engineer in charge of work.

iv. Filling Pot-holes and Patch Repairs on roads within the stipulated time period.

v. Any other items of works required to maintain the project area in good shape and condition of usage.

During the O&M period, the contractor will submit the quarterly invoices for routine and repair maintenance and bill for all such items will be paid as per the quoted/rationalized rates, for the items for the respective year of O&M period for the actual executed quantities.

All activities related to their work including setup of office for execution of work /field staff, and its working, labor camp, residential quarters, transit accommodation /transportation of their manpower and equipments will be done by contractor at their own cost with no extra amount payable. All type of fuel, diesel, oil, lubes for day-to-day working operation and maintenance of works and execution of works will be procured and managed by contractor at their own cost.

D. Penalty for poor performance

The contractor shall guarantee & maintain the design parameters such as riding surface, road utilities like drain, horticulture, footpath, street furniture, etc., throughout the Operation & Maintenance Period of 5 years (Including 1 year DLP). The contractor shall achieve the Performance Targets during the contract term to enhance the life and reliability of the system.

Maintenance Schedules: The contractor should comply with periodic maintenance program to ensure the best possible performance and efficiency of the system. Contractor should ensure daily, weekly, monthly, quarterly, runtime maintenance of components as annexed to this bid document as Annexure 1 (b).

Labor Regulations: The contractor shall comply the local statutory Operation & Maintenance manuals, Labor Regulations.

General: The contractor shall repair or replace to the satisfaction of the engineer-in-charge of work, any or all such work that may prove defective in workmanship, equipment or materials within O&M period including ordinary wear and tear and unusual abuse or, neglect together with any other work which may be damaged or displaced in so doing. In the event of failure to comply with the above mentioned conditions within a reasonable period of time of 7 days, after being notified in writing, the engineer-in-charge of work is authorize to proceed to have the defects repaired and made good at our expense, and the contractor shall pay the cost and charges thereof immediately upon demand without any let or demure.

Penalty:

- It is emphasized that failure to provide the minimum level of service on site as mentioned will invite penalty as per quantum of work.
- If the complaints are not rectified / attended within the specified time frame then the penalty of 0.1% of the O&M cost for the respective year shall be applicable for every day delay in works subjected to maximum of 10% of the cost.
- If contractor reaches the 50% cumulative cost (from all the defaulting activities during the O&M period) of O&M by defaulting, then the entire O&M cost from there on shall be carried out by the contractor free of cost to the employer. The decision of the Engineer- in charge of work in this aspect is final.

E. O&M Security

- The successful bidder should furnish the O&M performance security in the form of Bank Guarantee or equivalent to the cost of 5% of overall maintenance cost of O&M period, after which performance security of the main work will be returned (after DLP + one month).
- The successful bidder should also furnish additional performance security in the form of bank guarantee or equivalent acceptable to HDSCL for the unbalanced tender amount in case the bidder quotes the less rates for the O&M items of O&M period as per clause (29.1).

9.2 Since the payments to the Contractor shall be made over several years, the Net Present Value (NPV) method will be used for evaluation of the Commercial bids. The Bidder shall quote their O&M rates as per their own assessment. The Authority will calculate the NPV of the quoted amount as per the formula below. The Net Present Value of a contract is equal to the sum of the present values of all the cash flows associated with it. The formula for calculating NPV of a Commercial bid is illustrated below:

$P = C + [(O1) / (1+r)] + [(O2 / (1+r)^2] + [(O3) / (1+r)^3] + [(O4) / (1+r)^4]$
Where: P= Final Price
C = Total Capex Price,
O1 = Opex Price for Year 2,
O2 = Opex Price for Year 3,
O3 = Opex Price for Year 4,
O4 = Opex Price for Year 5,

r = Rate of Interest / Discounting Rate at 10%r = Rate of Interest / Discounting Rate at 10%
In order to equitably compare different O&M charges for different years, NPV (Net Present Value) would be used at Discounting Rate (r) to bring the O&M cost at the same footing in the assessment of total Tender Price.
Bidder shall quote O&M support cost for all the 5 years. However the rate and amount quoted for 1st year maintenance (DLP) will not be considered for financial evaluation.

10. Timeliness of the project
T0= Signing of agreement
T1= T0+12months of construction period
T2= T1+12 months - 1st year maintenance (defect liability period)
T3= T2+12months - 2nd year maintenance
T4= T3+12months - 3rd year maintenance
T5= T4+12months - 4th year maintenance
T6= T5+12months - 5th year maintenance

11. The payment will be done quarterly against the invoices/claim during O&M

period.

12. Safety

The Contractor shall be responsible for the safety of all activities on the Site, such as traffic diversion, barricading around work site, applicable permits as may be required from MESCOM / Water Board / Telecom etc. Provision of reflectors / delineators / safety ribbons / lighting /sign boards or information boards shall be made at work site.

13. Additional security for unbalanced tenders (Refer GCC 43)

Within 20 days of receipt of the Letter of Acceptance, the successful Tenderer shall deliver to the Employer a Security deposit in any of the forms given below for an amount equivalent to 5% of the Contract price plus Additional Security for Unbalanced Tenders* in accordance with Clause 25.5 of the ITT and clause 43 of the conditions of contract.

-Deleted, or

-A bank guarantee in the form given in Section 10; or

-Deleted

*(Unbalanced Tender is defined as a tender where the tender premium is negative beyond 10%, Additional Security shall be collected for all Tenders whose Tender Premium is negative beyond 10%, and no Additional Security shall be collected for all tenders whose Tender Premium is upto Minus 10%. Additional Security shall be collected only to the extent of negative premium beyond minus 10%).

The additional security to be provided in the form of a Bank Guarantee and it shall be issued either by a Nationalized/Scheduled bank encashable at Hubballi Dharwad. The Bank Guarantee shall be valid till the completion of the construction period and an additional period of 45 days.

SECTION 6: CONTRACT DATA		
Items marked "N/A" do not apply in this Contract		
The following documents are also part of the Contract:		**Clause Reference**
The Employer is:		
Name:	The Managing Director,	[1.1]
Address:	Hubballi Dharwad Smart City Limited	
Name of authorized Representative:		
The name and identification number of the Contract is **Rehabilitation Nehru Stadium including Operation and Maintenance for five years for Hubballi Dharwad Smart City Limited**		[1.1]
The Works consist of	**Rehabilitation Nehru Stadium including Operation and Maintenance for five years for Hubballi Dharwad Smart City Limited**	
The start date shall be within one weeks from the date of issue of notice to proceed with the work.		[1.1]
The Intended Completion Date for the whole of the Works is **12 (Twelve) Months** with the following mile stones. And five years of O&M.		[17,26]
Milestone dates:	Physical works to be completed	Period from the date of issue of Notice to proceed with the work
Milestone 1	Dismantling, Earthwork, PCC, RCC, frame structures, Landscape (Hardscape & Soft scape) with a minimum financial progress of Rs 25% of contract value	4 months
Milestone 2	PCC, RCC frame structures masonry work, Landscape (Hardscape & Soft scape) with a cumulative financial progress of Rs 60% of contract value	8 months
Milestone 3	Completing all works in all respects	12 months
The Site Possession Date is: one weeks from the notice to proceed with the work.		[21]
The Site is located in Hubballi Dharwad Municiapal Corporation limits.		[1.1]
Since the payments to the Contractor shall be made over several years, the Net Present Value (NPV) method will be used for evaluation of the financial bids, so as to bring all bidders to a common denomination for determination of lowest bidder. The Bidder shall quote their O&M rates as per their own assessment. However, the Authority will calculate the		[26.1]

NPV of the quoted amount as per the formula below for the purpose of evaluation. The Net Present Value of a contract is equal to the sum of the present values of all the cash flows associated with it. The formula for calculating NPV of a financial bid is illustrated below: $P = C + [(O1) / (1+r)] + [(O2 / (1+r)^2] + [(O3) / (1+r)^3] + [(O4) / (1+r)^4]$ Where: P= Final Price C = Total Capex Price, O1 = Opex Price for Year 2, O2 = Opex Price for Year 3, O3 = Opex Price for Year 4, O4 = Opex Price for Year 5,	
The Successful Bidder shall submit the following Performance Bank Guarantees at his own expense submit unconditional and irrevocable Performance Bank Guarantee (PBG) to the Authority, GoK. The PBG shall be from a Nationalized Bank/Scheduled bank in the format prescribed in Section 10, payable on demand at any of the bank branch at Hubballi , for the due performance and fulfilment of the contract by the bidder. 1. Implementation Performance Bank Guarantee (IPBG) shall be submitted within Twenty-One (21) working days from the date of issuance of LOI, for an amount equivalent to 5% of the total CAPEX price towards the implementation Phase, valid for a period of 28 days beyond the Defect Liability Period. (Valid for 12 months + One year DLP + 28 days) 2. Operational Performance Bank Guarantee (OPBG) shall be submitted to the authority prior to expiry of the IBPG at least 3 months in advance, towards the Operation Phase for an amount equivalent to 5% of the total OPEX price valid for a period of 5 years plus 60 days.	[29.1]
The Defects Liability Period is one Year. (365days)	[31]

Insurance requirements are as under: [13]

Sl.No	Type of Cover	Minimum cover for Insurance
(i)	Works and of Plant and materials	The sum stated in the Agreement (Contract Value) plus 20%
(ii)	Loss or damage to equipment	Full replacement cost
(iii)	Loss or damage to property of Third Party	Full replacement cost
(iv)	Personal injury or death insurance (a) for Third Party (For Two)	

Sl.No	Type of Cover	Minimum cover for Insurance
	(b) for Contractor's employees or labour	In accordance with the statutory requirements applicable to Karnataka minimum of Rs. 5 lakh per person and insurance shall cover minimum 4 persons

Price Adjustment: The formulae for price Adjustment shall be as prescribed in Annexure -1 to the G.O. No.FD 59 PRO. Cell/2004 dated 26-11-2004 and **Government order No. FD 3 PCL 2008, Bangalore, Dated : 21-11-2008)**
Price Adjustment Formula; [40]

R= Value of work as defined in Clause 40.1 of Conditions of Contract.

Adjustment for labour component:
(g) Price adjustment for increase or decrease in the cost due to labour shall be paid in accordance with the following formula:

VL = 0.85 X PL /100 X R X (Li - Lo) /Lo Where,
VL = Increase or decrease in the cost of work during the quarter under consideration due to
Changes in rates for local labour;
Lo = the average consumer price index39 for industrial workers for Hubli/Dharwad Centre for the quarter preceding the date of opening of tenders as published by the Labour Bureau,
Ministry of Labour, Government of India;
Li = the average consumer price index for industrial workers for Hubali/Dharwad Centre for the quarter under consideration as published by Labour Bureau, Ministry of Labour, Government of India
PL = Percentage of labour component of the work

Adjustment for Cement Component:
(ii) Price adjustment for increase or decrease in the cost of cement component procured by the contractor shall be paid in accordance with the following formula.
VC = 0.85 X PC /100 X R X (Ci - Co) /Co, Where,
VC = Increase or decrease in the cost of the work during the quarter under consideration due to changes in the rates for cement;
Co = the all India average wholesale price index 41for cement (Ordinary Portland Cement) for
The quarter preceding the date of opening of the tenders as published by the Office of Economic Advisor, Ministry of Commerce and Industry, Government of India , New Delhi; Ci = The all India average wholesale price index for cement (Ordinary Portland Cement) for the quarter under consideration as published by the Office of Economic Advisor, Ministry of
Commerce and Industry, Government of India, New Delhi
PC = Percentage of cement component of the work

Adjustment for TMT steel component:
(iii) Price adjustment for increase or decrease in the cost of steel procured by the contractor shall be paid in accordance with the following formula.
VS = 0.85 X PS /100 X R X (Si – So)/So where,
VS = Increase or decrease in the cost of work during the quarter under consideration due to changes in the rates for steel;
So = The all India average wholesale price index for steel (M.S. Bars and rods) for the quarter preceding the date of opening of Bids as published by the Office of Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
Si = The all India average wholesale price index for steel (M.S. Bars and Rods) for the

quarter under consideration as published by the Office of Economic Advisor, Ministry of Commerce and Industry, New Delhi
PS = Percentage of steel component of the work

Adjustment of Bitumen Component:
(iv) Price adjustment for increase or decrease in the cost of bitumen shall be paid in accordance with the following formula:
VB = 0.85 X PB/100 X R X (Bi – Bo)/Bo, Where
VB = Increase or decrease in the cost of work during the quarter under consideration due to changes in the rate for bitumen.
Bo = The all India average wholesale price index for Bitumen for the quarter preceding the date of opening of Bids as published by the Office of Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
Bi = = The all India average wholesale price index for Bitumen for the quarter under consideration as published by the Office of Economic Advisor, Ministry of Commerce and Industry, New Delhi.
PB = percentage of bitumen component of the work.

Adjustment for Electro Mechanical Component:
(v) Price adjustment for increase or decrease in the cost of **Electro Mechanical Component** procured by the contractor shall be paid in accordance with the following formula:
VP = 0.85 X P_{EM}/100 X R X (Pi – Po)/Po, Where
VP = Increase or decrease in the cost of work during the quarter under consideration due to changes in the rates for electromechanical component.
Po = The all India average wholesale price index for electrical equipment for the quarter preceding the date of opening of bids, as published by the Office of the Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
Pi = The all India average wholesale price index for electrical equipment for the quarter under consideration as published by the Office of the Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
P_{EM} = Percentage of electrical equipment component of the work.

Adjustment for PVC fitting and other materials:
(v) Price adjustment for increase or decrease in the cost of PVC fitting and other materials procured by the contractor shall be paid in accordance with the following formula:
VP = 0.85 X P_P/100 X R X (Pi – Po)/Po, Where
VP = Increase or decrease in the cost of work during the quarter under consideration due to changes in the rates for PVC fitting and other materials component.
Po = The all India average wholesale price index for PVC fitting and other materials for the quarter preceding the date of opening of bids, as published by the Office of the Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
Pi = The all India average wholesale price index for PVC fitting and other materials for the quarter under consideration as published by the Office of the Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
P_P = Percentage of PVC fitting and other materials component of the work.

Adjustment for Other materials.
(vii) Price adjustment for increase or decrease in the cost of other materials other than cement, steel, bitumen and Fuel and Lubricants48 procured by the contractor shall be paid in accordance with the following formula:
VM = 0.85 X PM/100 X R X (Mi – Mo)/Mo, Where
VM = Increase or decrease in the cost of work during the quarter under consideration due to changes in the rates for local materials other than cement, steel, bitumen and

Fuel and Lubricants.
Mo = The all India average wholesale price index for all commodities for the quarter preceding the date of opening of bids, as published by the Office of the Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
Mi = The all India average wholesale price index for all commodities for the quarter under consideration as published by the Office of the Economic Advisor, Ministry of Commerce and Industry, Government of India, New Delhi
PM = Percentage of other material component (Other than cement, steel, bitumen and Fuel and Lubricants) of the work.

The following percentages 49will govern the price adjustment for the entire contract:

1.	Labour (P_L)	-	50%
2.	Cement (P_C)	-	3%
3.	TMT Steel (Ps)	-	8%
4.	Bitumen (P_B)	-	1%
5.	Electro Mechanical (P_{EM})	-	9%
6.	PVC fitting and other materials (P_P)	-	1%
7.	Other (P_O)	-	28%
	TOTAL		**100%**

The liquidated damages for the whole of the works are

For Milestone 1: Rs. 25300.00/- per day [41]
For Milestone 2: Rs. 35420.00/- per day
For Milestone 3: Rs. 40480.00/- per day

The maximum amount of liquidated damages for the whole of the works [41] is **10%** (ten percent) of final contract price

The amounts of the advance payment are:
[42]

Nature of Advance	Amount (Rs.)	Conditions to be fulfilled
1. Mobilization	Not Applicable	Not Applicable

(The advance payment will be paid to the Contractor no later than 30 days after fulfillment of the above conditions).

Repayment of advance payment for mobilization: [42]

The advance loan shall be repaid with percentage deductions from the interim payments certified by the Engineer under the Contract. Deductions shall commence in the next Interim Payment Certificate following that in which the total of all such payments to the Contractor has reached not less than 15 percent of the Contract Price or 3 months from the date of payment of first installment of advance, whichever period concludes earlier, and shall be made at the rate of 7.5% percent of the amounts of all Interim Payment Certificates until such time as the loan has been repaid, always provided that the loan shall be completely repaid prior to the expiry of the original time for completion pursuant to Clauses 17 and 26.

The date by which “as-built” drawings in 2 sets are required is within 30 days of issue of certificate of completion of Whole or Section of the Work as the case may be.
[48]

The date by which Operating and Maintenance Manuals are required is within 30 days of issue of certificate of completion of Whole or Section of the Work as the case may be. [48]

The amount to be withheld for failing to supply “as built” drawings or supply of
Operation and Maintenance Manuals by the date required is 0.5 %of the contract value
[48]

The following events shall also be fundamental breach of the contract: [49.2]

1. The contractor has contravened Sub-clause 7.1 and Clause 9 of CC.

The percentage to apply to the value of the work not completed representing the Employer's
additional cost for completing the works shall be 30 percent [50.1]

SECTION 7: SPECIFICATIONS

Enclosed / uploaded as separate file

(a) Materials/ Methodology/ Quality Assurance/ Testing
(b) Operation and Maintenance

SECTION 8: DRAWINGS

Enclosed/ uploaded as separate file

SECTION 9: BILL OF QUANTITIES

Enclosed/ uploaded as separate file

The contractor has to quote for each item of work in Bill of Quantities made available in e-procurement portal

Note:

(1) Item for which no rate or price has been entered in will not be paid for by the Employer when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities (refer: ITB Clause 11.2 and CC Clause 37.2).

(2) Unit rates and prices shall be quoted by the Tenderer in Indian Rupees.

SECTION 10: FORMAT OF BANK GUARANTEE FOR SECURITY DEPOSIT

To:

WHEREAS _____ *[name and address of Contractor]* (hereinafter called "the Contractor") has undertaken, in pursuance of Contract No. _____ dated _____ to execute _____ *[name of Contract and brief description of Works]* (hereinafter called "the Contract");

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for the sum specified therein as security for compliance with his obligations in accordance with the Contract;

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee;

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Contractor, up to a total of Rs._____ *[amount of guarantee]* _Rupees_____ _____*[in words]*, and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of _____ *[amount of guarantee]* as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us with the demand.

We further agree that no change or addition to or other modification of the terms of the Contract or of the Works to be performed there under or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

This guarantee shall be valid until 30 days from the date of expiry of the Defects Liability Period.

Signature and seal of the guarantor _____
Name of Bank _____
Address _____
Date _____

HUBBALLI DHARWAD SMART CITY LIMITED
HUBBALLI

TENDERS FOR THE WORK OF

Rehabilitation Nehru Stadium including Operation and Maintenance for five years for Hubballi Dharwad Smart City Limited

Volume II – Special Specification

Indent No: UDD/2017-18/OW/WORK_INDENT509

TENDER Notification No : HDSCL/SCP Tender/MD/2018-19

Address for communication:
Hubballi Dharwad Smart City Limited,
IT Park, "B" Block, IV floor,
Opp Indira Glass House,
Hubballi – 580029
Ph: 0836 – 2355331
Email : sohdsmartcity@gmail.com

CONTENTS

1. TECHNICAL SPECIFICATIONS – DATA SHEET

1.1. SCOPE

The specification covers the general requirements and the specific technical requirements for the works, which are not covered by any of the other component specifications of Section D, but are required to be carried out for the satisfactory completion of the work. This specification and the other component technical specifications contained in Section D are mutually dependent and essential for correct interpretation of the contract. If the requirements of this section and the other technical specifications in Section D conflict, those of this section shall govern. It shall be noted that all Codes of Practice and Standards shall be those of latest issue.

It shall be very clearly understood that the specifications given in Section D are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices for the modern buildings or as directed by ENGINEER from time to time. Items for which separate specifications have not been indicated shall be carried out in consultation with and as directed/approved by ENGINEER. The decision of ENGINEER as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever shall be entertained on this account.

The BIDDER is advised to visit the site and get him acquainted with the conditions at the site. The BIDDER shall carefully note the working conditions and assess the difficulty level of execution, before quoting prices for the project. The BIDDER shall clearly note that the remodelling work in the existing structure areas shall be carried out in such a way that minimum disturbance is caused to the on going activities in the existing plant area. The areas of structures under reconstruction and dismantling shall be protected for safety of men and machinery in the vicinity. Necessary protective arrangements like barricading, supporting, netting, dust preventing shall have to be provided during the execution of the work. Flooring in the existing plant area shall be done with great care, such that no machinery, utilities and service lines are affected during the work. The entire work shall be carried out with such a care that environment shall be disturbed only to minimum possible extent.

1.2. SUB-SOIL DATA

The OWNER has briefly carried out the soil investigations. However, Bidder is advised to visit the site and get acquainted with the site conditions, etc.

1.3. CEMENT

The CONTRACTOR shall arrange to supply 43/53 grade OPC (Ordinary Portland Cement) or Portland Pozzolana Cement from time to time. Necessary tests on

cement, if required and as directed by ENGINEER shall be done by CONTRACTOR at his own cost. CONTRACTOR shall make available adequate shuttering and staging materials and make sufficient fabrication arrangements. No delays and extra claims shall be entertained on this account.

CONTRACTOR shall make temporary arrangement for storage of the Cement at his own cost. The location for this storage shall be as directed by ENGINEER/OWNER. As the space available within the OWNER's plot premises is limited, the CONTRACTOR shall make his own arrangement for storage of cement inside the premises with prior approval from the ENGINEER/ OWNER.

1.4. CONCRETE

All the structural concrete of grade M20 and above shall be of Design Mix Concrete. Grade of concrete will be indicated in the respective drawings.

All concrete shall be dense and water tight and with finish as specified. CONTRACTOR shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

CONTRACTOR shall take special care for concrete for liquid retaining structures, underground structures, and those others specifically called for to guarantee the finish and water tightness. All such structures shall be hydro-tested. CONTRACTOR shall include in his price of hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines, etc. Any temporary arrangements that may have to be made to ensure stability of the structure shall also be considered to have been taken into account while quoting the rates. Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/ epoxy pressure grouting, guniting or such other method as may be approved by ENGINEER. CONTRACTOR shall do all such rectification to the entire satisfaction of OWNER/ENGINEER at no extra cost to OWNER.

CONTRACTOR shall design the mix for concrete for all the types of grades required for civil works, such as normal weight concrete, heavy weight concrete, and super-heavy concrete and high performance concrete. The mix designed thus shall be got approved from the ENGINEER prior to start of the work.

1.5. FORM WORK

Form work for the slabs and columns shall be adequate in quantity so as to meet the proposed schedule. Multiple sets of formwork shall be kept ready if required. A detailed plan of fixing the shuttering, laying of concrete and deshuttering after desired period shall be prepared.

Exclusively new shuttering shall be procured & used for the proposed work at this site.

The formwork and staging shall be sufficiently strong to carry dead loads of slabs, movement of people, vibrations due to machinery etc. All the staging arrangement,

struts, jacks, ties and beam frames shall be capable of carrying the loads at all heights corresponding to this thickness.

1.6. CONCRETE SURFACE FINISH

Concrete surfaces shall not be plastered unless otherwise shown on the drawings or directed by ENGINEER. The concrete surfaces above ground shall be of high quality stain free, smooth and even with no shutter marks. Approved shutter/ mould release agents shall be used; however, ENGINEER's approval shall not relieve CONTRACTOR of his contractual obligations and his responsibilities for ensuring and providing the finish specified or removing/ rectifying defective work.

1.7. WATER

The CONTRACTOR shall arrange for construction water and drinking water for construction labours, from outside of OWNER's premises and at his own cost. Also, temporary storage facility and further distribution network for pumping, pipelines, etc. required at site shall be arranged by CONTRACTOR at his own cost. The OWNER will not make any arrangement for Construction Water.

1.8. TESTING STRUCTURES FOR LEAKAGE

Hydro-static test for water tightness shall be done at full storage level as described below:

a) In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

b) In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hours over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the structure. ENGINEER shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

c) Each compartment/ segment of the structure shall be tested individually and then all together.

For structures such as pipes etc., the hydrostatic test shall be carried out by filling with water, after curing as specified and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the

equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

1.9. EXPANDING GROUT

Grouting where directed shall be done with 1:1 cement mortar (1 cement: 1 fine sand) with an approved plasticized expanding grout admixture, in proportion as per the manufacturer's recommendation. The surfaces to which the grout is to bond shall be roughened and then cleaned with water jets and compressed air. No excess/free water shall be present whenever the grout is to be placed. The water/cement ratio of the grouting mortar shall be kept low. The grout shall be well rammed, finished flush and cured for minimum 7 days.

1.10. WATER-PROOFING ADMIXTURE

Water-proofing admixture shall conform to the requirements of IS 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the ENGINEER. Details of waterproofing shall be as indicated in the drawings.

1.11. CHAJJAS, SLAB & SILL PROJECTIONS

All chajjas slab and sill projections shall be provided with drip mould and/ or throating.

1.12. STRUCTURAL STEEL WORKS

a) Fabrication Yard: The CONTRACTOR shall make at his own cost the arrangement for the structural steel fabrication yard.

b) Painting On Steel Structure: Surfaces to be painted on steel structure shall be as described in Bill of Quantities.

c) Fabrication Drawings: CONTRACTOR shall prepare detailed fabrication and erection drawings based on the design drawings furnished by ENGINEER as called for in component specification “Fabrication of Structural Steel”. Fabrication shall be taken up only after ENGINEER's approval of the drawings.

1.13. SPACE FOR STORAGE OF CONSTRUCTION MATERIALS

CONTRACTOR shall arrange for stacking of construction material. The construction material requirement shall be planned by the CONTRACTOR in advance so as to meet the construction schedule. These materials shall be brought to the site by the CONTRACTOR as and when required at his own cost.

1.14. LIST OF MINIMUM CONSTRUCTION EQUIPMENT BY CONTRACTOR

To ensure efficient and speedy construction, material handling shall be affected by mechanical means only, to the maximum extent possible. For this purpose the CONTRACTOR shall mobilise and maintain all equipment in good working condition.

As the space available in the plot is limited, CONTRACTOR shall plan meticulously, all his construction activities to meet the stipulated Time Period. If any additional equipment, tools and tackles are required for the construction, the CONTRACTOR shall immediately arrange for the same.

Arranging all the construction equipment, tools and tackles shall be deemed to have been included in the CONTRACTOR's Offer. No extra cost shall be paid on account of deployment of any number of tools and tackles required for the project.

The CONTRACTOR's storage yard, fabrication yard, if located outside the OWNER's plot, shall be accessible to the OWNER/ ENGINEER at any time. For any inspection, site supervision, quality control activities, the transportation cost and arrangement of personnel of OWNER/ ENGINEER to and from between OWNER's plot and CONTRACTOR's fabrication yard, shall be included in the CONTRACTOR's offer and no extra Cost to OWNER.

1.15. DESIGN AND PARTICULAR REQUIREMENTS FOR COFFERDAM

Earthen embankment with or without stone pitching, sand bags or impervious geo-membrane, etc. or any other economical method can be used by contractor for constructing cofferdam subjected to engineer's approval.

Following are particular requirements for embankment:

a) The Contractor shall submit a detailed design, construction methodology along with the specifications for the cofferdam for approval of Engineer one month prior to start of work.

b) The cofferdam shall be temporarily constructed for the purpose of construction of intake well. As a part of scope of works in the Contract, the cofferdam will be demolished and removed from site after the construction works related to the intake well and the connection with the offshore intake pipes are completed.

c) The cofferdam shall be strong enough to withstand the loads acting on it during the entire offshore construction period without large or uneven settlements.

d) During demolition of the cofferdam, care shall be taken not to disturb the offshore intake pipes.

e) Contractor shall take care that materials and construction methodology used for construction and removal of the cofferdam shall not create adverse environmental impact on the surrounding river water

2. SPECIFICATIONS FOR EXCAVATION IN HARD ROCK

2.1. SCOPE

This specification covers general requirements of excavation in all types of hard rock as classified in Clause 7 of specification no. “TCE-10282A-H-RMC-401-D3: Earthwork in Grading, Excavation and Backfilling”.

2.2. GENERAL REQUIREMENTS

Unless otherwise stated herein, I.S. specification “IS-4081 (Latest Revision): Safety code for Blasting and related Drilling Operations” shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths, and profiles as are shown on the drawings or such other lines and grades, as may be specified by Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosives used shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer/Owner at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by Engineer, the rock shall be removed by wedging, pick, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from OWNER’s stores or from supplier arranged by him, from the authorities dealing with explosives. The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Government authorities and statutory bodies/regulations. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosives shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as far as possible from the area to be blasted; Engineer’s prior approval shall be taken for the location proposed for the magazine. Reconciliation of the explosives should be done on a daily basis.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

2.3. SPECIFIC REQUIREMENTS

For blasting operations, the following points shall be observed.

a) Contractor shall employ a competent and experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

b) Before any blasting is carried out, Contractor shall intimate Owner and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

c) Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m. radius from the firing point, at least 5 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.

d) The blasting of rock near any existing buildings, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done with small charges only and where directed by Engineer; a trench shall have to be cut by chiselling prior to the blasting operation, separating the area under blasting from the existing structures.

e) The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

f) A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming, which may consist of sand or stone dust or similar inert material.

g) Contractor shall preferably detonate the explosives electrically.

h) The explosives shall be exploded by means of a primer, which shall be fired by detonating a fuse instantaneous detonator (F.I.D.) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.

i) In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatine with detonator and fuse wire may be used. Underwater or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

j) Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.

k) When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stopping in rock excavation shall be done by hand trimming.

l) Contractor shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of explosives, or any other Authority duly constituted under the State and/or Union Government.

2.4. MEASUREMENT

Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the drawings. No payment will be made for excavations/overbreak beyond payment line specified. Where such measurement is not possible as in the case of strata intermixed with soil, excavated rock shall be properly stacked as directed by Engineer/Owner and the volume of rock stacked as directed by Engineer/Owner and the volume of rock calculated on the basis of stack measurements after making appropriate allowance for voids. The allowance to be made for voids shall be decided by Engineer/Owner and this will not be a subject matter of dispute or appeal.

3. EARTHWORK IN GRADING, EXCAVATION AND BACK FILLING

3.1. SCOPE

This specification covers the general requirements of earthwork in excavation in different materials, site grading, filling in areas as shown in drawing, filling back around foundations and in plinths, conveyance and disposal of surplus soils or stacking them properly as shown on the drawings and as directed by the ENGINEER and all operations covered within the intent and purpose of this specification.

3.2. APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

1	IS 783	-	Code of practice for laying of concrete pipes.
2	IS 1200	-	Method of measurement of building and civil engineering works.
	(Part 1)		Part 1 Earthwork
	(Part 27)		Part 27 Earthwork done by mechanical appliances.
3.	IS 3764	-	Excavation work-code of safety.
4.	IS 2720	-	Methods of test for soils:
	(Part 1)	-	Part 1 Preparation of dry soil samples for various tests.
	(Part 2)	-	Part 2 Determination of water content.
	(Part 4)	-	Part 4 Grain size analysis.
	(Part 5)	-	Part 5 Determination of liquid and plastic limit.
	(Part 7)	-	Part 7 Determination of water content-dry density relation using light compaction.
	Part (9)	-	Part 9 Determination of dry density - moisture content relation by constant weight of soil method.
	(Part 14)	-	Part 14 Determination of density index (relative density) of cohesionless soils.
	(Part 28)	-	Part 28 Determination of dry density of soils in place, by the sand replacement method.

(Part 33) - Part 33 Determination of the density in place by the ring and water replacement method.

(Part 34) - Part 34 Determination of density of soil in place by rubber balloon method.

(Part 38) - Part 38 Compaction control test (Hilf Method).

3.3. DRAWINGS

The ENGINEER will furnish drawings wherever, in his opinion, such drawings are required to show areas to be excavated/ filled grade level, sequence of priorities etc. The CONTRACTOR shall follow strictly such drawings.

3.4. GENERAL

The CONTRACTOR shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the job in accordance with the specification requirements.

The CONTRACTOR shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/ grid lines at 5 m. intervals or nearer as determined by the ENGINEER based on ground profile. These shall be checked by the ENGINEER and thereafter properly recorded.

The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety.

The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the ENGINEER, within the lead specified and levelling the same so as to provide natural drainage. Rock/ soil excavated shall be stacked properly as directed by the ENGINEER. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

3.5. CLEARING

The area to be excavated filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by the ENGINEER (but the responsibility lies with the contractor). Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

3.6. PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY, ETC.

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the OWNER and the CONTRACTOR shall duly preserve the same to the satisfaction of the OWNER and from time to time deliver the same to such person or persons as the OWNER may from time to time authorise or appoint to receive the same.

3.7. CLASSIFICATION

All materials to be excavated shall be classified by the ENGINEER, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of the ENGINEER regarding the classification of the material shall be final and binding on the CONTRACTOR and not be a subject matter of any appeal or arbitration.

In general any earthwork will be classified under any of the following categories:

a) **Black cotton Soil**: black colored soil encountered in the top layers of the stratum, having expansive properties, the soil is as predominantly clayey soil or silty clay and can be classified as MH, CH, OH or Pt soils, surficial organic soil layer that may contain living matter. However topsoil may occur at greater depth, having been buried by geological processes or manmade fill, and can be termed a buried topsoil. Contains finely divided organic matter; may have distinctive smell; may stain; may oxidize rapidly. Describe as for inorganic soils, consists predominantly of plant remains, can be further described according to its degree of decomposition and strength.

- Firm: Fibres already compressed together
- Spongy: Very compressible and open structure
- Plastic: Can be moulded in hand and smears in fingers
- Fibrous: Plant remains recognisable and retains some strength
- Amorphous: No recognizable plant remains

They exhibit high swelling and shrinking when exposed to changes in moisture content, these soils contain high inorganic matter and hence shall not be used as engineered soil or for filling. Generally the top 500- 600 mm depth of strata shall be considered as Black cotton soil.

b) **Other soils**: soil of any color encountered below the Black Cotton Soil or at NGL, but not defined as black cotton soil shall be taken as this type of soil. These shall include all kinds of soils containing pebbles (kankar), sand, silt, Soft fully disintegrated rock, gravel, clay, loam, peat, ash, shale, etc. These soils can be classified as a mixture of GW, GP, GM, GC, SW, SP, SM, and

SC. These can generally be excavated by spade, pick axes and shovel, and which is not classified under "Soft and Decomposed Rock" and "Hard Rock" defined below. This shall also include embedded rock boulders no longer / bigger than 1 meter in any one direction and not more than 300 mm in any one of the other two directions. Generally any strata, such as sand, gravel, loam, clay, mud, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete mud concrete and their mixtures which for excavation yields to application of picks, showels, jumper, sacrifiers, ripper and other manual digging.

c) **Disintegrated rock (murrum):** Stratum which is gravelly stratum formed from highly weathered and disintegrated rock. The composition shall include rock, boulders, Highly disintegrated and highly weathered rock, slag, chalk, slate, hard mica schist, laterite difficult to break / excavate manually with a pick axe of a spade or required very light mechanical excavating machines, but does not need blasting. The mere fact that the Contractor resorts to blasting for reasons of his own, shall not qualify for classification under 'Hard Rock'. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level.

d) **Weathered rock:** The rock mass is not significantly weaker than the compact hard rock. At point of defects/ cracks may be widened, the density of defects or cracking due to physical disintegration and start of the weathering. Excavation by manual means is not possible nor is blasting required. Excavation may require mechanical excavators or chiseling to loosen the rock mass. While excavating manual with pick axe or spade the rock cannot be scraped or peeled or sometimes difficult to make a mark, but easily fractures or breaks under mechanical hammer.

e) **Compact (Hard Rock**): this shall include all rock occurring in large continuous masses, which can be removed by blasting only. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of the Engineer, require blasting and or pneumatic breaking equipment shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified above shall be classified as hard rock. The rock which cannot be chipped with mechanical hammer and requires many blows of the hammer to break it or requires blasting can be termed as compact (hard rock). Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

3.8. EXCAVATION

All excavation work shall be carried out by mechanical equipment unless, in the opinion of the ENGINEER, the work involved and time schedule permit manual work.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the ENGINEER. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final level and extra excavation filled up as directed by the ENGINEER. The final excavation, if so instructed by the ENGINEER, should be carried out just prior to laying the mud-mat.

The CONTRACTOR may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by the ENGINEER, at his own cost outside the lines shown on the drawings or directed by the ENGINEER. Should any excavation be taken below the specified elevations, the CONTRACTOR shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by the CONTRACTOR on this account.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the ENGINEER shall be obtained by the CONTRACTOR in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the CONTRACTOR of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for if the slips are due to the negligence of the CONTRACTOR.

Excavation shall be carried out with such tools, tackles and equipment as described herein before. Blasting or other methods may be resorted to in the case of hard rock; however not without the specific permission of the ENGINEER.

The ENGINEER may also direct that in some extreme case, the rock may be excavated by heating and sudden quenching for splitting the rock. Fire-wood shall be used for burning and payment shall be made for such work as called for in the schedule of quantities.

3.9. BLASTING

In ordinary rock blasting operations shall not be generally adopted. However, the contractor may resort to blasting with the permission of the Engineer-in-charge, but nothing extra shall be paid for such blasting operations.

Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to blasting operation.

The contractor shall obtain license from the competent authority for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Act, 1884 as amended up to date and the Explosive Rules, 1983.

The contractor shall purchase the explosives fuses, detonators, etc. only from a licensed dealer.

The contractor shall be responsible for the safe transportation, storage and custody as per explosive rules and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives.

The Engineer-in-Charge or his authorized representative shall have the right to check the contractor's store and account of explosives. If required the contractor shall provide necessary facilities for this.

The contractor shall be responsible for any damage arising out of accident to workmen, public or property due to storage, transportation and use of explosive during blasting operation.

3.10. BLASTING OPERATIONS

Blasting operations shall be carried out under the supervision of a responsible authorized agent of the contractor (referred subsequently as agent only), during specified hours as approved in writing by the Engineer-in-Charge.

The agent shall be conversant with the rules of blasting.

The position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the contractor's agent. Bore holes shall be of a size that the cartridge can easily pass down.

After the drilling operation, the agent shall inspect the holes to ensure that drilling has been done only at the marked locations and no extra hole has been drilled.

The agent shall then prepare the necessary charge separately for each bore hole.

The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping.

One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length.

All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular nitch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the nitch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

The maximum of four bore holes shall be loaded and fired at one occasion.

The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety.

The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited.

Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded.

During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations have been done by the agent for the misfired boreholes.

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

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

Before leaving the site of work, the agent of one shift shall inform another agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent.

The Engineer-in-Charge shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

3.11. GENERAL PRECAUTIONS

For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out.

All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200 metres from the blasting site.

Audio warning by blowing whistle shall be given before igniting the fuse.

Blasting work shall be done under careful supervision and trained personnel shall be employed.

Blasting shall not be done within 200 metres of an existing structure, unless specifically permitted by the Engineer-in-Charge in writing.

All procedures and safety precautions for the use of explosives drilling and loading of explosives drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081.

3.12. PRECAUTIONS AGAINST MISFIRE

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

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

The detonator shall be inserted into the cartridge so that about one third of the copper tube is left exposed outside the explosive.

The safety fuse just above the detonator shall be securely tied in position in the cartridge.

Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.

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

3.13. STRIPPING LOOSE ROCK

All loose boulders, semi-detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the ENGINEER, to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter, or render unstable or unsafe the portion which was originally sound and safe.

Any material not requiring removal as contemplated in the work, but which, in the opinion of the ENGINEER, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the ENGINEER. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

3.14. FILL, BACK FILLING AND SITE GRADING

3.14.1. `

All fill material will be subject to the ENGINEER's approval. If any material is rejected by the ENGINEER, the CONTRACTOR shall remove the same forthwith

from the site at no extra cost to the OWNER. Surplus fill material shall be deposited/ disposed off as directed by the ENGINEER after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the ENGINEER.

3.14.2. Material

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill up the voids and the mixture used for filling.

If any selected fill material is required to be borrowed, the CONTRACTOR shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the ENGINEER. The approved borrow pit area shall be cleared of all bushed, roots of trees, plants, rubbish etc. top soil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by the ENGINEER (but the responsibility lies with the contractor). The CONTRACTOR shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his own cost (Rate quoted shall be inclusive of all such preliminary works).

The CONTRACTOR shall send the material from borrow pit for testing to the laboratories. CONTRACTOR shall be allowed to bring the material only after approval of test reports (The expenses towards such testing is deemed to included in the rates quoted).

CONTRATOR shall submit following test reports of the approved borrow pit to ENGINEER for approval

a) C & ϕ Values

b) Sieve Analysis

c) Moisture content

d) In-situ density

e) Standard proctor density

(Note: Contractors shall have to carry these tests as many times as required.)

3.14.3. Filling In Pits And Trenches Around Foundations Of Structures, Walls Etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris,

and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed and properly consolidated to 95% proctor density, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of the ENGINEER. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the ENGINEER is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to proper profile as directed by the ENGINEER or indicated on the drawings.

3.14.4. Plinth Filling

Plinth filling shall be carried out with approved material as described herein before in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. The Engineer may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finished level of the filling shall be trimmed to the level/ slope specified.

Where specified in the schedule of works, compaction of the plinth fill shall be carried out by means of 12 tonne rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

The thickness of each unconsolidated fill layer can in this case be upto a maximum of 300 mm. The Engineer will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of the Engineer, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

At some locations/ areas it may not be possible to use rollers because of space restrictions etc. The Contractor shall then be permitted to use pneumatic tampers; rammers etc. and he shall ensure proper compaction

3.14.5. Sand Filling In Plinth And Other Places

At places backfilling shall be carried out with local sand if directed by the Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be

dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill

3.14.6. Filling In Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centreline of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centreline of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm. above the top of the pipe shall be done with fine materials, such as earth, murrum etc. The filling up of the level of the centreline of the pipe shall be done by hand compaction in layers not exceeding 8 cm. Whereas the filling above the centreline of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm. above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

3.15. GENERAL SITE GRADING

Site grading shall be carried out as indicated in the drawings and as directed by the ENGINEER. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under Clause 10.0 and elsewhere unless otherwise indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 10.0 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the CONTRACTOR at his own cost.

The tests shall be carried out after each layer of filling.

Equipments for the following in-situ tests shall be made available at site by CONTRACTOR

a) Core cutter Method

b) Sand replacement method

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well. The frequency for carrying out in-situ tests shall be one test for every 600 to 800 Sqm of backfill area and shall be carried out for every layer of backfill.

The CONTRACTOR shall protect the earth fill from being washed away by rain damaged in any other way. Should any slip occur, the CONTRACTOR shall remove the affected material and make good the slip at his cost.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If specifically permitted by the ENGINEER, compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the CONTRACTOR to demonstrate that the desired/ specified compaction has been obtained. In order that the fill may be reasonably uniform throughout, the material should be dumped in place in approximately uniform layers. Traffic over the fill shall then be so routed to compact the area uniformly throughout.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cm approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne vibro roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

3.16. FILL DENSITY

The compaction, only where so called for, in the schedule of quantities/ items shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The CONTRACTOR shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

3.17. LEAD

Lead for deposition/ disposal of excavated material, shall be as specified in the respective item of work. For the purpose of measurement of lead, the area to be excavated or filled or area on which excavated material is to be deposited/ disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centrelines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route taken by the CONTRACTOR. No extra compensation is admissible on the grounds that the lead

including that for borrowed material had to be transported over marshy or 'katcha' land/ route.

3.18. MEASUREMENT AND PAYMENT

All excavation shall be measured net. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base of foundations of the walls, columns, footings, tanks, rafts or other foundations/ structures to be built, multiplied by the mean depth from the surface of the ground in accordance with sizes mentioned in the drawings. Excavation in side slopes will not be paid for. The CONTRACTOR may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety or excavation. If concreting is proposed against the excavated sides, no such over-excavation will be permitted. In such cases over-excavation shall be made good by the CONTRACTOR with concrete of the same class as in the foundations at his cost.

Unless otherwise specified, the unit rates quoted for excavation in different types of material shall also account for a basic lead of 50 metres for disposal as specified or directed. Only leads beyond the basic lead of 50 metres will be considered as extra lead and paid for at the rates quoted in the schedules.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation including backfilling shall include stacking of excavated material as directed, excavation/ packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule material to be backfield shall be stacked temporarily within the basic lead of 100 metres unless otherwise directed by the ENGINEER. If the ENGINEER directs/ permits a lead of over 100 metres for such material, the conveyance of the material for the extra distance over the basic lead of 100 metres for backfilling will be paid for.

Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified/ directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. Payment for this work will be made based on measurement of plinth/ trench dimensions filled. The plinth ground levels shall be surveyed before hand for this purpose. If no compaction is specified / desired, such filling will not be separately paid for. In such an event, the fill shall be levelled/ finished to the profile as directed at no extra cost.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc. as specified. Actual quantity of consolidated filling whichever is less shall be measured and paid for in cubic metres. The lead, lift etc. shall be as indicated in the schedule of quantities.

Actual quantity of consolidated sand filling shall be measured and paid in cubic meters.

3.19. TOLERANCES

The finished levels shall be within ± 50 mm with respect to the levels mentioned in the drawing.

3.20. MODE OF MEASUREMENT

Following procedure shall be followed for measuring quantity of Soil / Hard rock.

a) After completion of cleaning and grubbing activity CONTRACTOR shall take levels at every 5M X 5M grid on the natural ground in presence of ENGINEER. The record shall be signed jointly by CONTRACTOR and ENGINEER.

b) After completion of the land grading activity as per the drawings, final levels shall be taken at previously marked grid in presence of ENGINEER & shall be recorded.

c) The quantities shall be worked out based on the initial and final levels and by using mutually agreed quantity calculation procedure such as Simpsons rule or as approved by ENGINEER

3.21. DRY STONE PITCHING

3.21.1. Stones

These shall be clean, hard stones, free from decay and weathering. They shall be in block and hammer dressed on all sides.

The size of the pitching stones shall be approximately 22.5 cm.in depth and not less than 15 cm. in any other direction.

3.21.2. Preparation Of Surface

The sides and bottom of earth work to be pitched and shall be brought to the required slope and gradient and shall be compacted to a firm and even surface.

3.21.3. Pitching

Pitching shall be of 22.5cm 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 cm. 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 of pitching shall be provided at an interval of approximately 3 metres centre to centre both longitudinally and transversely. The interstices between adjacent stones shall be filled in with stone 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 on 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.

3.21.4. Mode Of Measurement

The measurements shall be taken in sqm.

3.21.5. Rate

The rate shall include the cost of the materials and labour involved in all the operations described above.

3.21.6. Access Road

Roads, whether of temporary or other nature, required to be constructed for access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material etc. to or over borrow areas and/or to or over areas on which fill has to be deposited shall be constructed by the Contractor at his cost. Such costs shall be deemed to have been included in the unit rates quoted by the Contractor. Such access in roads shall be maintained in good condition during all seasons to ensure completion of work according to time schedule.

4. SPECIFICATIONS FOR TIMBER SHORING

4.1. SCOPE

This specification covers the general requirements of timber shoring for excavation of trenches, pits, open excavations etc.

4.2. GENERAL REQUIREMENTS

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as directed by Engineer. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walings of strong wood at maximum 1.2 metres spacings, strutted with ballies or as directed by Engineer. The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Engineer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.

Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from Engineer.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

In the case of open timbering, the entire surface of the side of trench or pit in not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacings shall be subject to the approval of Engineer. In all other respects, specification for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking for sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut. If, however,

Engineer directs any timbering to be left-in, keeping in mind the type of construction or any other factor, Contractor shall be paid for at the scheduled item-rate for such left-in timbering.

4.3. MEASUREMENT

The actual effective area of shored faces as approved by Engineer shall be measured in sq.m. The area of planking embedded in the bed/sides of excavation will not be considered, nor the area supporting inclined struts in case of large pits/open excavation. All planks, boards, wallings, verticals, struts, props and all other materials required for shoring and subsequent safe dismantling and removal shall be included in the quoted unit rates.

5. SPECIFICATIONS FOR DEWATERING

5.1. SCOPE

This specification covers the general requirements of dewatering excavations in general.

5.2. GENERAL REQUIREMENTS

All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations / trenches required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer, as large, well point system - Single stage or multi stage, shall be adopted. Contractor shall submit to Engineer his scheme of well point system including the stages, the spacing, number and diameter of well points, headers etc., and the numbers, capacity and location of pumps of approvals. Unless separately provided for in the Schedule of prices, the cost of dewatering shall be included in the item rate for excavation.

5.3. MEASUREMENT

Unless separately provided for in the Schedule of quantities, dewatering is deemed to have been included in the unit rates quoted for excavation. If separately provided for, the unit of measurement shall be as indicated in the schedule of quantities.

6. RAIN WATER DRAINAGE

6.1. SCOPE

This section covers the drainage of rain water in excavated areas.

6.2. GENERAL REQUIREMENTS

Grading in the vicinity of excavation shall be such as to exclude rain / surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the CONTRACTOR may be using for his work by suitably pumping out the same at no extra cost to the owner. The scheme for pumping and discharge of such water shall be approved by the ENGINEER.

CONTRACTOR shall ensure that the surface runoff outside the excavated pit/working area shall be collected through a catch water drain excavated around the working area and led away to a natural stream, at no extra cost to the OWNER .CONTRACTOR shall maintain the catch water drains in proper condition during the construction period at no extra cost to the owner.

7. SPECIFICATIONS FOR LINE DRILLING AND PRESHEARING

7.1. SCOPE

This specification covers the general requirements of line drilling and preshearing method of hard rock excavation. The classification of rock shall be as per Clause 7 of specification No.TCE.10282A-H-RMC-401-D3 “Earthwork in Grading, Excavation and Backfilling”.

1.1. PROCEDURE

Line drilling and Preshearing in rock shall be resorted when so specified or directed by the Engineer. This technique shall be used when the excavation in rock (hard and stratified) has to be carried out to exact lines and levels and when absolutely no over excavation is permissible. It shall also be used where rock blasting is required to be carried out in the close proximity of existing structures, equipment etc.

This technique consists of drilling holes, as close as warranted by the rock conditions and to such depth as may be necessary, along the periphery (or line) of the area within which excavation has to be carried out. This will ensure that when rock inside the area is blasted, over excavation/ over break damage to adjoining property is avoided as the rock shears off along the line of drilled holes.

The diameter, depth and spacing of holes, shall be decided by the Engineer or as specified in the drawings/ schedules. The holes shall be generally 48 mm in diameter. The Engineer may direct a second line or subsequent lines of holes to be drilled in addition at suitable location/s to facilitate safe excavation.

The layout of the interior blasting holes shall be carefully planned. Only light blasting is permitted in the interior holes which are close to the line drilled holes.

The Contractor shall have to carry out tests to determine the amount of explosives required to ensure an even break at the line drilled holes, so that damage to structure outside line drilled holes as also over breaks are avoided.

After the interior holes are blasted any irregularities in the vertical line drilled face which was line drilled shall be removed and trimmed by wedging, splitting, chiselling and barring.

Excavation shall generally be carried from the centre to the outside.

The Engineer may direct a trench to be cut between adjacent line drilled holes. In such a case, rock between line drilled holes shall be blasted with such pattern of holes as will not cause any damage to any structure close by and also not shatter or render unsuitable any good rock outside the line drilled holes.

Line drilling and preshearing will only be permitted in hard rock.

7.2. MEASUREMENT

Measurement and payment for this item will be made on the basis of the total length of holes drilled for this purpose. It shall be clearly understood that only line drilled hole will be measured and blasting holes will not be considered for payment, preshearing will not also be paid for separately. Rock excavation by blasting will be paid for under “Hard Rock Excavation”.

8. SPECIFICATIONS FOR SITE FILLING

8.1. SCOPE

Apart from any other work/ purpose for which this specification may be made applicable by the Engineer, this shall generally govern work involving filling site/ plant over the entire area/ most of the area to raise the general grade level to the desired elevation. This work shall be carried out as per applicable clauses of specification TCE.10282A-H-RMC-401-D3: “Earthwork in Grading, Excavation and Backfilling”,

8.2. FILL MATERIAL

8.2.1. General

All fill material whether such material is brought from outside borrow areas or from excavation from within the site, will be subject to the Engineer’s approval. Notwithstanding any approval given to the fill material of borrow areas from which fill material is proposed to be brought, the Engineer/ Owner reserves the right to reject such material which in his opinion either does not meet the specification requirements or is unsuitable for the purpose for which it is intended.

8.2.2. Borrow Areas

It shall be Contractor’s responsibility to locate suitable borrow areas for borrowing fill material. Such area will be inspected by the Engineer and approved before the Contractor makes arrangements to borrow the fill material. The top soil, which may contain vegetation, rubbish, slush, etc., shall not be used. If demanded by the Engineer, the Contractor shall arrange to have trial pits of specified dimensions and numbers dug at locations specified, for the Engineer to examine the nature and type of material likely to be obtained from the borrow area.

8.2.3. Lead, Lift And Transportation

Unless separately provided for, all lead, lift and transportation required for bringing in the fill material from borrow areas or from excavation from within the site shall be included in the Contractor’s quoted unit rates.

8.2.4. Quality

The borrowed soil shall be generally granular, and non-cohesive. It shall consist of sand, silty sand, murrum, ordinary soil, gravel and shingle. Dredged material shall also be free from sulphates, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by the Engineer shall be removed from the site immediately.

8.3. ACCESS ROAD

Roads, whether of temporary or other nature, required to be constructed for access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material etc. to or over borrow areas and/or to or over areas on which fill has to be deposited shall be constructed by the Contractor at his cost. Such costs

shall be deemed to have been included in the unit rates quoted by the Contractor. Such access in roads shall be maintained in good condition during all seasons to ensure completion of work according to time schedule.

8.4. CLEARING

Site clearing before filling shall be carried out as specified in the specification no. TCE.10282A-H-RMC-401-D3: “Earthwork in Grading, Excavation and Backfilling”.

8.5. FILLING

8.5.1. Sand Fill

Sandy fill shall be deposited to bring the grade level to desired elevation after compaction of fill.

Sandy fill shall be compacted, where so specified, by 12 tonne vibratory rollers as indicated below. The fill material shall be compacted to the specified density, where so specified.

If the density of fill or use of rollers for compaction is not specified, the Contractor shall ensure necessary compaction by the passage of trucks, carrying the fill material over the deposited fill in such a way that the entire fill area is covered. This will reasonably compact the sand fill and will be accepted by the Engineer. However, the Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200 mm in thickness.

Compaction of sandy fill by flooding the area shall be carried out where so specified. In this case, the Contractor should ensure that the fill material is not washed away. This work shall be carried out as directed by the Engineer.

8.5.2. Soil Fill

Approved soil fill consisting of ordinary soil, murrum, soil containing gravel, shingle etc. shall be deposited in layers not exceeding 200 mm. The Contractor should ensure that all clods of earth are broken down to a size not larger than 100 mm.

Where density of fill or use of rollers is not specified the fill shall be carried out as specified in Clause 5.1 above.

Where the fill material has to be compacted by use of rollers procedure as specified in specification no TCE.10282A-H-RMC-401-D3: “Earthwork in Grading, Excavation and Backfilling” shall be followed.

Where specified, the required density of fill shall be obtained by proper compaction.

8.6. MEASUREMENT

Measurement will be made on the basis of Clauses specified in specification referred to in 1.0 above.

9. SPECIFICATIONS FOR ADMIXTURES FOR CONCRETE

9.1. SCOPE

This Specification covers the general requirements of chemical admixtures for concrete used in general construction, their applicability, acceptability criteria, proportioning, sampling, testing and precautions to be taken. The different types of admixtures covered by this specification are Accelerator, Retarder, Air entraining agents, Plasticizers and Super plasticizers. However, the requirements of Integral water proofing admixtures / compounds shall be in accordance with IS 2645.

9.2. APPLICABLE CODES & SPECIFICATIONS

The following specifications, standards and codes, including all official amendments/revisions and other specifications and codes referred to therein, shall be considered a part of this specification. In all cases the latest issue/ edition/ revision shall apply. In case of any discrepancy between this specification and those referred to herein, this specification shall govern.

1) IS 9103 - Specification for Admixtures for concrete
2) IS 2645 - Specification for Integral Cement Water Proofing Compounds
3) IS 3812 (Part-II) - Specification for fly ash for use as Admixture for concrete
4) IS 4926 - Ready mixed concrete
5) IS 1199 - Method of sampling and analysis of concrete
6) IS 516 - Method of test for strength of concrete
7) IS 6925 - Methods of test for determination of water soluble chlorides in Concrete admixtures.
8) BS 5075 (Part-1) - Specification for accelerating admixtures, retarding admixtures and water reducing admixtures
9) BS 5075 (Part-3) - Specification for super plasticising admixtures
10) ASTM 494 - Standard specification for chemical admixtures for concrete

9.3. TERMINOLOGY

9.3.1. Admixture

A material other than water, aggregates and hydraulic cement, used as an ingredient of concrete or mortar and added to the batch immediately before or during its

mixing to modify one or more of the properties of concrete in the plastic or under hardening state.

9.3.2. Accelerator

A substance, when added to concrete, mortar or grout, increases the rate of hydration of a hydraulic cement, shortens the time of set, or increases the rate of hardening or strength development.

9.3.3. Retarder

An admixture which delays the setting of cement-paste and hence of mixtures, such as cement mortar or concrete.

9.3.4. Air Entraining Agents

An admixture for concrete or mortar which causes air to be incorporated in the form of minute bubbles in the concrete or mortar during mixing, usually to increase workability and resistance to freezing and thawing and disruptive action of de-icing salts.

9.3.5. Water Reducing Admixtures Or Plasticiser

A material which either increases workability of freshly mixed mortar or concrete without increasing water content or maintains workability with a reduced amount of water. The reduction in water content for plasticisers is of the order of not more than 10 to 15%.

9.3.6. High Range Of Water Reducers (Super Plasticisers)

Super plasticisers are the high range water reducing admixtures. The reduction in water content in the case of superplasticisers will be of the order of 25-30%. Chloride based Superplasticisers are not recommended for reinforced concrete, which may give rise to corrosion of steel.

9.4. GENERAL

Chemical admixtures may be used if permitted by the Engineer, based upon evidence that with the passage of time neither the compressive strength nor its durability is reduced. In case their use is permitted, the type, amount and method of use of an admixture proposed by the Contractor shall be submitted to the Engineer for approval. No admixture shall be considered for use unless all tests complying with relevant codes (IS 9103 or IS 2645) have been done and a complete report from an independent laboratory of standing is submitted for scrutiny and approval of the Engineer.

The admixture shall be chloride free and shall be tested in accordance with IS 6925.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded parts. When Calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added

to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

The contractor shall provide the following information concerning each admixture to the Engineer.

a) Compliance to Indian/International standards with test reports

b) Description of the product and its composition / chemical names of main ingredients and properties

c) Primary uses of the product, applicability, advantages, etc.

d) Information to be considered in relevant mix design

e) Manufacturer's instructions regarding usage of admixtures

f) Typical dosage/consumption and effects of over dosage, chances of air entrainment when used as per the recommended dosage

g) The chloride ion content and water soluble sulphate content (expressed as SO3) expressed as percentage by weight of admixture.

h) Manufacturers written confirmation of compatibility of two or more admixtures if proposed to be used in any one mix

i) Any deleterious effects on concrete or any increase in risk of corrosion of the reinforcement or other embedments

j) Product storage procedure

k) Precautions to be taken while using the product

9.5. PHYSICAL REQUIREMENTS

Concrete made with admixtures when compared with identical concrete made without the admixture (Reference or Control Concrete) in accordance with clause 6.0 shall conform to the requirements given in Table-1, except in the case of Air-entraining admixture. In the case of Air-entraining admixtures, a reference admixture of approved quality shall be used in the control concrete to entrain identical amount of air.

TABLE 1 PHYSICAL REQUIREMENTS

(Ref: Compiled from IS 9103, BS 5075, ASTM 494)

SI No.	REQUIREMENT	ACCELE-RATING	RETAR-DING	WATER REDUCING ADMIXTURE					AIR ENTRA-INING
				NORMAL	ACCELE-RATING	RETAR-DING	HIGH RANGE	HIGH RANGE RETARDING	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
I	Water content, % of control sample, Max	-	95	-	95	95	88	88	-
ii	Time of setting, allowable deviation from control sample, hours								
	Initial								
	Max	-3	+3	±1	-3	+3	±1	+3	-
	Min	-1	+1	-	+3	-	+1	-	-
	Final								
	Max	-2	+3	±1	-2	+3	±1	+3	-
	Min	-1	-	-	-1	-	-	-	-
iii	*Compressive Strength, % of control sample, Min								
	3 days	125	90	110	125	110	125	125	90
	7 days	100	90	110	110	110	115	115	90
	28 days	100	90	110	110	110	110	110	90
	6 months	90	90	100	100	100	100	100	90
	1 year	90	90	100	100	100	100	100	90
iv	*Flexural strength, % of control sample, Min								
	3 days	110	90	100	110	100	110	110	90
	7 days	100	90	100	100	100	100	100	90
	28 days	90	90	100	100	100	100	100	90
v	**Length change, Percent of control	135	135	135	135	135	135	135	-
	% increase over control sample, Max								

	28 days	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
	6 months	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
	1 year	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
vi	Bleeding, % increase over control sample, Max	5	5	5	5	5	-	-	2
vii	Compacting factor (nor more than below control mix)	-	-	0.02	0.02	0.02	-	-	-
viii	Workability (Slump mm) (nor more than below control mix)	-	-	-	-	-	15	15	-

* The compressive and flexural strength of concrete containing the admixture under test at any test age shall be not less than 90 percent of that attained at any previous test age. The objective of this limit is to require that the compressive or flexural strength of concrete containing the admixture under test shall not decrease with age.

** Percent of control limit applies when length change of control is 0.030 percent or greater; increase over control limit applies when length change of control is less than 0.030 percent.

9.6. SAMPLING & TESTING

The performance and effect of admixtures for concrete shall be evaluated to conform to the physical requirements given in Table-1 by testing the concrete with admixture and comparing with reference concrete. The sampling and testing shall be in accordance with stipulations given in IS: 9103.

9.6.1. Sampling

The method of sampling of admixtures and concrete for testing purpose shall be in accordance with the stipulations given in IS: 9103.

Samples of admixtures shall be packed in moisture proof air containers.

The admixture shall be used strictly as per the recommendations of the manufacturer.

For general evaluation of admixture the cement shall conform to Portland cement to IS:269 and aggregates shall conform to the requirements given in IS:383.

When an admixture is required to be evaluated for a specific work as directed by the Engineer the test samples shall be prepared using the materials proposed to be used on that particular work.

Whenever the admixture has not been used previously with particular combination of materials and / or when special types of cements are adopted, and also when the mixing and placing temperatures are outside the normal range, then in all such cases the admixtures shall be specifically evaluated for that work.

When an admixture is to be tested for air entrainment it shall be used in such a quantity that it produces air content in the range of 3.5 to 7 %.

The concrete mix shall be proportioned to have the cement content specified for the work and to meet the stipulated workability and strength requirements.

9.6.2. Testing

The fresh concrete and hardened concrete shall be tested for the tests described below.

9.6.3. Testing Of Fresh Concrete

Sampling of fresh concrete shall be done according to the requirements given in IS:1199. The concrete shall be analysed for the following tests.

a) Test for workability as per IS 1199

b) Test for air-content as per IS 1199

c) Test for Time of Setting as per IS 8142

d) Test for bleeding as per IS 9103

e) Test for water content as per IS 9103

The above tests shall be carried out at the time of actual concreting work at site.

9.6.4. Testing Of Hardened Concrete

Specimens for tests on hardened concrete shall be prepared from at least three separate batches for concrete with and without the admixture. The specimen shall be analysed for the following tests below.

a) Test for Compressive Strength as per IS 516

b) Test for Flexural Strength as per IS 516

c) Tests for Length Change (Drying Shrinkage): It shall be determined as given in IS 1199. The moist-curing period, including the period in moulds shall be 14 days.

9.7. USE OF ADMIXTURES

Admixtures shall be used strictly in accordance with the instructions provided by the Manufacturer of the admixture.

Intermixing of admixtures prior to introduction into the concrete should be avoided unless tests indicate that there will be no adverse effect or the manufacturer's instructions permit.

The time of addition of admixture into the concrete shall be clearly obtained from the manufacturer.

The maximum water content in the concrete mix containing superplasticiser shall be 88% to 84% of water content in control mix.

The admixtures shall be added precisely and mixed thoroughly. In general, the admixture should be added to the mix along with approximately 25 percent of total mixing water. First, about 50 percent of the total water is added on the dry mix of cement and aggregates for about 15 to 30 seconds, then the mixture of admixture and 25 percent of the total water is added and finally the balance 25 percent of the total water is poured into the mix. However, careful attention should be given to the instructions provided by the manufacturer.

An admixture shall be compatible with other admixtures when used in the same concrete. All admixtures should be added to the concrete separately and must not be mixed together prior to addition. Also trials to assess the effects of overdosing in a particular mix are strongly recommended. Preference to Melamine-based Super plasticizer for concrete in cold weather condition and to Naphthalene-based (retarding type) super plasticiser in hot weather conditions shall be given.

9.8. MODE OF MEASUREMENT AND PAYMENT

Admixture shall not be measured separately if its usage is already included in the scope of the concrete work, since the rate per cubic meter of concrete work is deemed to include for admixtures as specified. In such case the item description for concrete work shall explicitly mention the term "providing necessary admixtures". If it is envisaged to maintain the " use of admixtures in concrete" as a separate item i.e., without including in the cost of concrete work then the method of payment shall be based on the volume of concrete in which the admixture is added.

10. SPECIFICATIONS FOR CONCRETE AND ALLIED WORKS

10.1. SCOPE

This Specification covers the general requirements for ready mixed concrete and for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for completed works.

It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by ENGINEER from time to time. The decision of ENGINEER as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.

10.2. APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

10.2.1. Materials

a) IS:269 Specification for 33 grade ordinary portland cement.

b) IS:455 Specification for portland slag cement.

c) IS:1489 Specification for portland pozzolana cement(Parts 1 & 2)

d) IS:8112 Specification for 43 grade ordinary portland cement.

e) IS:12330 Specification for sulphate resisting Portland Cement.

f) IS:383 Specification for coarse and fine aggregates from natural sources for concrete.

g) IS:432 Specification for mild steel and medium tensile (Parts steel bars and hard drawn steel wires for 1 & 2) concrete reinforcement.

h) IS:1786 Specification for high strength deformed steel bars and wires for concrete reinforcement.

i) IS:1566 Specification for hard drawn steel wire fabric for (Parts II) concrete reinforcement.

j) IS:9103 Specification for admixtures for concrete.

k) IS:2645 Specification for integral cement waterproofing compounds.

l) IS:4900 Specification for plywood for concrete shuttering work.

m) IS:4926 Ready mixed concrete

n) IS:12269 Specification for 53 grade ordinary portland cement.

o) IS:8041 Specification for rapid hardening cement.

p) IS:12600 Specification for low heat cement.

q) IS:6909 Specification for supersulphated cement.

r) IS:12089 Specification for granulated ground blast furnace slag.

s) BS:6699 Specification for granulated ground blast furnace slag.

t) BS:6073 Specifications for precast concrete masonry units (Part 1)

Methods for specifying precast concrete masonry (Part 2)

10.2.2. Material Testing

a) IS:4031 Methods of physical tests for hydraulic cement. (Parts 1 to 15)

b) IS:4032 Method of chemical analysis of hydraulic cement.

c) IS:650 Specification for standard sand for testing of cement.

d) IS:2430 Methods for sampling of aggregates for concrete.

e) IS:2386 Methods of test for aggregates for concrete (Parts 1 to 8)

f) IS:3025 Methods of sampling and test (physical and chemical) water used in industry.(Part 1 to 51)

g) IS:6925 Methods of test for determination of water soluble chlorides in concrete admixtures.

10.2.3. Material Storage

a) IS:4082 Recommendations on stacking and storing of construction materials at site.

10.2.4. Concrete Mix Design

a) IS:10262 Recommended guidelines for Concrete Mix Design.

b) SP:23 Handbook on Concrete Mixes.

10.2.5. Concrete Testing

a) IS:1199 Method of sampling and analysis of concrete.

b) IS:516 Method of test for strength of concrete.

c) IS:9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.

d) IS:8142 Method of test for determining setting time of concrete by penetration resistance.

e) IS:9284 Method of test for abrasion resistance of concrete.

f) IS:2770 Methods of testing bond in reinforced concrete.

10.2.6. Equipment

a) IS:1791 Specification for batch type concrete mixers.

b) IS:2438 Specification for roller pan mixer.

c) IS:4925 Specification for concrete batching and mixing plant.

d) IS:5892 Specification for concrete transit mixer and agitator.

e) IS:7242 Specification for concrete spreaders.

f) IS:2505 General Requirements for concrete vibrators: Immersion type.

g) IS:2506 General Requirements for screed board concrete vibrators.

h) IS:2514 Specification for concrete vibrating tables.

i) IS:3366 Specification for pan vibrators.

j) IS:4656 Specification for form vibrators for concrete.

k) IS:11993 Code of practice for use of screed board concrete vibrators.

l) IS:7251 Specification for concrete finishers.

m) IS:2722 Specifications for portable swing weigh batchers for concrete (single and double bucket type).

n) IS:2750 Specifications for steel scaffoldings.

10.2.7. Codes Of Practice

a) IS:456 Code of practice for plain and reinforced concrete.

b) IS:457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

c) IS:3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)

d) IS:3935 Code of practice for composite construction.

e) IS:2204 Code of practice for construction of reinforced concrete shell roof.

f) IS:2210 Criteria for the design of reinforced concrete shell structures and folded plates.

g) IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.

h) IS:5525 Recommendation for detailing of reinforcement in reinforced concrete works.

i) IS:2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.

j) IS:9417 Specification for welding cold worked bars for reinforced concrete construction.

k) IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.

l) IS:3414 Code of practice for design and installation of joints in buildings.

m) IS:4326 Code of practice for earthquake resistant design and construction of buildings.

n) IS:4014 Code of practice for steel tubular scaffolding. (Parts 1 & 2)

o) IS:2571 Code of practice for laying in situ cement concrete flooring

p) IS:7861 Part1 - Recommended practice for hot weather concreting

Part2 – Recommended practice for cold weather concreting

q) IS:3370 Code of practice for concrete structures for the storage of liquid (Part I to IV)

10.2.8. Construction Safety

a) IS:3696 Safety code for scaffolds and ladders.(Parts 1 & 2)

b) IS:7969 Safety code for handling and storage of building materials.

c) IS:8989 Safety code for erection of concrete framed structures.

10.2.9. Measurement

a) IS:1200 (Part 1 to 12) Method of measurement of building and engineering works (Part 2 and 5)

10.3. GENERAL

ENGINEER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and ENGINEER's approval obtained, prior to starting of concrete work. This shall, however, not relieve CONTRACTOR of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional

requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall only be used. Other materials may be used after approval of the ENGINEER and after establishing their performance suitability based on previous data, experience or tests.

10.4. MATERIALS

10.4.1. Cement

Unless otherwise specified or called for by ENGINEER/OWNER, cement shall be ordinary Portland cement conforming to IS 269, IS 8112 or IS: 12269.

The portland pozzolana cement shall conform to IS 1489 and it shall be used as directed by ENGINEER. Where portland pozzolana or Portland slag cements are used, it shall be ensured that consistency of quality is maintained and there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in any one mix unless specifically approved by ENGINEER. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without prior approval from ENGINEER.

Cement, which is not used within 90 days from its date of manufacture, shall be tested at a laboratory approved by ENGINEER and until the results of such tests are found satisfactory, it shall not be used in any work.

10.4.2. Aggregates

Aggregates shall consist of naturally occurring stones and gravel (crushed or uncrushed) and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/organic impurities/deleterious materials and conform to IS:383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse affect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2. If use of sand having fineness modulus more than 3.2 is unavoidable then it shall be suitable blended with crusher stone dust.

The maximum size of coarse aggregate shall be as stated on the drawings, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For most work 20mm aggregate is

suitable. Where there is no restriction to the flow of concrete into sections, 40mm or larger size is permitted.

In concrete elements with thin sections, closely spaced reinforcements or small cover, consideration should be given to the use of 10mm nominal maximum size.

Plums 160 mm and above of a reasonable size may be used where directed. Plums shall not constitute more than 20% by volume of concrete unless specified by ENGINEER.

10.4.3. Water

Water used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

The pH value of water shall not be less than 6.

Seawater shall not be used for concrete mixing and curing.

The proposed admixtures shall comply with requirements of TCE.10282A-H-RMC-401-D9.

10.4.4. Reinforcement

Reinforcement bars shall conform to IS: 432 and/ or IS: 1786 and welded wire fabric to IS: 1566 as shown on the drawing.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust or any other substance that will destroy or reduce bond.

Special precaution like coating of reinforcement may be provided with the prior approval of ENGINEER.

10.4.5. Wastage

Wastage allowance for cement and steel (supplied by OWNER) shall be as specified under Instruction to Bidders.

10.4.6. Samples And Tests

All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by ENGINEER.

Manufacturer’s test certificate shall be furnished for each batch of cement/steel and when directed by ENGINEER samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER at no extra cost to OWNER. However, where material is supplied by OWNER, all testing charges shall be borne by OWNER, but transportation and preparation of material samples for the laboratory shall be done by CONTRACTOR at no extra cost.

Sampling and testing of aggregates shall be as per IS: 2386 under the supervision of ENGINEER. The cost of all tests, sampling, etc. shall be borne by CONTRACTOR. For coarse aggregate crushing value shall be tested.

Water to be used shall be tested to comply with clause 5.4 of IS: 456.

CONTRACTOR shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

10.4.7. Storing Of Materials

All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

CONTRACTOR will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by OWNER. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cost of such rejected cement, where cement is supplied by OWNER, shall be recovered at issue rate or open market rate which ever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by ENGINEER**.** Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt. CONTRACTOR shall maintain record of receipt and consumption of cement.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from dropping leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

CONTRACTOR shall make his own arrangements for storing water at site in tanks of approved capacity. The tanks shall be cleaned at least once a week to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/ water. Each type and size shall be stacked separately.

10.5. CONCRETE

10.5.1. General

Concrete grade shall be as designated on drawings. Concrete in the works shall be "DESIGN MIX CONCRETE" OR "NOMINAL MIX CONCRETE". All concrete works of upto grade M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

10.5.2. Design Mix Concrete

Design Mix Concrete are classified in three categories, viz. "Normal Concrete (M)", "Heavy Concrete (H)", "Super Heavy Concrete (SH)". Each class of concrete shall be identified by a prefix and two numbers. Prefix "M" would denote Normal Concrete, prefix "H" would denote heavy concrete and prefix "SH" would denote super heavy concrete. The two numbers e.g. 25 - 40 would denote the crushing strength of cube at 28 days in N/sq.mm and maximum size of the coarse aggregates in millimetres respectively.

Normal concrete shall have a net dry unit weight of not less than 25 kN/cum, for the finished structure after curing, Heavy concrete shall have a net dry unit weight of not less than 36.30 kN/cum, for the finished structure after curing and special heavy concrete shall have a net dry unit weight of not less than 41 kN/cum for the finished structure after curing.

Mix Design & Testing

For Design Mix Concrete, the mix shall be designed as per any of four methods given in SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate during placement and should result in a dense and durable concrete capable of giving the specified finish. For liquid retaining structures, the mix shall also result in watertight concrete. The CONTRACTOR shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum grade of concrete shall be as per Table 5 of IS: 456 for various exposure conditions of concrete. For various environmental conditions, refer Table 3 of IS: 456.

The minimum cement content for Design Mix Concrete shall be as per Table 5 of IS: 456 or as given below, whichever is higher.

Grade of Concrete, M	Minimum Cement Content in kg/cum. of Concrete
20	300
25	300
30	320
35	340
40	360
45	400

The minimum cement content stipulated above shall be adopted irrespective of whether the CONTRACTOR achieves the desired strength with less quantity of cement. The CONTRACTOR's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR on this

account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

It shall be CONTRACTOR's sole responsibility to carry out the mix designs at his own cost. He shall furnish to ENGINEER for approval at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS: 516 shall comply with the requirements of IS: 456.

Grade of Concrete M	**Minimum Compressive Strength N/Sq.mm at 7 days**	**Specified Characteristic compressive strength N/sq.mm at 28 days**
15	10.0	15.0
20	13.5	20.0
25	17.0	25.0
30	20.0	30.0
35	23.5	35.0
40	27.0	40.0
45	30.0	45.0

A range of slumps recommended for various types of construction, unless otherwise instructed by the ENGINEER, shall be as given below:

Structure/Member	**Slump in millimeters**	
	Maximum	**Minimum**
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	75	25
T.G. and massive compressor foundations	50	25
Slabs, Beams and reinforced walls	50	25
Pumps & miscellaneous Equipment Foundations	75	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25
Liquid retaining/ conveying structures	50	25

(NOTE: These values are not meant for pumped concrete placed using slip formed technique.)

Where single size graded coarse aggregate are not available, aggregates of different sizes shall be properly combined. The contractors mix design shall show that combined grading of coarse aggregate meets the requirements of Table 2 of IS: 383 for graded aggregates.

10.5.3. Batching & Mixing Of Concrete

Proportions of aggregates and cement, as per approved concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within ±2% for cement and ±3% for aggregate. The batching equipment shall be calibrated at the frequency decided by ENGINEER.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by ENGINEER shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional sand and cement to allow for sticking in the drum.

Arrangement should be made by CONTRACTOR to have the cubes tested at his own expense in an approved laboratory or in field with prior consent of ENGINEER. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456. It is preferable to cast additional cubes (minimum 3 specimens) for testing at 7 days and 14 days.

10.6. NOMINAL MIX CONCRETE

10.6.1. Mix Design & Testing

Mix Design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS:456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 9 of IS: 456. However, it will be CONTRACTOR's sole responsibility to adopt appropriate nominal mix proportions to achieve the specified characteristic strength.

10.6.2. Batching & Mixing Of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only. Appropriate correction shall be made for bulking of sand after testing.

10.7. READY MIX CONCRETE

All specification as per IS: 4926 – "Specification for ready mixed concrete" shall be used.

The Contractor shall identify **at least two sources** of ready mix concrete supplier and get it approved by ENGINEER prior to start of the Works. Any change in the source of the RMC, shall be got approved by the ENGINEER.

The design mix prepared by the RMC supplier shall be the responsibility of the Contractor. The testing of concrete as per Codal provisions and the specifications shall be done by the Contractor same as the normal concreting works.

10.8. PRECAST CONCRETE

10.8.1. General

Precast concrete shall comply with the preceding Sections relating to Concrete as far as they are applicable. Precast concrete blocks shall comply with the requirements and recommendations of BS 6073.

10.8.2. Precasting Bed

All precast units shall be cast on, or their shutters supported from a suitably prepared level unyielding paved area.

10.8.3. Marking

All units shall be suitably marked in a clean and legible manner with a reference number and the date of casting, which information shall be clearly visible when units are stacked. Reinforced precast members shall be clearly marked to indicate the upper face.

10.8.4. Formwork

The formwork shall be either steel or lined with steel, waterproof / laminated board or such other material as directed and approved by the ENGINEER. Forms shall be strongly constructed, closely jointed and smooth and shall be such as to ensure true sharp arises and a perfect surface. Forms shall be so designed that they can be taken apart and reassembled readily.

10.8.5. Casting Tolerance

The casting tolerance, unless otherwise ordered or directed, shall be within +3mm of true dimensions.

10.8.6. Striking Forms

The method and time of striking the side shutters after casting the units will normally be left to the discretion of the CONTRACTOR, but the ENGINEER may specify minimum time in which case the CONTRACTOR must comply with the ENGINEER'S directions. In the event of any damage resulting from premature removal of shutters, or from any other cause, the unit will be liable to rejection and replacement by the Contractor at his own cost, whether the Engineer has specified a minimum striking time or not.

10.8.7. Lifting, Stacking And Removal

Precast units shall not be lifted, transported or used in the Works until they are sufficiently mature. The crushing tests on the test cubes, which are to be kept along with relevant the precast units, will be used to assess the maturity of the units.

Lifting, stacking and removal of precast units shall be undertaken without causing shock, vibration or undue stress to or in the units. The CONTRACTOR shall satisfy the ENGINEER that the methods he proposes for lifting, transporting and setting precast units will not overstress or damage the units in any way. In the event of overstress or damage due to whatever cause, the unit or units concerned will be liable to rejection. Rejected units shall be immediately broken up and removed from the site. The CONTRACTOR shall replace such rejected units at his own cost.

10.8.8. Curing

The top and sides of all precast units shall be kept covered constantly and in a damp condition with clean, potable fresh water for at least seven days after casting or for such further period as the ENGINEER may direct. It is preferable to have a curing pond for this purpose.

10.8.9. Precasting Records

Complete records shall be maintained of all precast work. Every unit shall have a reference number, date of casting, date of removal from bed and date and position of placing shall be recorded together with corresponding test cube reference number and results.

CONTRACTOR shall submit a method statement to ENGINEER for approval, furnishing details of each stage of operation.

10.9. FORMWORK

Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs, etc. including ties, anchors, hangers, inserts, falsework, wedges, etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of CONTRACTOR. However, if so directed by ENGINEER, the drawings and calculations for the design of the formwork shall be submitted to ENGINEER for approval.

Formwork shall be designed to fulfil the following requirements:

Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

Capable of easily striking without shock, disturbance or damage to the concrete.

Soffit forms capable of imparting a camber if required.

Soffit forms and supports capable of being left in position if required.

Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of lined timber, waterproof / plastic coated plywood, steel, plastic depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of ENGINEER. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structure shall be sufficiently tight to prevent loss of slurry from concrete using foam and rubber seals.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces, dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of ENGINEER. CONTRACTOR shall equip himself with enough quantity of shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves may be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified or shown on drawings all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of ENGINEER, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, as directed by ENGINEER, than that required as per drawing to compensate for irregularities in excavation.

CONTRACTOR shall provide adequate props of adjustable steel pipes carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.5 m or as directed by ENGINEER. CONTRACTOR shall temporarily and securely fix items to be cast (embedments/inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be removed. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at CONTRACTOR's cost.

The striking time for formwork shall be determined based on the following requirements:

a) Development of adequate concrete strength;

b) Permissible deflection at time of striking form work;

c) Curing procedure employed - its efficiency and effectiveness;

d) Subsequent surface treatment to be done;

e) Prevention of thermal cracking at re-entrant angles;

f) Ambient temperatures; and Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Before removing formwork of soffit of slabs/ beams compressive strength at 7/14/21 days shall be checked.

Under normal circumstances (generally where temperatures are above 20 Deg. C) forms may be struck after expiry of the period given in IS: 456 unless directed otherwise by ENGINEER. For Portland Pozzolona/slag cement the stripping time shall be suitably modified as directed by the ENGINEER. It is the CONTRACTOR's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

10.10. REINFORCEMENT FABRICATION AND PLACEMENT

Reinforcing bars supplied in the form of bent coils shall be straightened cold without damage at any extra cost. No bending shall be done when ambient temperature is below 5 Deg.C. Suitable preheating may be permitted if steel bar bending is to be done at below 0 Deg.C. Bars supplied in bent coils shall be straightened only by machine.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by ENGINEER. Bar bending machines shall be used to achieve desired accuracy.

Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire, etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by ENGINEER prior to concrete placement. Spacers (PVC or Concrete) shall be of such material and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be proposed by CONTRACTOR and approved by ENGINEER.

If permitted by ENGINEER, welding of reinforcement shall be done in accordance with IS: 2751, IS: 9417 and SP: 34 as applicable.

Tolerance on placement of reinforcement shall be as per Cl. 12.3 of IS: 456.

10.11. TOLERANCES

Tolerance for formed and concrete dimensions shall be as per IS: 456 and/ or ACI-117-90, ACI-347 unless specified otherwise.

Tolerance specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

Tolerance for top of concrete of equipments and structural steel foundations shall be as under:

a) Where grout thickness is less than or equal to 25mm: +5mm and – 10mm.

b) Where grout thickness is more than 25mm: ±15mm.

10.12. PREPARATION PRIOR TO CONCRETE PLACEMENT

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by ENGINEER. CONTRACTOR shall maintain separate Pour Card for each pour as per the format enclosed.

10.13. TRANSPORTING, PLACING AND COMPACTING CONCRETE

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, CONTRACTOR shall provide suitable drops and “Elephant Trunks”. Concrete shall not be dropped form a height of more than 1.5 m as stipulated in clause 9.13.

Concrete shall not be placed in flowing water. Under water concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the CONTRACTOR shall proceed as specified below and also ensure the following:

a) Continuously between construction joints and predetermined abutments.

b) Without disturbance to forms or reinforcement.

c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits, etc.

d) Without dropping in a manner that could cause segregation or shock.

e) In deep pours only when the concrete and formwork is designed for this purpose and by using suitable chutes or pipes.

f) Do not place if the workability is such that full compaction cannot be achieved.

g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.

h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

i) Ensure that there is no damage or displacement to sheet membranes.

j) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes (Initial setting time) of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids, thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration leads to segregation and shall be avoided.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by ENGINEER. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

CONTRACTOR shall submit a method statement to ENGINEER for approval, furnishing details of pour sequence, thickness of each layer, mixing and conveying equipments proposed etc. preferably with a sketch.

Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as determined by ENGINEER. Concrete shall be protected against damage until final acceptance.

10.14. PLACING OF CONCRETE BY PUMPING METHODS

10.14.1. General

Placing of concrete by pumping will be as specified or authorised by Engineer to achieve the required speediness of construction and maintain targeted schedules.

Pumping of concrete shall be done only after conducting pumpability trials to ascertain the performance of fresh concrete on pumping in presence of the Engineer as per approved procedure. During pumping, concrete shall be conveyed either through rigid pipe or through flexible hose and discharged directly into the desired area. A steady supply of pumpable concrete is necessary for satisfactory pumping. Pumpable concrete requires properly graded aggregates, material uniformity, consistent batching and thorough mixing. Concrete pumps used shall be able to

deliver concrete over a horizontal distance of about 400 m or of about 100 m in a vertical direction, (with intermediate figures for a combination of horizontal and vertical movements). They shall be used for concreting densely reinforced structures, internal structural elements of buildings and for large pours of concrete.

Placement of normal concrete by pumping will be permitted as specified or authorised by the Engineer. The decision, whether or not to pump any particular mix shall rest entirely with the Engineer and no extra claims for payment on this account will be entertained. The pumping equipment, pipe lines and accessories as well as proportioning of pumpable concrete shall generally confirm to the recommendations of ACI-304.2 (latest revision) – Placing of concrete by pumping method - Proportioning of pumpable mixes gives certain guide lines on concrete mix. However, final selection of mix shall be as instructed by the Engineer.

10.14.2. Pumping Equipment

Requisite numbers of modern dependable concrete pumps capable of pumping concrete of specified quality at a rate required to meet the construction schedules, together with a balanced complement of pipelines, accessories, spare parts, power controlled placing booms, and experienced pump operators and maintenance staff shall be provided at locations and in a manner approved by the Engineer.

The pumping plant shall be completely installed on each occasion, with preliminary mock operation for a sufficient length of time prior to scheduled placement of a particular concrete pour, to enable the Engineer to conduct pumpability tests and necessary adjustments for the concrete mix, prior to use of the pumping for placement of concrete.

10.14.3. Type Of Pump

The selection of the concrete pump shall be done as per the project requirement. The Contractor shall submit the concrete pump data sheets proving the suitability for the given project to ENGINEER for approval.

The concrete pump shall be selected on its best pumping capacity and the speediness to be achieved in the project. The piston pumps of a net horizontal pumping capacity of 30 m^3/hr or 20 m^3/hr or 15 m^3/hr or 10 m^3/hr can be utilised. The combination of various pumps to be used shall be decided by Contractor and shall submit the necessary documents and targeted progress to be achieved in line with the Time Period and Milestones.

These pumps shall have capacity to pump the concrete upto at a horizontal distance of 400 m and capable of generating a minimum pressure of 80 bar. These parameters shall depend upon the building sizes, manoeuvrability and other construction features. These pumps shall consist of a receiving hopper with a bolted grill at top of capacity not less than 600 litres. The hoppers shall be provided with hydraulically driven re-mixing blades or other agitating devices to keep the concrete mixed continuously and maintain consistency and uniformity. The pumps shall be provided with two cylinders with maximum diameter not less than 150 mm, stroke of about 1200 mm and the number of strokes not exceeding 25 per minute. The outlet

valves shall be located on the discharge lines. Type of inlet and outlet valves may vary depending on the manufacturer, but they shall preferably be of sliding-rod-flat-gate type. The piston shall be hydraulically driven. Primary power shall be supplied by gasoline, diesel or electric motor of requisite power rating. Care shall be taken by the Contractor to ensure uninterrupted operation of the pumps during the entire period of concreting by providing adequate standby arrangements. The primary power and pump equipment shall be either truck or trailer mounted, and not skid mounted.

10.14.4. Pipelines And Accessories

Rigid pipelines

Concrete transported to the placement area by pumping methods shall be pumped thorough rigid pipes or a combination of rigid and heavy-duty flexible hoses. Rigid pipe shall be made available in minimum 125 mm diameter size. Aluminium alloy lines shall not be used for delivery of concrete. Rigid pipes shall be furnished in such lengths as can be manually handled by a single person.

Flexible conduit (hose)

Flexible conduit shall be made of rubber, or spirally wound flexible metal, and plastic flexible conduits generally present greater resistance to movement of concrete and their performance is not the same as that of a rigid pipe and also larger sizes (100 mm to 123 mm) have a tendency to leak. Flexible conduits provided, shall be interchangeable with rigid pipes and their use restricted to curves, difficult placement areas, and as connection to moving cranes or to water borne lines.

Couplings

The couplings provided to connect both flexible and rigid pipe sections shall be adequate in strength to withstand handling during erection of the pipe system, misalignments, and poor support along the lines. They should be nominally rated for at least 3.45 MPa and greater for rising over 30 meters. The strength and tightness of joints shall be guaranteed. Couplings shall be designed to allow replacement of any pipe section without moving other pipe sections, and shall provide a full internal cross-section with no obstructions or crevices to disrupt the smooth flow of concrete.

Accessories

The pump and the distribution system for a particular concreting job shall use the accessories as listed below and they shall be approved by the Engineer.

a) Rigid and flexible pipes in varying lengths such as 3, 1.5, 0.9, 0.6 and 0.3 m lengths.

b) Curved sections of rigid pipes such as large radius elbows at angles of 90 deg., 45 deg., 22 deg. 30 min. and 11 deg. 15 min.

c) Swivel joints and rotary distributors.

d) Pin and gate valves to prevent back-flow in the pipe line.

e) Switch valve to direct flow into another pipe line.

f) Connection devices to fill form the bottom up.

g) Temporary supports, rollers and other devices for protection of conduit over rock, concrete, reinforcement steel and forms. Lifting and leashing points.

h) Extra strong coupling for vertical runs in inaccessible areas.

i) Transition for connecting different sizes of pipes.

j) Air vents for downhill pumping

k) Clean-out equipment

l) Adequate numbers of separate placement booms of various radius and reach, either stationary steel column mounted or tower crane mast mounted moving on rail tracks, or truck mounted shall be provided by the Contractor to match within concrete placement schedule and pumps. For maximum flexibility of operation the separate placement boom shall be such that they can be easily lifted by the tower cranes provided. Their mounting arrangements shall be quick connecting type and interchangeable between tower crane masts, steel columns and truck mountings etc. The placement booms shall consist of three hinged parts incorporating a concrete pipe line with articulated inserts at boom joints and ending in a flexible hose. The boom shall be remote controlled.

10.14.5. The Pumping Plant And The Pipe Distribution System

The concrete pumping plant apart from the receiving hopper and the pump shall also be provided with a water pressure valve, connecting pipes with needle valve, cleaning rods, outlets for drainage water and a high pressure pumps for flushing out the concrete in pipe line.

The shortest way shall be selected in planning the direction of the concrete pipeline, and the number of bends (elbows) shall be as small as possible. Should a change be made of the direction in plan of the pipe lines or a change of their vertical profile, these shall be arranged with easy transitions.

Before the pipeline is assembled all pipe flanges shall be tested and carefully cleaned, packing rings cleaned or replaced, and the internal surfaces of all pipe section cleaned. Horizontal lengths of concrete pipe lines shall be laid on supports, wooden trestles, scaffolding, staging etc. Vertical and inclined lengths of pipe shall be fastened by clamp irons or stirrups to masts, or to the frame of the structure being erected. It is recommended to replace vertical sections of the pipeline by inclined sections where possible. Sharp turns and bends at an angle of 90 deg. shall be avoided. Pipes shall be supported in such a manner that they do not disturb the forms during concreting.

A vertical section of the concrete pipeline shall not be arranged closer than 8 to 9 m from the concrete pump. Before a vertical section a valve shall normally be placed, to prevent back flow of the concrete when the pump stops or when the pipe is cleaned or replaced. When pumping vertically through the placer boom, a thrust block shall be provided at the base of the vertical riser to resist the forces in the pipeline due to the pumping of concrete.

When pumping downwards, 15 m or more, it is desirable to provide an air release valve at the middle of the top bend.

10.14.6. Line Resistance And Lubrication

When concrete is pumped through a straight section of a pipe or hose, it moves as a cylinder riding on a thin lubricant film of a grout or mortar. At changes in direction or cross-section some re-mixing occurs. In all cases at the start of pumping operation lubricating mortar is required, and this shall be a properly designed mortar of cement-sand grout (1:1) or a batch of the regular concrete with the coarse aggregate omitted. Except for a small portion of this mortar which may be used for bedding at the construction joint, it shall be wasted and not used in the concrete placement. It can be assumed that about 0.35 cu. m of mortar will lubricate a 125 mm diameter horizontal pipeline of about 300 m length and the lubrication shall be maintained as long as the pumping continues. For vertical or smaller lines less mortar will be required. The mortar shall have the same cement content as that of the concrete. The water cement ratio shall be determined by the placing condition and finally decided by the Engineer. In order to ensure that only minimum quantity of grout mortar is used to lubricate the pipeline, a rubber sponge ball shall be allowed to pass through the pipeline immediately before the first batch of grout mortar is pumped. This rubber ball shall be pushed by the following mortar along the pipeline slowly and allowed to emerge at the open end. The cost of the lubricating mortar to be used, shall be deemed to have been included in the general rate structure for works in the schedule of items and nothing extra shall be payable.

It shall be taken into account when planning the pipeline that, in straight horizontal and vertical section of pipe and at bends the resistance to the movements of concrete differ. For convenience in calculating the resistance of a concrete pipeline experimental co-efficient of equivalent length shall be used by means of which the equivalent length of a horizontal concrete pipeline is to be obtained. In absence of the pump manufacturer's data, equivalent lengths of concrete pipeline as indicated in Table –8 may be used.

Table –8

EQUIVALENT LENGTH OF CONCRETE PIPELINES

Characteristics of a length of concrete Pipeline	Equivalent length of horizontal concrete pipeline in meter
Bend in pipeline at an angle of 90 deg.	12

Bend in pipeline at an angle of 45 deg.	7
Bend in pipeline at an angle of 22 deg. 30 min.	4
1 m of vertical concrete pipeline	8

The equivalent length of the concrete pipeline must be less than or equal to the range of feed in horizontal direction as specified by the pump manufacturer for the same rate of pumping. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends and preferably with no change in pipe size. If two sizes of pipes are required to be used, the smaller diameter shall be used at the pump end and the larger at the discharge end. The contractor shall exercise care in handling of the pipeline, during assembly, cleaning and dismantling so as to lower the line resistance by preventing the formation of rough surfaces, dents in pipe section and crevices in couplings. If any pipe, bend, coupling and other accessories are considered to be defective or damaged by the Engineer, the same shall not be used in the concrete pipeline till such time the defect has been removed and the damage repaired to the entire satisfaction of the Engineer. Qualified chemical admixtures shall be used effectively to get workable concrete.

10.14.7. Proportioning Pumpable Concrete

Basic Consideration

a) Although the ingredients of concrete to be placed both by pumping and by other means are the same, more emphasis shall be laid on the quality control and proportioning of a dependable pumpable mix. Dependability is affected by the equipment and the operator, with the control of all of the ingredients in the mixture, the batching and mixing operations, and the knowledge and experience of all the personnel from beginning to end.

b) Concrete mixes for pumping shall be “plastic” at all times. Stiff mixes shall not be used for pumping as they do not pump well. Particular attention shall be given to the mortar (cement, sand and water) and the amounts and sizes of coarse aggregates.

10.14.8. Normal Weight Aggregates

Coarse normal weight aggregates

The maximum size of angular coarse aggregate shall be limited to one-third of the smallest inside diameter of the hose or pipe based on simple geometry of cubical shape aggregates. For well-rounded aggregates, the maximum size shall be limited to 40% of the pipe or hose diameter. Adequate provisions shall be made to eliminate over size particles in the concrete by screening or by careful selection of aggregate. Gradation of sizes of coarse aggregates shall correspond to Grades A and B of Table –9 and shall meet IS: 2386 requirements. If required certain fractional sizes shall be combined and blended to produce the required gradation. Greater emphasis shall be laid on uniformity of gradation throughout the entire job.

The maximum size of the coarse aggregate has a significant effect on the volume or amount of coarse aggregate that may be effectively used in a mix. As will be seen from Table –10 the quantity of coarse aggregate must be substantially reduced as the maximum size become smaller. Mixes consisting of too large a portion of coarse aggregate with less cement shall be avoided.

Table –9

Grading Requirement of Coarse Aggregates for Pumped Concrete

Grade - A (Maximum Size 40 mm)		**Grade –B** (Maximum Size 20 mm)	
Sieve Size	Percent Passing by weight	Sieve Size	Percent passing by weight
50 mm	100	25 mm	100
40 mm	95 to 100	20 mm	90 to 100
20 mm	35 to 70	12.5 mm	20 to 55
10 mm	10 to 30	10 mm	0 to 15
4.75 mm	0 to 5	4.75 mm	0 to 5

Table –10

Volume of coarse Aggregate per unit

of volume of concrete.

Max. size	Volume of Dry-rodded Coarse Aggregate per Unit volume of aggregates of concrete for different fineness modulli of sand			
	FMS =2.40	FMS =2.60	FMS =2.8	FMS =3.00
10	0.50	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.60
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.70
50	0.78	0.76	0.74	0.72

Note :

- Volumes are based on aggregates in dry-rodded condition.
- These volumes are selected from empirical relationships to produce concrete with a degree of workability suitable for usual reinforced construction. When placement is to by pump, they shall be reduced by about 10 percent.
- FMS = Fineness Modulus of Sand.

Fine normal weight aggregate

Fine aggregate shall consist of natural sand, manufactured sand or a combination thereof and shall be graded within the following limits.

Sieve Size	Percent passing by weight
9.5 mm	100
4.75 mm	95 to 100
2.36 mm	80 to 100
1.18 mm	50 to 85
600 microns	25 to 60
300 microns	10 to 30
150 microns	2 to 10

Fine aggregates shall conform to the requirements of IS: 2386. Particular attention shall be given to those passing through finer screen sizes. For small line system (less than 150 mm) 15 to 30 percent shall pass 300 micron sieve and 5 to 10 percent shall pass 150 micron sieve. Sands which are deficient in either of these two sizes shall be blended with selected finer sands or inert material such as quarry dust to produce these desired percentages.

The fineness modulus of sand meeting the above grading limits will fall between 2.13 and 3.37 with the median being 2.75. Pumpability of mixes will generally improve with a decrease in the fineness modulus value or in other words with the use of finer sands. Sands having a fineness modulus between 2.40 and 3.00 are generally satisfactory provided that the percentages passing 300 micron and 150 micron sieves meet the previously stated requirements. It shall also be emphasized that for uniformity, the fineness modulus of the sand shall not vary more than 0.20 from the average value used in proportioning.

Table –10 is suggested as a guide to determine the amounts of coarse aggregate to be combined with sand of different fineness modulus. The foot note of Table –10 require a reduction in the volume of coarse aggregate by 10 percent for pumping.

This margin shall be considered as a safety margin for variations in sand gradation to reduce pumping pressure. Under conditions of good materials control and uncomplicated line systems, this reduction may not be required.

Although in practice it may not be possible to duplicate this recommended sand gradation exactly, sands having a gradation closer to the upper limit (fine sand) are more desirable for pumping than those near the lower limit (coarse sand). The fineness modulus of sand according to the recommended curve is 2.68 and the gradation meets all the requirements stated earlier.

10.14.9. Water And Slump

Water requirements and slump control for pumpable normal weight concrete are interrelated and extremely important considerations. The mixing water requirements for a particular mix shall be determined by the Engineer and modified to suit the fineness of sands, quality of admixtures, additives, cement replacements or other special materials being used in the concrete.

The Contractor shall establish the optimum slump jointly with the Engineer for a pumpable mix at the discharge hose end and shall maintain control of that particular slump through out the course of a job. Excess water shall not be added in the receiving hopper to make the concrete mix pumpable; instead attempt shall be made to obtain 'truly plastic mix' by proper proportioning.

Slump of concrete may undergo change between initial mixing and final placement. If the slump at the discharge hose end is to be maintained within specified limits, it will be necessary for the concrete to enter the pump at a higher slump to give the required mobility during transport. Slump adjustments by re-proportioning of the constituents as may be required shall be carried out by the Contractor jointly in consultation with the Engineer for every type of mix and for every new placement and set up of pump and pipelines.

10.14.10. Cement Content

a) The determination of the cement content for a normal weight pump mix shall follow the same basic principles used for conventionally placed concrete. The water cement ratio shall be established by the Engineer on the basis of exposure conditions, strength requirements or minimum cement consumption, whichever governs. However, because of slightly higher ranges of slump and ratios of fine to coarse aggregates, the pump mix may require an increase in the amount of cement above those pumpable concrete mass. The total quantity of fines passing through the 300 micron sieve including cement, fine sand, stone dust etc. shall be in the range of 380 to 450 kg/cum of concrete.

b) Cement content in case of M-50 shall be maximum of 425 kg/m^3, and shall be a mix with high range of workability i.e. 175 mm±25 mm. All the contents shall be mixed based on the mix design & trial studies.

c) While establishing the cement content for normal weight trial mixes, it will be necessary to take into account the capabilities of the particular pump and its

operator for over strength proportioning in the laboratory to provide for field variations.

d) In case of pumping difficulties, it is desirable and economical to correct any deficiencies in the aggregates, especially in the sand instead of using extra quantities of sand. With well graded coarse and fine aggregates properly combined, the cement requirement for pumpable mixes shall closely resemble to those used in conventionally placed concrete.

10.14.11. Admixtures

The use of poor aggregate grading or aggregate with continuous change in overall grading of the 'combinations' during concreting operation will make special admixtures quite useful in overcoming the main difficulty like blockage in pumping. These admixtures shall be incorporated in pumpable concrete to aim the following.

- Increase in the range of mix designs which may be successfully pumped using water reducing admixtures/Super plasticizers with the approval of the Engineer.

- Reducing the risk of pipeline blockages by preventing segregation of concrete mix.

- To have satisfactory/specified performance both in fresh and hardened state.

Any admixture that increases workability in normal weight concrete may usually improve pumpability. The choice of type of admixture and the advantage gained from its use in concrete to be pumped will depend on the characteristics of the pump mix and will be finally decided by the Engineer in consultation with the admixture manufacturer.

For improvement of pumpability the following admixtures are generally recommended. Such admixtures used shall be conforming to ASTM C-494/IS 9103.

a) Water Reducing Admixtures/Super Plasticizers

These cause reduction in water requirements at constant slump or an increase in slump at constant water-cement ratio. They can be designed to have no apparent effect on setting time, or alternately to achieve varying degrees of acceleration or retardation in rate of hardening of the mixture. Most water reducing admixtures increase the pumpabillity of the concrete mix through plasticising action.

b) Air Entraining Admixtures

Air entrained concrete is considerably plastic and more workable than non air entrained concrete. It can be pumped with less coarse aggregate segregation and has less tendency to bleed. Start-up after shut down is also generally easier due to reduced bleeding. For pumped concrete these limits shall be obtained at the point of placement in the structure. To compensate for air content loss in the air entrained concrete higher entrainment of air may

be required at the batching plant. The required adjustment of admixture dose shall be carried out by the Engineer after carrying out necessary air loss tests. An air content in the range of 3 to 5 % shall be preferred as higher ranges reduces the delivery capacity of pump systems due to increased compressibility of the concrete and also reduces strength of concrete.

If air-entraining plasticizer is used, typically 13 % minimum water reduction is possible. Therefore, strength loss due to air entrainment will be compensated by using such air-entraining plasticizer.

c) Finely Divided Mineral Admixtures

Contractor, if specifically approved by the engineer, can use mineral admixture. In concrete mixtures, deficient in fines, the addition of a finely divided inert mineral admixture generally improves workability, pumpability, reduces the amount of bleeding and increases the strength. The effect on strength depends on the type of mineral admixture used, conditions under which the concrete is cured, and the amount of admixture used. Water soluble polymers obtained from cellulose derivations may also be used as an admixture with a small dose of 60 to 150 gms/cum. to increase viscosity of the mixing water and reduce the frictional resistance to flow and bleeding in the pipe system.

10.14.12. Trial Mixes

The trial mixes for pumping shall be prepared and tested in the Site laboratory by contractor in accordance with clause 10.14.13 of this specification. The ingredients, particularly the coarse and fine aggregates shall also be checked for the conformance to the desired properties described, by the contractor. Table –10 may be used to select the volume of coarse aggregate per cu. m. of concrete. In using this table it is recommended that the highest probable fineness modulus of sand be used rather than the average fineness modulus to ensure consistent performance during pumping. For additional plasticity, 10 % reduction in coarse aggregate quantities shall be considered. Experience with the use of local aggregate and their uniformity shall also be considered in the proportioning concepts.

10.14.13. Mix Design For Pumpable Concrete

Taking the above factors into account, the concrete shall first be designed for normal placement conditions and then modified as necessary to suit pumping. The following procedure shall be adopted:

a) Design the mix for specified characteristic strength and workability.

b) Check and ensure combined grading of aggregates i.e. as uniform grading as possible. This requirement is vital as gaps or partial gaps are the basic reasons for poor water retention property and segregation under pressure.

c) Determine the optimum sand content for the required workability and increase sand content by reducing volume of coarse aggregate per unit

volume of concrete by about 10 % as a degree of protection against under sanding due to batch variations.

d) Recheck the minimum cement content for durability.

e) Examine the total fines content i.e. cement and fine aggregates passing through 300 micron sieve and readjust the mix, if necessary. A very rich mix with fine sand will be as problematic as coarse sand with lean mix.

f) Re-appraise the grading if the particle shape of any particular fraction is such as may cause excessive voids. Re-adjust as required, if necessary examining the void ratio of various combinations, using void meter to achieve minimum voids at the expense of 'sufficient fines' content.

g) If dissatisfied with (a) to (f) as above, consider what remedial action may be taken to overcome the troublesome factor. For example, the following two situations may occur :

h) If the sand has more coarser fraction it is worth considering the addition of a proportion of finer sand, or alternately if the sand has finer fraction, the addition of coarse fraction may be considered. Addition or reduction of cement may help, but the correct solution is to overcome the gap in overall grading as stated above.

i) In a 20 mm aggregate max. size, if there is an excess of 10 to 4.75 mm fraction, and this fraction is flaky with unduly large surface area, either increase the sand content to reduce the possibility of segregation and to reduce the inter-practical stresses, or (better) re-grade using single sized aggregates.

j) At the trial mix stage small variations can be made preferably in the light of the pressures registered and observed performances through the pump. In certain cases admixtures may be economically and beneficially used to improve or eliminate circumstances that cannot readily be overcome by other means.

10.14.14. Testing For Pumpability

No mix shall be accepted for use on a pumping job until an actual test under field condition has been completed. Testing a mix for pumpability involves duplication of the anticipated job condition from beginning to end. The batching and conveying by truck mixers shall be the same as will be used; the same pump and operator shall be present. The pipe and hose layouts shall simulate the actual condition as far as practicable. Prior use of a mix on another job may furnish evidence of pumpability but only if conditions are duplicated. Before commencing a new concreting job, the contractor shall carry out pumpability tests in consultation with the Engineer. Concrete used in such tests shall not be used in the actual construction, unless specifically permitted by the Engineer.

Following parameter shall be established by pumpability trials:

a) In situ compressive & split tensile strength of concrete by

b) Curing the sample at Site by sprinkling water.

c) Curing the sample at Laboratory in curing tanks.

d) Wet sieve analysis of concrete to ensure that proportions of ingredients before and after pumping are same.

10.14.15. Field Practices

a) Proper planning of concrete supply, pump location, line layout, placing sequence and the entire pumping operation shall be done by the Contractor and got approved by the Engineer on every occasion before commencement of concreting job. The pump shall be as near the placing area as practicable, and the entire surrounding area must have adequate bearing strength to support the concrete delivery trucks, thus assuring a continuous supply of concrete. For important concrete placements and large jobs, adequate standby power and pumping equipment shall be provided as replacement, should break down occur.

b) Direct communications shall be maintained between the pump operator, concrete placing crew and batching plant. The placing rate shall be estimated so that concrete can be operated at an appropriate delivery rate. As a final check, the pump shall be started and operated without concrete to ascertain that, all moving parts are operating properly. As stated previously, the grout mortar shall be pumped into the line to provide initial lubrication for the concrete. As soon as concrete is received, the pump shall be run slowly until the lines are completely full and the concrete is slowly moving. Once the pumping is started, the operator shall ensure that the hopper of the pump is not emptied beyond a certain level, as air may enter the pipeline and cause choking. Continuous pumping should be ensured. If a delay occurs because of concrete delivery, form repairs, or other factors, the pump shall be slowed down to maintain some movement of the concrete till normal supply is resumed. For longer delays, the concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with one stroke of the pump. In confined areas, attempt shall be made by the Contractor to run a return line back to the pump, so that concrete can be re-circulated during delays.

c) The Contractor shall ensure that obstructions are not found in the pipe due to interruption in the feed of the concrete by more than 30 to 45 minutes.

d) Minor blockages shall be cleared by operating a few strokes of the pump in reverse momentarily and then by returning to normal forward pumping. If this fails, a succession of reverse and forward strokes shall be carried out to remove the blockage. Should this fail also, the blockage may be due to air-lock and the entrapped air has to be removed.

e) Attempt to push through the obstructions by repeatedly starting the pump will result in compaction of the concrete and complicate the removal of the

concrete in the pipe. Blockages in the pipe are usually discovered by the sound when the pipe is struck. To remove the obstruction, the concrete pipe shall be taken apart at the assured position and cleaned. Then the pumping process shall be started all over again.

f) This method of checking the blockage and setting it right shall be done with great speed as excessive delay will cause setting of concrete in the pipeline downstream of the choke and will lead to further blockage. When the blockage is being found out and remedied, the pump shall periodically be given one or two strokes forward to keep the concrete in motion. If blockage occurs in the placer boom, a pipe joint near the base of the placer boom shall be opened and the boom made vertical to drain the pipeline by gravity.

g) Cleaning blockages are time consuming and as such major blockages shall best be avoided by ensuring a pumpable mix. Concrete that is either under or over sanded, short of fines, gap graded, has an excess of a particular size, or excessively wet or dry will be rejected by the pump either by blockage or by hard pumping involving excessive pressures.

h) The termination of pumping operations shall be carefully planned to utilize the concrete dormant in the pipeline and the hopper when the pump is stopped and to avoid wastage.

i) When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a go-devil is inserted and forced through the line to clear it out. Water under pressure shall be used to push the go-devil. The go-devil shall be stopped about one metre from the end of the line, so that the water in the line will not spill over into the placement area. After flushing, water in the pipe shall be removed by drain cock which shall be located for this purpose in the lowest part of the line. After all concrete has been removed from the lines, all lines and equipment shall be immediately cleaned thoroughly.

10.14.16. Quality Control

a) Contractor shall ensure that workmanship and plant shall be maintained at peak efficiency. Degree of control on all the concrete operation from selection of the ingredients to the final testing of specimen shall be in line with the assumptions made in mix design with respect to the standard deviation and co-efficient of variation.

b) The Contractor shall ensure that any compromise in quality is not done for the pumped concrete. To be pumpable, a high level of quality control for the assurance of uniformity must be maintained. Sampling at both the truck discharges and point of final placement shall be done by the Contractor and the Engineer jointly, as frequently as the Engineer desires to determine, if any change in the slump air content, and other significant mix characteristics occur take necessary corrective actions.

c) The Contractor shall engage experienced supervision at all levels. The placing crew shall be experienced and qualified and each operation shall be well planned and properly scheduled.

d) All the crew engaged in each of the concrete activities shall demonstrate in the presence of the Engineer, their skills and capabilities to produce the final product as specified.

10.15. MASS CONCRETE WORKS

Sequence of pouring for mass concrete works shall be as approved by ENGINEER. CONTRACTOR shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

10.16. PLACING TEMPERATURE OF CONCRETE

Placing temperature of concrete should be maintained as specified in Bill of Quantities or as directed by ENGINEER, to avoid shrinkage cracking

Mixing water shall be kept cool by storing it under cover. Chilled water or crushed ice as part of the mixing water to achieve the specified placing temperature shall be used. For chilled water, it is recommended that the contractor install and maintain refrigeration facility of required capacity. The contractor shall also build and maintain well insulated adequate capacity storage tank for cold water with insulated connected piping. To supplement this refrigeration facility, the contractor will have to have ice plant or use commercial ice subject to approval of the ENGINEER. The full quantity of crushed ice shall be stored in cold storage 24 hours in advance of the start of concreting. The temperature in cold storage shall not be more than $-2^{o}c$. The contractor should study the placing temperature condition and work out plant capacity commensurate with the construction schedule requirements and submit his scheme along with the tender.

Ice when used as replacement for a portion or all the mixing water shall be produced from water which meets the requirements of clause 10.4.3. Ice when used shall be in flakes of size 3mm or below or crushed condition and the crushed ice shall be such as to pass completely, 10mm sieve.

10.17. CURING

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

a) Premature drying out, particularly by solar radiation and wind;

b) Leaching out by rain and flowing water;

c) Rapid cooling during the first few days after placing;

d) High internal thermal gradients;

e) Low temperature or frost;

f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless directed otherwise by ENGINEER, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is directed to be used by the ENGINEER, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be got approved from the ENGINEER before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

Extra precautions shall be exercised in curing concrete during cold and hot weather as per Clause no. 8.3 of IS: 7861(Part II) and Clause no. 8.2 of IS: 7861(Part I) respectively.

Curing arrangement shall be subjected to ENGINEER's approval.

10.18. CONSTRUCTION JOINTS AND KEYS

Construction joints (location and type) shall be as shown on the drawing or as approved by ENGINEER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of ENGINEER.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as directed by ENGINEER.

Before resuming concreting on a surface which has hardened all laitance and loose aggregates shall be thoroughly removed by wire brushing and/ or hacking, the surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and a 15 mm thick layer of cement sand mortar for horizontal joints, the ratio of cement and sand being the same as in the concrete mix.

When concreting is to be resumed on a surface, which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

Approved epoxy Bonding agent, for bond between old (say 28 days or more) and new concrete may also be used as per manufacturer's specifications.

10.19. FOUNDATION BEDDING

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy area shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as directed by ENGINEER. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

10.20. BASE CONCRETE

The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

Before placing the blinding concrete of 1:4:8 mix, 50/75mm thick as per the item of work, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

MEASUREMENT

Measurement shall be in sqm correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

10.21. FINISHES

10.21.1. General

The formwork for concrete works shall be such as to give the finish as specified. The CONTRACTOR shall make good as directed any unavoidable defects consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. CONTRACTOR shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

Surface Finish Type F1

This type of finish shall be for non-exposed concrete surfaces against which back fill or concrete is to be placed. The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface

irregularities which would interfere with proper and effective application of waterproofing material specified for use.

Surface Finish Type F2

This type of finish shall be for all concrete work which will be exposed to view upon completion of the job. The appearance shall be that of a smooth dense, well-compacted concrete showing only the slight marks of well fitted shuttering joints. The CONTRACTOR shall make good any blemishes.

Surface Finish Type F3

This type of finish shall be for concrete work which will be exposed to view but to give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, arises, air holes, etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by CONTRACTOR.

10.21.2. Integral Cement Finish On Concrete Floor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener of appropriate thickness as approved by the ENGINEER shall be supplied and used as recommended by the manufacturer.

10.22. REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches, etc. shall be brought to the notice of ENGINEER who may permit patching of the defective areas or reject the concrete work. ENGINEER'S decision on rejection of concrete work shall be final.

All through holes for shuttering shall be filled with cement mortar for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as directed by the ENGINEER.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER as to be the method of repairs to be adopted shall be final and binding on the CONTRACTOR and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand

mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by ENGINEER.

CONTRACTOR shall submit a method statement for such repairs to ENGINEER for approval.

10.23. VACUUM DEWATERING OF SLABS

Where specified floor slabs, either on grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturer's recommendation. The equipment to be used shall be subject to ENGINEER'S approval.

10.24. HOT WEATHER REQUIREMENT

Concreting during hot weather shall be carried out as per specifications in IS: 7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40 °C at the time of placement of fresh concrete.

Where directed by ENGINEER, CONTRACTOR shall spray non-wax based curing compound on unformed concrete surface at no extra costs.

10.25. COLD WEATHER REQUIRMENTS

Concreting during cold weather shall be carried out as per IS: 7861 (PART 2).

The ambient temperature during placement and upto final set shall not fall below 5 deg.c. Approved anti-freeze/accelerating additive shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

10.26. LIQUID RETAINING STRUCTURES

The CONTRACTOR shall take special care for concrete of liquid retaining structures, under ground structures and those other specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be of smooth type. All such structures shall be hydro-tested.

The CONTRACTOR shall include in his price hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines, etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other method as may be approved by the ENGINEER. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the OWNER/ENGINEER at no extra cost to the OWNER.

10.27. TESTING CONCRETE STRUCTURES FOR LEAKAGE

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by ENGINEER, as described below.

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The ENGINEER shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/segment of the structure shall be tested individually and then all together.

For structures such as pipes, tunnels, etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

10.28. OPTIONAL TESTS

If ENGINEER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the ENGINEER, as per relevant IS Codes. OWNER shall pay only for the testing of material supplied by the OWNER; otherwise CONTRACTOR shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the CONTRACTOR at no extra cost to OWNER.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strength, ENGINEER reserves the right to order the CONTRACTOR to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, as per relevant IS specifications. All these tests shall be carried out by CONTRACTOR at no extra cost to the OWNER. Alternately ENGINEER also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

If the structure is certified by ENGINEER as having failed, the cost of the test and subsequent dismantling/reconstruction shall be borne by CONTRACTOR.

The quoted unit rates/prices of concrete shall deemed to provide for all tests mentioned above.

10.29. GROUTING

For details of grouting, refer TCE.10282A-H-RMC-401-D18.

10.30. QUALITY CONTROL

a) TCE Consulting Engineers have over the years developed in house quality control formats for concrete works. CONTRACTOR shall note that it required adopting all such formats. A copy of formats shall be furnished to CONTRACTOR by ENGINEER/ OWNER after the contract is awarded.

b) Alternatively, if CONTRACTOR has his own QC formats he may adopt them subjected to such modifications considered necessary by ENGINEER.

c) In either case CONTRACTOR shall submit his detailed Quality Assurance Plan along with the bid. This would be reviewed, appropriately modified and approved by CONSULTANT after the award of contract.

10.31. INSPECTION

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER. Materials rejected by ENGINEER shall be expressly removed from site within 3 working days and shall be replaced by CONTRACTOR immediately at no extra cost to OWNER.

10.32. CLEAN-UP

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

10.33. ACCEPTANCE CRITERIA

10.33.1. Any Concrete Work Shall Satisfy The Requirements Given Below Individually And Collectively For It To Be Acceptable.

a) properties of constituent materials;

b) characteristic compressive strength;

c) specified mix proportions;

d) minimum cement content;

e) maximum free-water/cement ratio;

f) workability;

g) temperature of fresh concrete;

h) density of fully compacted concrete;

i) cover to embedded steel;

j) curing;

k) tolerances in dimensions;

l) tolerances in levels;

m) durability;

n) surface finishes;

o) special requirements such as :

i. Water tightness

ii. Resistance to aggressive chemicals

iii. Resistance to freezing and thawing

iv. Very high strength

v. Improved fire resistance

vi. Wear resistance

vii. Resistance to early thermal cracking

ENGINEER's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the CONTRACTOR.

For work not accepted, ENGINEER may review and decide whether remedial measures are feasible so as to render the work acceptable. ENGINEER shall in that case direct the CONTRACTOR to undertake the remedial measures. These shall be expeditiously and effectively implemented by CONTRACTOR. Nothing extra shall become payable to CONTRACTOR by OWNER for executing remedial measures.

10.34. MODE OF MEASUREMENT AND PAYMENT

The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items and leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the Schedule of Quantities. No extra claim shall also be entertained due to change in the number, position and/or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding etc. All these factors shall be taken into consideration while quoting the unit rates. Unless provided for in the schedule of Quantities the rates shall also include fixing inserts in all concrete work, whenever required.

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 Sq.m, in areas where concrete is measured in sq.m. and 0.010 cum. where concrete is measured in cubic metres. Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly, the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slabs.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by ENGINEER shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rate for reinforcement shall include all wastage, binding wires, chairs, spacer bars etc. for which no separate payment shall be made.

Where the formwork is paid for separately, it shall be very clearly understood that payment for formwork in inclusive of formwork, shuttering, shoring, propping, scaffolding, deshuttering etc. complete. Only the net area of concrete formed (shuttered) shall be measured for payment.

Where reinforcement is supplied by OWNER, the quantity of chairs and spacer bars shall be measured for accounting wastage only.

CONCRETE POUR CARD

a) CLIENT: DATE: POUR NO:

b) PROJECT:
STRUCTURE :

c) CONTRACTOR :

d) MAX AGGREGATE SIZE mm SLUMP : mm

e) DRG. NO.

f) START/COMPLETION TIME :

g) CONCETE GRADE/QUANTITY : M / M^3 MIXING TIME :

SR. NO.		ITEM		CONTRACTOR'S REP. SIGNATURE	ENGINEER'S SIGNATURE	REMARKS
1.	BEFORE CONCRETING	CENTERLINES CHECKED				
2.		FORMWORK AND STAGING CHECKED				
3.		REINFORCEMENT CHECKED				
4.		COVER0000000 TO REINFORCEMENT CHECKED				
5.		VERFIED TEST CERTIFICATE FOR CEMENT /STELL		YES/NO	YES/NO	
6.		ADEQUENCY OF MATERIALS/EQUIPMENT FOR POUR		YES/NO	YES/NO	
7.		EMBEDED PARTS CHECKED (LOCATION & PLUMB)	CIVIL			
			MECHANICAL			
			ELECTRICAL			
POUR AUTHORISED SITE ENGINEER						

SR. NO.	ITEM	CONTRACTOR'S REP. SIGNATURE	ENGINEER'S SIGNATURE	REMARKS
8.	SOFFIT(S) AND POUR TOP (T) LEVELS CHECKED BEFORE (B) AND AFTER (A) FROM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN & IMPORTANT STRUCTURES LIKE T.G. ETC.)	S(B) S(A)	T(B) T(A)	
9.	CONSTRUCTION JOINT LOCATION & TIME (IF NOT AS PER DRAWING)			
10.	CEMENT CONSUMPTION IN kg.			
11.	NUMBER OF CUBES AND IDENTIFICATION MARK			
12.	TEST CUBE RESULTS (7 DAYS/ 28 DAYS)	/ / /		
13.	CONCRETE CONDITION ON FORM REMOVAL	V.GOOD/GOOD/FAIR/POOR		
				SITE-IN-CHARGE

NOTES:

a) EACH ITEM TO BE CHECKED & SIGNED BY THE RESPECTIVE ENGINEERS.

b) ITEMS 8 TO 13 (BOTH INCLUSIVE) TO BE FILLED BY ONLY TCE ENGINEER.

c) EACH POUR TO HAVE SEPARATE CARDS, IN TRIPILCATE ONE EACH FOR CLIENT, TCE & SITE OFFICE. FORM 279

d) UNDER REMARKS INDICATE DEVIATIONS FROM DWGS & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURENCES, SUCH AS FAILURE OF EQUIPMENT'S, SINKING OF SUPPORTS/PROPS, HEAVY RAINS AFFECTING CONCRETEING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATION ETC.

11. SPECIFICATIONS FOR FABRICATION OF STRUCTURAL STEEL

11.1. SCOPE

This specification covers the general requirements for supply where specified, fabrication and delivery at site of structural steel. Section C covers the specific requirements for the project. The two parts are complementary and are to be read together for a correct interpretation of the provisions of this specification. Where requirements of the two parts conflict, those of Section C shall govern.

This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection and shop painting of structures.

11.2. APPLICABLE CODES & SPECIFICATIONS

The following specifications, standards and codes are made a part of this specification. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and other documents referred to herein, this specification shall govern.

a) Materials

i) IS: 808 Dimensions for Hot Rolled Steel sections

ii) IS: 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel

iii) IS: 1161 Steel Tubes for structural purposes

iv) IS: 1239 Mild steel tubes, tubulars and other Wrought steel fittings

Part 1 - Mild steel tubes

Part 2 - Mild steel Tubulars and other wrought steel pipe fittings

v) IS: 1363 Hexagon Head Bolts, Screws and Nuts of product (Parts 1 to 3) Grade C (Size range M5 to M64)

vi) IS: 1367 Technical Supply Conditions for Threaded Fasteners (All Parts)

vii) IS: 1852 Rolling and Cutting Tolerances for Hot Rolled Steel Products

viii) IS: 1977 Structural Steel (Ordinary Quality)

xi) IS: 2062 Steel for General Structural Purposes

x) IS: 2074 Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming

xi) IS: 3502 Steel Chequered Plate

xii) IS: 3757 High Strength Structural Bolts

xiii) IS: 5369 General Requirements for Plain Washers and Lock Washers

xiv) IS: 5372 Taper Washers for Channels

xv) IS: 5374 Taper Washer for I Beams

xvi) IS: 6610 Heavy Washers for Steel Structures

xvii) IS: 8500 Structural Steel-micro alloyed (medium and high strength qualities)

b) Codes of Practice

i) IS: 800 Code of Practice for General Construction in Steel

ii) IS: 801 Code of practice for use of Cold formed light gauge steel structural members in general building construction

iii) IS: 803 Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks

iv) IS: 806 Code of practice for use of steel tubes in general building construction

v) IS: 816 Code of Practice for use of Metal Arc Welding for General construction in Mild Steel

vi) IS: 822 Code of Procedure for Inspection of Welds

vii) IS: 1182 Recommended Practice for Radiographic examination of Fusion - Welded Butt Joints in Steel Plates

viii) IS: 1200 Method of Measurement in Building Civil Engineering Works

ix) IS: 1477 Code of Practice for Painting of (Parts 1 & 2) Ferrous Metals in Buildings

x) IS: 2595 Code of Practice for Radiographic Testing

xi) IS: 3658 Code of Practice for Liquid Penetrant Flaw Detection

xii) IS: 4000 High strength bolts in Steel Structures - Code of Practice

xiii) IS: 5334 Code of Practice for Magnetic Particle Flaw Detection of Welds

xiv) IS: 7215 Tolerances for Fabrication of Steel Structures

xv) IS: 9595 Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

11.3. STEEL MATERIALS

Steel materials shall comply with the specifications laid down under clause 2.0 and/or as called for on the design drawings.

All materials used shall be new, unused and free from defects.

Steel conforming to IS: 1977 shall be used only for the following:

Fe310-0(St 32-0) : For general purposes such as door/ window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.

Fe410-0(St 42-0) : For structures not subjected to dynamic loading other than wind loads such as: Platform roofs, foot over bridges, building, factory sheds etc.

Fe410-0(St 42-0) : grade steel shall not be used

a) if welding is to be employed for fabrication.

b) if site is in severe earthquake zone.

c) if plastic theory of design is used.

11.4. USE OF STEEL SUPPLIED BY THE PURCHASER

The VENDOR/CONTRACTOR shall use steel supplied by the PURCHASER judiciously and to the best advantage so as to minimise splicing and wastage. All steel materials remaining after completion of the report, whether in the form of balance pieces or unutilised prime steel, shall be returned to the PURCHASER's stores by the VENDOR/CONTRACTOR at his own cost. An unaccountable wastage upto a maximum of 1% of the fabricated steel will be allowed. This wastage does not include the balance cut lengths/pieces of steel returned to the PURCHASER.

11.5. DRAWINGS PREPARED BY THE OWNER

Design drawings will be furnished to the VENDOR/CONTRACTOR and all drawings so furnished shall form a part of this specification. These design drawings prepared by the ENGINEER will show all the, levels, forces on members where shall necessary, size and orientation of each member, location/size of openings, to enable the VENDOR/CONTRACTOR to prepare drawings for fabrication and erection. It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details.

The ENGINEER reserves the right to make changes. Revisions to drawings, even after release for preparation of shop drawings, are very likely to be made to reflect

additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the VENDOR/CONTRACTOR shall be considered a part of this specification and contract. The PURCHASER shall not entertain IS any extra claims on this account.

Where the fabrication drawings are to be furnished by the ENGINEER, he will issue to the VENDOR/CONTRACTOR the required copies of such drawings in the sequence required for the fabrication of the components in the order they will be required to be erected at site. Such drawings will be issued in such numbers as required for the VENDOR/CONTRACTOR to adhere to the project schedule.

Should the VENDOR/CONTRACTOR during the execution of his work, find discrepancies in the information furnished by the ENGINEER, he shall refer such discrepancies to the ENGINEER before proceeding with such work.

11.6. DRAWINGS PREPARED BY THE VENDOR/CONTRACTOR

The VENDOR/CONTRACTOR shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

The VENDOR/CONTRACTOR shall not commence detailing unless ENGINEER's design drawings are officially released for preparation of shop drawings. The VENDOR/CONTRACTOR shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the VENDOR/CONTRACTOR to reflect all revisions in design drawings as and when such revisions are made by the ENGINEER.

All fabrication drawings shall be submitted to the ENGINEER for approval.

No fabrication drawings will be accepted for ENGINEER’s approval unless checked and approved by the VENDOR/CONTRACTOR's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the VENDOR/ CONTRACTOR only after ENGINEER's approval of fabrication drawings. Approval by the ENGINEER of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering & design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The ENGINEER's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.

11.7. FABRICATION

11.7.1. General

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise directed/ approved, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

11.7.2. Connections

Shop/field connections shall be as per approved fabrication drawings.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be atleast three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

All connections and splices shall be designed for full strength of members or loads indicated on ENGINEER's design drawings. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws etc. shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

All members likely to collect rain water shall have drain holes provided.

11.7.3. Straightening

All materials, shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the ENGINEER in writing.

11.7.4. Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

11.7.5. Rolling And Forming

Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

11.7.6. High Strength Friction Grip Bolting

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

11.7.7. Welding

Welding procedure shall be submitted to ENGINEER for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS 817, IS: 7310 (Part 1) and IS: 7318 (Part 1).

While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the ENGINEER shall not relieve the CONTRACTOR of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

No welding shall be done on base metal at a temperature below -5 Deg.C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

Inspection of Welds

All welds shall be inspected for flaws by any of the methods described under clause 8 "Inspection". The choice of the method adopted shall be determined by the PURCHASER/ENGINEER.

The correction of defective welds shall be carried out as directed by the ENGINEER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the ENGINEER shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the VENDOR/CONTRACTOR's account.

11.7.8. Tolerances

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS:1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS:7215.

11.7.9. End Milling

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

11.8. INSPECTION

11.8.1. General

The VENDOR/CONTRACTOR shall give due notice to the PURCHASER/ENGINEER in advance of the works getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the PURCHASER's/ENGINEER's approval / inspection. The fact that certain material has been accepted at the VENDOR/CONTRACTOR's shop shall not invalidate final rejection at site by the PURCHASER/ENGINEER if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the PURCHASER may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or despatched to site without inspection and approval by the PURCHASER/ ENGINEER unless such inspection is waived in writing by the ENGINEER.

The VENDOR/CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the ENGINEER.

11.8.2. Inspection and tests on structural steel members shall be as set forth below:

Material Testing

If mill test reports are not available for any steel materials the same shall be got tested by the VENDOR/CONTRACTOR to the ENGINEER's satisfaction to demonstrate conformity with the relevant specification.

11.8.3. Tests on Welds

Magnetic Particle Test

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the ENGINEER.

Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

Radiographic Inspection

All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

11.8.4. Dimensions, Workmanship & Cleanliness

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the VENDOR/CONTRACTOR's approved fabrication drawings and the ENGINEER's drawings.

11.8.5. Test Failure

In the event of failure of any member to satisfy inspection or test requirement, the CONTRACTOR shall notify the ENGINEER or his authorised representative. The VENDOR/CONTRACTOR must obtain permission from the ENGINEER before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the ENGINEER.

The ENGINEER has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the PURCHASER, only in case of successful testing.

The VENDOR/CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER or his authorised representative.

11.9. SHOP MATCHING

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. if so desired by the ENGINEER. All these shop assemblies shall be carried out by VENDOR/CONTRACTOR at no extra cost to the PURCHASER.

11.10. DRILLING HOLES FOR OTHER WORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the VENDOR/CONTRACTOR at no extra cost to the PURCHASER. The information for such extra holes will be supplied by the PURCHASER/ENGINEER.

11.11. MARKING OF MEMBERS

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

11.12. ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the ENGINEER as defective workmanship. In case ENGINEER rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the ENGINEER's requirements by VENDOR/CONTRACTOR free of cost at site.

11.13. PAINTING

All fabricated steel material, except those galvanised shall receive protective paint coating as specified in specification No. TCE.10282A-F-CV-403-D13.

Galvanising of fabricated steel wherever specified, shall be as per TCE.10282A-F-CV-403-D19.

11.14. METHOD OF MEASUREMENT

For the purpose of payment, the weight of the actual completed structures shall be calculated from the approved drawings for different items of work. The VENDOR/CONTRACTOR shall submit to the PURCHASER relevant material list containing weight of each item.

No allowances will be permitted for bolts, nuts, washers, studs, screws etc, galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean ONE METRIC TONNE i.e. 1000 Kg.

The weight of a member made out of standard rolled section such as beams, channels, angles, etc. shall be based on the standard IS:808 without deductions for holes, notches, bevel cuts, etc. Where a component consists of a cut joist or channels, the full weight of the rolled section shall be considered only if more than half the depth of the original section is used. Otherwise, only half the section unit weight shall be considered for calculation of the weight of the components.

Deductions shall be made in the weight of gussets/plates for cuts and notches of 900 sq. cm. or larger.

For gussets/plates used in trusses, bracings, columns, beams, etc, the area shall be that of the minimum circumscribing rectangle except as stated in 14.3 above.

The weight of any built-up members shall be based on the weight of each component.

12. SPECIFICATIONS FOR ERECTION OF STRUCTURAL STEEL

12.1. SCOPE

This specification covers the general requirements for erection of structural steel. It covers the supply and delivery of all necessary materials, labour, scaffolding, tools, tackles, equipment and everything that is necessary for the satisfactory completion of the job on schedule. Data Sheet A covers the specific requirements for the project. The two parts are complementary and are to be read together for a correct interpretation of the provisions of this specification. Where requirements of the two sections conflict, those of Data Sheet A shall govern.

12.2. APPLICABLE CODES & SPECIFICATIONS

The following specifications, standards and codes are made a part of this specification. All standards, specifications and codes of practice referred to herein shall be the latest editions, including all applicable official amendments and revisions.

In case of discrepancy between this specification and other documents referred to herein, this specification shall govern. In case of discrepancy between tender drawings and this specification, the tender drawings shall govern.

Structural

(a) IS: 800 Code of Practice for General Construction in Steel

(b) IS: 801 Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction

(c) IS: 806 Code of Practice for Use of Steel Tubes in General Building Construction

(d) IS: 7205 Safety Code for Erection of Structural Steel Work

(e) IS: 7215 Tolerances for Fabrication of Steel Structures

(f) IS: 4000 High Strength Bolts in Steel Structure - Code of Practice

(g) AISC Specifications for Design, Fabrication and Erection of Buildings

12.3. ERECTION SCHEME

Each Bid shall be accompanied by a broad erection scheme with dates and estimated completion time for various parts of the work prepared by BIDDER after a thorough study of the Bid drawings and the site conditions. This erection scheme shall describe the methods proposed to be employed by BIDDER for transporting his equipments, tools, tackles, gas cylinders, electrodes and all that is necessary to site, unloading, transporting within the

site, handling, assembling, hoisting and erecting of the structural steel components and the type, capacity and quantity of equipment that BIDDER proposes to bring to site for all these operations. The scheme shall also indicate the strength and tradewise composition of the work force and supervisory personnel that will be deployed by BIDDER for the various operations.

12.4. ERECTION PROGRAMME

Within two weeks of the acceptance of his Bid, the successful BIDDER shall submit, a detailed erection programme. This programme shall be accompanied by a layout plan identifying the areas proposed for unloading, main storage, subsidiary storage, assembly and the transportation of equipment and fabricated material between the storage and work areas. The layout shall clearly indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc. The locations and extent of site offices and stores, labour quarters if any, layout of electrical cables and water pipes from the tap-off points shall also be indicated in detail on the above layout. Full details of the method of handling, transport, hoisting and erection including false work/staging, temporary bracing, guying, etc. shall be furnished by CONTRACTOR in this erection programme along with complete details of the quantity and capacity of the various items of erection equipment that will be used. A site organisation chart showing the number of supervisory personnel, and the number and composition of the various gangs shall also accompany the erection programme.

Any modifications to the erection programme directed by ENGINEER for the reasons of inadequacy of the quantity and/or capacity of the erection equipment, erection personnel and supervisors, temporary bracing, guying etc., or safety of the erection methods, or stability of the erected portions of structures, or unsuitability of the erection sequence due to interference with the work of other agencies shall be incorporated by CONTRACTOR and the work shall be carried out in accordance with the revised programme. Approval by ENGINEER shall not relieve CONTRACTOR from the responsibility for the safe, sound, accurate and timely erection of structural steel work as required by ENGINEER/OWNER. CONTRACTOR shall also make no extra claims for bringing additional equipment to site for erection, if so directed by ENGINEER. CONTRACTOR shall be deemed to have visualised all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

12.5. SITE OPERATIONS

An experienced and qualified Superintendent shall be in full time charge of the job.

CONTRACTOR shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading and pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel

as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel at site.

CONTRACTOR shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. CONTRACTOR shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of OWNER/ENGINEER and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain CONTRACTOR's electrical equipment and connections.

CONTRACTOR shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by CONTRACTOR shall be rectified entirely at CONTRACTOR's cost, to the satisfaction of OWNER/ENGINEER. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, CONTRACTOR must ensure suitable safety precautions in consultation with ENGINEER.

If a portion of the work of the project area cannot be made available to CONTRACTOR for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. CONTRACTOR shall work in coordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

12.6. ACCEPTANCE OF STEEL, ITS HANDLING & STORAGE

Point of delivery of fabricated steel shall be as specified in Data Sheet A.

CONTRACTOR shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of OWNER/ ENGINEER.

No dragging of steel shall be permitted. All shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by CONTRACTOR. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by CONTRACTOR well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer specified under Data Sheet A for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

12.7. ANCHOR BOLTS & FOUNDATIONS

CONTRACTOR shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures can be properly

erected as shown on the drawings, any discrepancy in the anchor bolts/foundation shall be reported to ENGINEER.

Levelling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by CONTRACTOR at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by CONTRACTOR at not extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by CONTRACTOR, unless the grouting is specifically excluded from the CONTRACTOR'S scope.

12.8. ASSEMBLY & CONNECTIONS

Field connections may be effected either by riveting, bolting, welding or by use of high strength friction grip bolts as specified in Data Sheet-A and as shown on the design and erection drawings.

All field connection work shall be carried out in accordance with enclosed Data Sheet - A. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by Erector free of cost.

All assembling shall be carried on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of ENGINEER.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to ENGINEER.

12.9. ERECTION

All structural steel shall be erected as shown on the drawings. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. unless so permitted by ENGINEER in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls steel or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at such points that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as directed by ENGINEER. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

(a) Welding of stiffening angles/vertical stiffening ribs

(b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through

(c) Splicing as shown in relevant drawings

(d) Smoothening of edges

(e) Fixing of chequered plates by tack welding or by countersunk bolts

(f) Providing lifting hooks for ease of lifting.

As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by ENGINEER. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of ENGINEER.

Test certificates as specified in Data Sheet A shall be furnished by CONTRACTOR.

12.10. INSPECTION

ENGINEER/OWNER or their authorised representatives shall have free access to all parts of the job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at CONTRACTOR’s cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by ENGINEER.

12.11. TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/suppliers which will be indicated in the drawings.

12.11.1. Columns

a) Deviation of column axes at foundation top level with respect to true axes:

(a)	In longitudinal direction	:	± 5 mm
(b)	In lateral direction	:	± 5 mm

b) Deviation in the level of bearing surface of columns at foundation top with respect to true level : ± 5 mm

c) Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top:

(a)	For columns upto and including 15 metres in height	:	± 1/1000 of column height in mm or ±15mm whichever is less
(b)	For columns exceeding 15 metres in height	:	± 1/1000 of column height in mm or ±20mm which is less

d) Deviation in straightness in longitudinal and transverse planes of column at any point along the height : ± 1/1000 of column height : in mm or ± 10 mm whichever is less

e) Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance : ± 10 mm

f) Deviation in any bearing or seating level with respect to true level : ± 5 mm

g) Deviation in differences in bearing levels of a member on adjacent pair of columns both across and along the building : ± 10 mm

12.11.2. Trusses and Beams

a)	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	:	± 1/250 of height of truss in mm or ±15mm whichever is less
b)	Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	:	± 1/1500 of span of truss in mm or ± 15 mm whichever is less
c)	Lateral shift in location of truss from its true vertical position	:	± 10 mm
d)	Lateral shift in location of purlin true position	:	± 5 mm
e)	Deviation in difference of bearing levels of trusses or beams from the true difference	:	i) ±20 mm for trusses ii) For beams : Depth < 1800mm: ±6mm Depth >1800mm:±10 mm
f)	Deviation in sag in chords and diagonals of truss between node points	:	1/1500 of length in mm or 10mm whichever is smaller
g)	Deviation in sweep of trusses, beams etc. horizontal plane	:	1/1000 of span in mm in the subject to a maximum of 10 mm

12.11.3. Crane Girders & Rails

a)	Shift in the centre line of crane rail with respect to centre line of web of crane girder	:	± 5 mm
b)	Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	:	± 5 mm
c)	Difference in alignment of crane rail in plan measured between any two points 2 metres apart along rail	:	± 1 mm
d)	Deviation in crane track with respect to time gauge		
	(a) For track gauges upto and including 15 metres	:	± 5 mm
	(b) For track gauges more than	:	± [5 + 0.25 (S-15)]

	15 metres		where S in metres is true gauge
e)	Deviation in the crane rail level at any point from true level	:	1/1200 of the gauge distance or ± 10mm whichever is less
f)	Difference in the crane rail actual levels between any two points 2 metres apart along the rail length	:	± 2 mm
g)	Difference in levels between crane track rails at		
	(a) Supports of crane girders	:	± 15 mm
	(b) Mid span of crane girders	:	± 20 mm
h)	Relative shift of crane rail surfaces at a joint in plan and elevation	:	2 mm subject to grinding of surfaces for smooth transition
i)	11.3.9 Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm		: 1/1000 of track gauge S in mm subject to maximum of 20 mm

12.11.4. Chimneys And Towers

a)	Out of plumbness (verticality) from the true vertical axis	:	1/1000 of the height of the chimney or tower in mm

12.11.5. Bunkers

a)	Deviation in length of bunker from true length	:	± 1/1000 of length in mm
b)	Deviation in width of bunker from true width	:	± 1/1000 of width in mm
c)	Deviation in height of bunker from true height	:	± 1/500 of height in mm
d)	Deviation in diagonal length in any horizontal cross section from the true diagonal length	:	± 1/500 of diagonal length in mm

12.12. PAINTING

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer specified in Data Sheet A. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

12.13. METHOD OF MEASUREMENT

For the purpose of payment, the weight of the actual, completed structures shall be calculated from the approved drawings for different items of work. CONTRACTOR shall submit to OWNER relevant material list containing weight of each item.

No allowance will be permitted for weights of rivets, bolts, washers, screws etc. in calculating the weight of the completed structure. No allowances will be permitted for galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean ONE METRIC TONNE i.e. 1000 Kg.

The weight of a member made out of standard rolled sections such as beams, channels, angles, etc. shall be based on the weight of the member given in IS 808, without deducting for holes, notches, bevel cuts, etc. Where a component consists of a cut joist or channel, the full weight of the rolled section shall be considered only if more than half the depth of the section is used. Otherwise only half the section unit weight shall be taken. Deductions shall be made in the weight of gussets/plates including chequered plates for skew cuts, notches and openings of 900 sq.cm. or larger.

For gussets/plates used in trusses, bracings, columns, beams etc. the area shall be that of the minimum circumscribing rectangle, except as stated in clause 13.3 above.

The weight of any built-up member shall be separated into the weight of each component.

Erection bolts installed by erector may be left in position on completion of erection; however, no additional payment shall be made either for supply or use of such bolts. If erection bolts are removed after erection is complete, holes shall be plug welded and ground smooth. No extra payment shall be made for such plug welding.

12.14. CLEAN UP OF WORK SITE

During erection, the CONTRACTOR shall without any additional payment, at all times keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to OWNER/ENGINEER.

SL.	DESCRIPTION	ALTERNATIVE
1.	DELIVERY OF FABRICATED STEEL (REFER CLAUSE 6.1)	AT SITE / RAILWAY SIDING LOCATED AT---------- / OWNERS STORE LOCATED AT---------- / FABRICATOR WORKSHOP LOCATED AT---------- /DELIVERED TO TRANSPORT CONTRACTOR AT ----------
2.	PAINTING OF SCRATCHED OR ABRADED STEEL WITH PRIMER COAT FOR PROTECTION AFTER UNLOADING AND HANDLING PRIOR TO ERECTION (REFER CLAUSE 6.3)	RED OXIDE / RED OXIDE ZINC CHROMATE / RED LEAD / ZINCPHOSPHATE/ / EPILUX 610 PRIMER / ANTISALINE METALLIC PRIMER / ----------
3.	TYPE OF FIELD CONNECTIONS (REFER CLAUSE 8.1)	. RIVETTING . BOLTING WITH . M.S.BOLTS TO CLASS 4.6 . H.T.BOLTS TO CLASS 6.6/8.8/10.9 /12.9 . H.S.F.G.BOLTS TO CLASS 8 G/10 K . H.S.F.G.BOLTS TO CLASS ASTM 325/ 490 . WELDING
4.	TESTS AND TEST CERTIFICATES (REFER CLSE 9.7) (a) LABORATORY TESTS. (b) SITE TESTS	. BOLTS AND RIVETS : PULL OUT/ SHEAR/PULL OUT AND SHEAR . WELDS : RADIOGRAPHY/ULTRASONIC//MAGNETIC PARTICLE/DYE PENETRATION . BOLTS,RIVETS AND WELDS : VISUAL/DIMENSIONAL/VISUAL AND DIMENSIONAL . WELDS : RADIOGRAPHY/ULTRASONIC/ MAGNETIC PARTICLE/ DYEPENETRATION . BOLTS,RIVETS AND WELDS :- VISUAL/DIMENSIONAL/VISUAL AND DIMENSIONAL
5.	PAINTING OF STEEL AFTER ERECTION WITH A PRIMER COAT FOR ALL ABRADED SPOTS, RIVET HEADS, FIELD WELDS, BOLT NUTS, ETC. (REFER CLAUSE 12.1)	RED OXIDE/RED OXIDE ZINC CHROMATE /RED LEAD/ZINC PHOSPHATE/EPILUX 610 PRIMER/ANTISALINE METALLIC PRIMER
6.	GROUTING OF BASE OF COLUMNS, BEAMS ETC.	INCLUDES / NOT INCLUDED IN THE SCOPE GROUTING SHALL BE OF . CM 1 : 1 . CM 1 : 2 . NON SHRINK GROUT

13. SPECIFICATIONS FOR PAINTING OF STRUCTURAL STEEL

13.1. SCOPE

This specification covers the general requirements for painting structural steel work involving the supply and delivery of all necessary materials, labour, scaffolding, tools and equipment. This document covers the aspects of surface treatment, application of primer paint and finish painting.

13.2. APPLICABLE CODES AND SPECIFICATIONS

The following Standard Specifications and Codes of Practice are made a part of this Specification. All standards and codes referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

i) IS: 102 Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.

ii) IS: 110 Ready Mixed paint, brushing, grey filler for enamels for use over primers.

iii) IS: 117 Ready Mixed paint, Brushing, Finishing, Exterior Semigloss for general purposes, to Indian Standard colours.

iv) IS: 158 Ready Mixed paint, Brushing, Bituminous, Black, Lead free, acid, alkali and heat resisting.

v) IS: 159 Ready Mixed paint, Brushing, Acid resisting.

vi) IS: 341 Black Japan, Types A, B and C

vii) IS: 1477 Codes of Practice for painting of ferrous metals in buildings.
Part I - Pre-treatment
Part II - Painting

viii) IS: 2074 Ready Mixed paints, Red Oxide Zinc chrome priming.

ix) IS: 2339 Aluminium paint for general purposes, in Dual container

x) IS: 2932 Specification for enamel, synthetic, exterior, type 1,
(a) undercoating (b) finishing

xi) IS: 2933 Specification for enamel, exterior, type 2,
(a) undercoating, (b) finishing

xii) IS: 5905 Sprayed aluminium and zinc coatings on Iron and Steel.

xiii) IS: 6005 Code of practice for phosphating of Iron and Steel.

xiv) IS: 9862 Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.

xv) IS: 13183 Aluminium paint, Heat resistant.

xvi) SIS-05-5900 Swedish Standard

13.3. SURFACE TREATMENT

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The type of surface treatment shall be as specified in the respective item of work. The workmanship shall generally conform to the requirements of IS 1477-Part I.

Oil and grease removal shall be carried out either by solvent cleaning or by using alkali type degreasing agents. To remove grease material the surface shall be cleaned with solvents containing emulsifier. After cleaning, the surface shall be washed with water. When the surface has cement pelts or salts, the cleaning shall be done with strong alkalies. After cleaning, water rinsing and subsequent passivation by dilute chromic acid rinsing shall be carried out to ensure that no traces of alkali are left on the surface. The procedure for cleaning by above mentioned methods shall be as per manufacturer's instructions.

Derusting and descaling of steel shall be carried out either manually, mechanically or chemically.

Manual or Hand Tool Cleaning

Loose mill scale, loose rust and loose paint shall be removed by wire brushing, scrapping, chipping and rubbing with abrasive paper or steel wool. This method shall not be employed when the surface has firmly adhering mill scale. After hand tool cleaning, the surface shall be rubbed with sand paper so as to ensure that no loose material exists and the surfaces shall be dusted off.

Mechanical Cleaning

a) Power Tool Cleaning

This shall be carried out by employing power operated wire brushes. Power tool cleaning shall be resorted to only if sand/shot blasting is not possible /permissible and high quality of surface preparation is required.

The surface prior to such cleaning shall be cleaned of dust, grease etc. and heavier layers of rust shall be removed by chipping.

The powertool cleaning shall remove loose mill scale and rust by adopting very thorough scrapping, grinding and machine brushing. After the surfaces are cleaned by compressed air, it shall have a pronounced metallic sheen.

b) Flame Cleaning

Hard mill scale and rust shall be removed through Oxy- acetylene flame. The work shall be carried out by trained workmen to ensure that only mill scale is removed without affecting the parent steel. The work shall be carried out carefully on welded surfaces so that the strength of weld is not affected due to heating.

Sand Blasting and Shot Blasting

Sand/shot blasting shall be resorted to only after removal of grease, oil and other contaminants. The work shall be carried out by impinging under pressure of air, a jet of sharp sand or granulated steel (steel grits) on to the metal surface. The process shall ensure complete removal of rust and firmly adhering mill scale. Special care shall be taken on weld areas to remove flux and spatter. Blasting shall ensure an even colour of the surface and the surface shall have silver grey colour. Precautions shall be taken when sand or shot blasting of light gauge steel surfaces to ensure that buckling does not occur to continuous impingement of sand or steel shots under high velocity.

Sand/shot blasting shall be adopted for structures which are exposed to corrosive conditions for which superior paint protection is to be adopted. The finished surfaces shall conform to the requirements of Sa 2½ or Sa 3 as per Swedish Standard SIS-05-5900 as specified in the item of work.

As Sandblasting causes dust nuisance necessary clearance shall be obtained by the CONTRACTOR from Competent authorities prior to commencing Sand blasting.

Chemical Cleaning (Pickling)

The cleaning shall be done by pickling in sulphuric, hydrochloric or phosphoric acids. Pickling shall be carried out in accordance with detailed procedure as given in IS 6005.

Washing after pickling shall remove all traces of the acids. All work pieces shall be thoroughly inspected and in particular the inaccessible corners.

13.4. MATERIALS

Primer Paint

Anti-corrosive primers shall be either lead based or lead free types. Red lead primer shall conform to IS 102 and red oxide zinc chrome primer shall conform to IS 2074.

Finish Paint

Synthetic enamel painting for undercoat and finish coat shall conform to IS 2932/IS 2933.

Acid, alkali and heat resistant bituminous paint shall conform to IS 158.

Acid, alkali, water and chlorine resisting bituminous paint shall conform to IS 9862.

Heat resistant aluminium paint shall conform to IS 13183.

Epoxy primer and epoxy paint shall be of the type as specified in the item of work from an approved manufacturer.

Chlorinated rubber based paint shall be of the manufacture as specified or any equivalent approved manufacture.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade prior to procurement for usage in the works.

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.

The colour and shade shall conform to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade/number from the alternatives available, CONTRACTOR shall adopt trial painting in small patches in consultation with and as directed by the ENGINEER.

All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically directed by the ENGINEER.

Paints shall be stirred thoroughly to keep the pigment in suspension.

CONTRACTOR shall at his own cost arrange for testing of paints as per relevant Indian Standards in standard laboratory whenever OWNER wants the tests to be carried out for each batch of paints. Test results shall be submitted to the OWNER for obtaining approval.

13.5. WORKMANSHIP

The type and the number of coats of the primer paint and finish paint shall be as specified in the respective items of work.

Painting shall be carried out only on thoroughly dry surfaces.

No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 5°C or lower.

Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

The application of paint film shall serve the twin purpose of protecting the steel from corrosion and giving the decorative appearance. A paint which gives the steel adequate protection over a long period together with good appearance shall therefore be adopted.

Workmanship shall generally conform to requirements specified in IS: 1477-Part II.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of primer paint shall be applied by brushing and working it well to ensure a continuous film without "holidays". After the first coat becomes hard dry a second coat of primer shall be applied by brushing to obtain a film free from holidays.

Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surfaces of the first coat during transport from shop to site and during erection shall be provided with a touch-up coat of the primer.

The dry film thickness of each coat of primer shall be not less than 25 microns.

Application of finishing paints shall be carried out within the shortest possible time interval after primer since the primer coats are too thin to give adequate corrosion protection to the steel surface over a long duration.

Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Fillers prepared by whiting and linseed oil by craftsmen at site shall never be used as such fillers may be unbalanced and incompatible with primer and finishing coats. Application of filler shall be done with good `putty knife' and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, due as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats shall be applied over the undercoats also.

Painting shall be carried out either by brushing or by spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of paint of optimum thickness shall be applied by brushing/spraying with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing or by spraying and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing or by spraying.

At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER.

Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.

The thickness of film shall be measured by an Elcometer to be supplied by the CONTRACTOR. The CONTRACTOR shall calibrate the Elcometer frequently for

different settings. Necessary calibrating accessories should be kept ready for calibration/testing of Elcometer at any time.

Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

Portion of steel members embedded/to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall receive the painting as specified.

Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting. The breakdown of a paint film is progressive from the top finish paint to the primer coat and the object of maintenance painting is to renovate periodically to effectively check the breakdown and protect the steel surfaces from corrosion. It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause. 7 of IS 1477-Part II.

CONTRACTOR shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls etc.

13.6. MEASUREMENT

Method of measurement for payment for painting shall be in sq. metres, correct to two places of decimals, if so specified, in the respective item of work.

Painting work shall not be measured separately, if primer painting and/or primer and finish painting is already included in the scope of the item of work of fabrication and erection of structural steel since the rate per tonne of steel is deemed to include for painting as specified.

In cases where primer and/or finish painting work as specified is carried out on erected structural steel executed by a different agency, the method of measurement for painting shall be on the basis of tonnage of the steel erected. For this purpose, the tonnage of erected steel as certified for payment to the different agency shall be considered as the basis and no measurement will be carried out separately.

14. SPECIFICATIONS FOR GENERAL BUILDING WORKS

14.1. SCOPE

This specification covers the general requirements for building works comprising brick and \ Solid concrete Block or siporex blocks and stone masonry, flooring, doors, windows, ventilators, wood/aluminium work, water-proofing, plastering, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for carrying out the work.

14.2. APPLICABLE CODES AND SPECIFICATIONS

The following codes, standards and specifications are made a part of this specification. All standards, specifications, codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

IS 110:1983 - Ready mixed paint, brushing, grey filler, for enamels for use over primers.

IS 269:1989 - Specification for 33 grade ordinary Portland cement.

IS 280:1978 - Specification for mild steel wire for general engineering purposes.

IS 287:1993 - Recommendations for maximum permissible moisture content of timber used for different purposes.

IS 337:1975 - Varnish, finishing interior.

IS 348:1968 - French polish.

IS 383:1970 - Specification for coarse and fine aggregates from natural sources for concrete.

IS 412:1975 - Expanded metal steel sheets for general purposes.

IS 419:1967 - Specification for putty for use on window frames.

IS 428:1969 - Distemper, oil emulsion, colour as required.

IS 702:1988 - Specification for industrial bitumen.

IS 710:1976 - Specification for marine plywood.

IS 712:1984 - Specification for building limes.

IS 733:1983 - Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes.

IS 777:1988 - Specification for glazed earthenware tiles.

IS 1003:1991 - Specification for timber panelled and glazed shutters (Part 1)

IS 1003:1994 - Specification for timber panelled and glazed shutters (Part 2)

IS 1038:1983 - Specification for steel doors, windows and ventilators.

IS 1077:1992 - Specification for common burnt clay building bricks.

IS 1081:1960 - Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.

IS 1124:1974 - Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.

IS 1237:1980 - Specification for cement concrete flooring tiles.

IS 1322:1993 - Bitumen felts for water- proofing and damp proofing.

IS 1346:1991 - Code of practice for water-proofing of roofs with bitumen felts.

IS 1361:1978 - Specification for steel windows for industrial buildings.

IS 1397:1990 - Specification for kraft paper.

IS 1443:1972 - Code of practice for laying and finishing of cement concrete flooring tiles.

IS 1477:1971 - Code of practice for painting of ferrous metals in buildings (Part 1).

IS 1477:1971 - Code of practice for painting of ferrous metals in buildings (Part 2).

IS 1542:1992 - Specification for sand for plaster.

IS 1580:1991 - Specification for bituminous compounds for water-proofing and caulking purposes.

IS 1597:1992 - Code of practice for construction of stone masonry: Part 1 Rubble stone masonry.

IS 1659:1990 - Specification for block boards.

IS 1661:1972 - Code of practice for application of cement and cement-lime plaster finishes.

IS 1834:1984 - Specification for hot applied sealing compound for joint in concrete.

IS 1838:1983 - Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type): Part 1 Bitumen impregnated fibre.

IS 1948:1961 - Specification for aluminium doors, windows and ventilators.

IS 1949:1961 - Specification for aluminium windows for industrial buildings.

IS 2074:1992 - Ready mixed paint, air drying, red oxide-zinc chrome, priming.

IS 2114:1984 - Code of practice for laying in-situ terrazzo floor finish.

IS 2116:1980 - Specification for sand for masonry mortars.

IS 2185:1967 - Specification for concrete masonry units (Parts 1,2 & 3).

IS 2202:1991 - Specification for wooden flush door shutters(Solid core type): Part 1.

IS 2202:1983 - -DO- Part 2.

IS 2212:1991 - Code of practice for brickwork.

IS 2250:1981 - Code of practice for preparation and use of masonry mortars.

IS 2338:1967 - Code of practice for finishing of wood and wood based materials (Part 1).

IS 2338:1967 - -DO- (Part 2)

IS 2339:1963 - Aluminium paint for general purposes, in dual container.

IS 2395:1994 - Code of practice for painting Concrete, masonry and plaster surfaces (Part 1).

IS 2395:1994 - -DO- Part 2

IS 2402:1963 - Code of practice for external rendered finishes.

IS 2571:1970 - Code of practice for laying in-situ cement concrete flooring.

IS 2572:1963 - Code of practice for construction of hollow concrete block masonry.

IS 2645:1975 - Specification of integral cement water-proofing compounds.

IS 2690:1993 - Specification for burnt clay flat terracing tiles: Part 1 Machine made

IS 2691:1988 - Specification for burnt clay facing bricks.

IS 2750:1964 - Specification for steel scaffoldings.

IS 2835:1987 - Flat transparent sheet glass.

IS 2932:1993 - Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing.

IS 3036:1992 - Code of practice for laying lime concrete for a water-proofed roof finish.

IS 3067:1988 - Code of practice of general design details and preparatory work for damp-proofing and water-proofing of buildings.

IS 3068:1986 - Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.

IS 3384:1986 - Specification for bitumen primer for use in water-proofing and damp-proofing.

IS 3461:1980 - Specification for PVC-asbestos floor tiles.

IS 3462:1986 - Specification for unbacked flexible PVC flooring.

IS 3495:1992 - Method of test for burnt clay building bricks : Part 1 to 4.

IS 3536:1966 - Specification for ready mixed paint, brushing, wood primer, pink.

IS 3564:1995 - Specification for door closers (hydraulically regulated.)

IS 3696:1987 - Safety code of scaffolds and ladders (Part 1).

IS 3696:1991 - -DO- (Part 2).

IS 3809 - Fire Resistance Test of Structure (SIPOReX block masonry)

IS 4020:1998 - Methods of test for wooden flush door (Part 1 to 16).

IS 4021:1995 - Specification for timber door, window and ventilator frames.

IS 4351:1976 - Specification for steel door frames

IS 4443:1980 - Code of practice for use of resin type chemical resistant mortars.

IS 4457:1982 - Specification for ceramic unglazed vitreous acid resisting tile.

IS 4631:1986 - Code of practice for laying epoxy resin floor toppings.

IS 4832:1969 - Specification for chemical resistant mortars (Part 2).

IS 4860:1968 - Specification for acid resistant bricks.

IS 4948:1974 - Specification for welded steel wire fabric for general use.

IS 5318:1969 - Code of practice for laying of flexible PVC sheet and tile flooring.

IS 5410:1992 - Cement paint, colour as required.

IS 5411:1974 - Specification for plastic emulsion paint (Part 1).

IS 5411:1972 - -DO- (Part 2)

IS 5437:1994 - Wired and figured glass.

IS 5491:1969 - Code of practice for laying of in-situ granolithic concrete floor topping,

IS 6041:1985 - Code of practice for construction of autoclaved cellular concrete block masonry.

IS 6042:1969 - Code of practice for construction of light weight concrete block masonry.

IS 6248:1979 - Specification for metal rolling shutters and rolling grilles.

IS 7193:1994 - Specification for glass fibre base coal tar pitch and bitumen felts

IS 7452:1990 - Specification for hot rolled steel sections for doors, windows and ventilators.

IS 8042:1989 - Specification for white portland cement.

IS 8543:1978 - Methods of testing plastics (Part 1/Section 1)

IS 8543:1979 - Methods of testing plastics (Part 1/Section 2)

IS 8543:1977 - Methods of testing plastics (Part 2/Section 1)

IS 8543:1977 - Methods of testing plastics (Part 2/Section 2)

IS 8543:1977 - Methods of testing plastics (Part 2/Section 3)

IS 8543:1978 - Methods of testing plastics (Part 3/Section 1)

IS 8543:1978 - Methods of testing plastics (Part 3/Section 2)

IS 8543:1984 - Methods of testing plastics (Part 4/Section 1)

IS 8543:1977 - Methods of testing plastics (Part 13/Section 1)

IS 9197:1979 - Specification for epoxy resin, hardeners and epoxy resin composites for floor topping.

IS 9862:1981 - Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting.

IS 12200:1987- Code of practice for provision of water-stops at transverse contraction joints in masonry and concrete dams.

14.3. BRICKWORK

14.3.1. MATERIALS

Bricks used in the works shall conform to the requirements laid down in IS 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

The nominal size of the modular brick shall be 200mm x 100mm x 100mm with the permissible tolerances over the actual size of 190mm x 90mm x 90mm as per IS 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230mm x ll5mm x 75mm with tolerance upto +3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, and homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the item.

The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the ENGINEER for approval and bricks supplied shall conform to approved samples. If demanded by ENGINEER, brick samples shall be got tested as per IS 3495 by CONTRACTOR at no extra cost to OWNER. Bricks rejected by ENGINEER shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to IS 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER. If so directed by the ENGINEER, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the ENGINEER. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

The CONTRACTOR shall arrange for test on mortar samples if so directed by the ENGINEER.

14.3.2. WORKMANSHIP

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200mm/230mm thick and shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 450. But in no case the level difference between adjoining walls shall exceed one metre. Brick-work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days. The arrangement for curing shall be got approved from the ENGINEER.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part 1). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be

permitted only in certain cases as decided by the ENGINEER. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/painting.

In the event of usage of traditional bricks of size 230 mmxll5mmx75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor or slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

RCC/steel beams resting on masonry wall shall be provided with plain or reinforced concrete bed blocks of dimensions as indicated in the drawings duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete as specified elsewhere before taking up plastering work.

The above items shall be measured and paid for separately under the respective items of work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction drawings are generally required to be provided in half brick partition walls. Reinforced concrete for transoms and mullions shall be measured and paid for separately under the respective items of work.

Where drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

CONTRACTOR shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and providing pockets, leaving openings, cutting chases etc. in accordance with the construction drawings. Miscellaneous

inserts shall he either supplied FREE by the OWNER or to he furnished by the CONTRACTOR. Any of the miscellaneous inserts which are required to be fabricated and supplied by the CONTRACTOR and cement concrete to be provided in the pockets for the hold fasts of door/window frames etc. shall however, be measured and paid separately under the respective items of work. .

Facing bricks of the type specified conforming to IS 2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of painting to be carried out shall be as specified in the item of work. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration etc., at all times.

14.3.3. MEASUREMENT

Measurement shall be in cu.m correct to two places of decimal for brickwork of thickness one brick i.e. 200mm/230mm and above. Measurement shall be in sq.m correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. l00mm/115mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transoms/mullions etc. All concrete works shall he measured and paid for separately under the respective items of work.

14.4. UNCOURSED RANDOM RUBBLE MASONRY, IN FOUNDATION, PLINTH AND SUPERSTRUCTURE

14.4.1. MATERIALS

Stones for the works shall be of the specified variety which is hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS 1597 (Part-1). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS 1124. The CONTRACTOR shall supply sample stones to the ENGINEER for approval. Stones shall he laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:6 unless otherwise specified in the respective items of work. Materials and preparation of mortar shall be as specified in clauses 3.1.6 to 3.1.8.

14.4.2. WORKMANSHIP

For all works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and band well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be upto a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls & chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall he provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall he raked back (and not saw toothed) at an angle not exceeding 45^0. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in Clause 3.2.6.

Installation of miscellaneous inserts in the masonry shall be as specified in Clause 3.2.13.

14.4.3. MEASUREMENT

Measurement shall be in cu.m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

14.5. COURSED RUBBLE MASONRY (FIRST SORT) FOR SUPERSTRUCTURE

14.5.1. MATERIALS

The material specification for the work shall be as per Clause 4.1.

14.5.2. WORKMANSHIP

All courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least 1/3rd the number of stones, shall tail into the work for a length not less than twice their-height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by atleast 75 mm.

The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for atleast 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

No spalls or pinnings shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid at proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones, in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stones shall be as specified in clause 4.2.6 with the further stipulation that these shall be provided at 1.5 m to 1.8 m apart clear in every course but staggered at alternate courses.

The quoins which shall be of the same height as the course in which they occur, shall not he less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall he rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 3.2.6.

Requirements of execution of the work and curing shall be as stipulated in clause 4.2.7 and clause 4.2.9.

Installation of miscellaneous inserts in the masonry shall be as specified in clause 3.2.13.

14.5.3. MEASUREMENT

Measurement shall be in cu.m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

14.6. SIPOREX (AERATED LIGHT WEIGHT CONCRETE-ALC) BLOCK MASONRY

14.6.1. MATERIALS

The blocks shall be Aerated Light Weight Concrete (ALC) blocks manufactured by SIPOREX INDIA LIMITED PUNE, conforming to IS 2185 (part 3)

The nominal dimensions of SIPOREX block shall be as under.

Sr. No.	Length	Breadth	Thickness
1	650	240	075
2	650	240	100
3	610	240	125
4	650	240	150
5	650	240	200

14.6.2. WORKMANSHIP

The size of SIPOREX block, thickness and grade based on the compressive strength for use in load bearing and / or non-load-bearing walls shall be as specified in the respective items of work. The minimum nominal thickness of non-load bearing internal walls shall be 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS 6041 for autoclaved cellular concrete block masonry works.

SIPOREX blocks shall be embedded with a mortar, which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works unless otherwise specified in the respective items of work. Preparation of mortar shall be as specified in clause 3.1.6 to 3.1.8.

The thickness of both horizontal and vertical joints shall be 10 mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10 mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed an the wall or an the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity. Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10 mm as each course is laid to ensure good bond for the plaster.

Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not he used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surface on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bond beam/studs, joint reinforcement shall he provided at locations as per details indicated in the construction drawings. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS 280 or welded wire fabric/high strength deformed bars as per the drawings.

Hold fasts of doors/windows should be so arranged that they occur at block course level.

At intersection of walls, the courses shall laid up at the same time with a true masonry bond between at least 50% of blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 3 for the brickwork.

Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 3.2.6 shall be adopted for execution of SIPOREX masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in multiples of half length and full height of units respectively, adapting modular co-ordination for walls, opening locations for doors, windows etc.

SIPOREX blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

14.6.3. MEASUREMENT

Measurement shall be in cu.m. correct upto two places of decimal. Measurement shall be for the quantities as actually executed duly deducting for openings, and concrete works. Concrete and reinforcement will be measured and paid separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work, which shall include for the specific sequential operations as stipulated in the construction drawings.

14.7. CONCRETE BLOCK MASONRY

14.7.1. MATERIALS

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS 2185 (Part 1).

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS 2185 (Part 2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS 2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

Length: 400, 500 or 600 mm.

Height: 100 or 200 mm.

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in lengths of 200, 250 or 300 mm to correspond to the full length blocks. Actual dimensions shall be 10 mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than + 5mm and maximum variation in height or width of the units shall not be more than + 3mm.

Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.

Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall be as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shal1 be square. The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume i.e. (1:6).

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. CONTRACTOR shall furnish the test certificates and also supply the samples, for the approval of ENGINEER.

14.7.2. WORKMANSHIP

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified in the respective items of work. The minimum nominal thickness of non-load bearing internal walls shall be 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship, shall generally conform to the requirements of IS: 2572 for concrete block masonry, IS:6042 for light weight concrete block masonry and IS:6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works unless otherwise specified in the respective items of work. Preparation of mortar shall be as specified in clause 3.1.6 to 3.1.8.

The thickness of both horizontal and vertical joints shall be 10 mm. The first course shall he laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10 mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may he applied either to the unit already placed an the wall or an the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity. Mortar while hardening shrinks slightly and thus pulls away from the

edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10 mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not he used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surface on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bond beam/studs, joint reinforcement shall he provided at locations as per details indicated in the construction drawings. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed bass as per the drawings.

For jambs of doors, windows and openings, solid concrete blocks shall he provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:7. Hold fasts of doors/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall laid up at the same time with a true masonry bond between atleast 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 3 for the brick work.

Curing of the mortar joints shall be carried out for atleast 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 3.2.6 shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in multiples of half length and full height of units respectively, adapting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

14.7.3. MEASUREMENT

Measurement shall be in cu.m. correct upto two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq.m correct upto two places of decimal for walls of 100mm/150mm in thickness. Measurement shall be for the quantities as actually executed duly deducting for openings, and concrete works. Concrete and reinforcement will be measured and paid separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

14.8. DAMP - PROOF COURSE

14.8.1. MATERIALS AND WORKMANSHIP

Where specified, all the walls in a building shall be provided with damp-proof course to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm down graded coarse aggregates.

The surface of brick/stone masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for atleast seven days after which it shall be allowed to dry for taking up further work.

14.8.2. MEASUREMENT

Measurement of damp-proof course shall be in Sq.m. correct to two places of decimal as actually executed. No separate payment will be made for formwork.

14.9. MISCELLANEOUS INSERTS, BOLTS ETC.

All the miscellaneous inserts such as bolts, pipes, plate embedments etc. either supplied FREE by the OWNER or to be furnished by the CONTRACTOR shall be accurately installed in the building works at the correct locations and levels, all as detailed in the construction drawings. CONTRACTOR shall prepare and use templates for this purpose, if so directed by the ENGINEER. In the event, any of the inserts are improperly installed, CONTRACTOR shall make necessary arrangements to remove and re-install at the correct locations/levels, all as directed by the ENG INEER without any extra cost to the OWNER.

14.9.1. MEASUREMENT

Miscellaneous inserts, supplied by the CONTRACTOR shall be measured and paid for as per the respective items of work.

14.10. WOOD WORK IN DOORS, WINDOWS, VENTILATORS & PARTITIONS

14.10.1. MATERIALS

Timber to be used shall be first class Teak wood as per IS:4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 9 to 14 percent of timber less

than 50mm in thickness for different regions of the country as stipulated In IS 287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed heart, pitch pockets or streaks an the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS 2202 (Part 1) and with particle board/hard board face panels shall conform to IS 2202 (Part 2).

Transparent sheet glass shall conform to the requirements of IS 2835. Wired and figured glass shall be as per IS 5437.

Builder's hardware of fittings and fixtures shall be of the best quality from approved manufacturers.

14.10.2. WORKMANSHIP

The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. CONTRACTOR shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the detailed drawings and/or as directed by the ENGINEER.

All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work. The workmanship shall generally conform to the requirements specified in IS 4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 long with split ends shall be fixed an each side of door and window frames, one at the centre and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber panelled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the drawings. The stiles and rails shall be joined by mortice and tenon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each

other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than + 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall, generally conform to the requirements specified in IS 1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as indicated in the bid drawings/item of work. Marine plywood panels conforming to IS 710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, venetian louver opening, teak wood lipping etc. shall be as indicated in the respective items of work. Panels of shutter shall be of marine plywood conforming to IS 710, if so specified in the item of work. Flush door shutters shall be from reputed manufacturers and CONTRACTOR shall submit test results as per IS 4020, if so desired by the ENGINEER.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS 2835. The thickness and type of glazing to be provided shall be as specified in the item of work.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminium shall be as specified in the item of work. The number, size and type of the fittings and fixtures shall be as indicated in the bid drawings/item of work.

Wood work shall not be provided with the finishes of painting, galvanising etc. unless it has been approved by the ENGINEER. The type of finish and the number of coats shall be as stipulated in the respective items of work. Preparation of the wood surface and application of the finishes shall be in accordance with clause 35.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the bid drawings/described in the item of work.

The framework of the partitions with mullions and transomes shall be with the sections of dimensions as per the item at work. Panels of double/single glazing/ plywood shall be fixed as per details indicated in the drawings. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.

Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by CONTRACTOR with work as per specification requirements, at no extra cost to the OWNER.

14.10.3. MASUREMENT

Measurement for doors, windows, ventilators architraves and partitions shall be in sq.m correct to two places of decimal. Hand railing shall be measured in running metres, correct to two places of decimal. Measurement shall be from out to out of

the frames. Rate quoted shall be for all the works including glazing, painting, builder's hardware of fittings and fixtures as specifically described in the respective items of work.

14.11. STEEL DOORS. WINDOWS AND VENTILATORS

14.11.1. MATERIALS

Steel door and window frames and shutters shall be of Galvanised Steel 'Polynorm' make, manufactured by B.G.Shirke Construction Technology Pvt. Ltd. Pune.

Type of frame i.e. single / double rebate shall be as per the requirement of the usage. Cross section of the frame shall be appropriate for the shutter thickness provided. Finish shall be powder coated or in zinc chrome yellow primer as specified on the drawing. Standard accessories like

Galvanised steel shutters shall be Polynorm Make, with type and dimensions as specified on the drawing. Standard fixtures like hinge, aldrop bush, and lock plate shall be included as specified.

Transparent sheet glass shall conform to the requirements of IS 2835. Wired and figured glass shall be as per IS 5437.

Other hardware of fittings and fixtures shall be of the best quality from approved manufacturers.

14.11.2. WORKMANSHIP

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings. Steel doors, windows and ventilators other that 'Polynorm' (if so required), shall conform to the requirements as stipulated in IS: 1038. Steel windows shall conform to IS: 1361.

Tolerance in overall dimensions shall be within □ 1.5mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the ENGINEER before further working by the CONTRACTOR.

Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and/or as shown in the drawings for single or composite units.

Pressed steel doer frames shall be provided with fixing lugs at each jamb, hinges, lock-strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as specified. Pressed steel doorframes shall be fixed as 'built-in', as the masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side and each course grouted with mortar to ensure solid contact with the door frame, without leaving any voids. Temporary

struts across the width shall be fixed, during erection to prevent bow/sag of the frame.

Double shutters shall have meeting stile edge rebated. Provision of glazed viewing panel, louvers shall be made as per the item of work and/or drawings. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting.

Doors, windows and ventilator panels shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The dimensions of the masonry opening shall have l0mm clearance all-round the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

Glazing of the units shall be either with flat transparent glass or wired/figured glass of the thickness as specified in the item of work. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS 419 or with metal beads. Pre-formed PVC or rubber gasket shall be provided for fixing the beads with concealed screws. The type of fixing the glazing shall be as indicated in the item of work and/or in drawings.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the item of work. The number, size and type of fittings and fixtures shall be as in the bid drawings/item of work.

Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081. Necessary holes etc required for fixing shall be made by the CONTRACTOR and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

14.11.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames. Rates quoted shall be for the works including glazing, painting, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

14.12. ALUMINIUM DOORS, WINDOWS, VENTILATORS & PARTITIONS

14.12.1. MATERIALS

Aluminium alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS 733.

Transparent sheet glass shall conform to the requirements of IS 2835. Wired and figured glass shall he as per IS 5437.

Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

14.12.2. WORKMANSHIP

All aluminium doors, windows, ventilators and partitions shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings. The doors, windows, ventilators shall conform to the requirements of IS 1948. Aluminium windows shall conform to IS 1949, if so specified.

All aluminium units shall be supplied with anodised finish. The minimum anodic film thickness shall be 0.015 mm.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS 1948. Tolerance in overall dimensions shall be within + 1.5mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminium swing type doors, aluminium sliding windows, partitions shall be as described in the item of work and/or bid drawings which indicate generally the arrangement along with the overall size of the various components and weight per running metre of the extruded sections to be adopted.

IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running metre of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the CONTRACTOR, will be reviewed by the ENGINEER and will be accepted only if they are equal to or marginally more than that specified in the codes/ drawings.

The framework of the partitions with mullions and transomes shall be with anodised aluminium box sections of dimensions as per the item of work. Anodised Aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS 4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawing. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.

Specific provisions as stipulated for steel doors, windows, ventilators under clauses 10.2.3, 10.2.4 and 10.2.7 to 10.2.12 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the item of work. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

14.12.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames. Rate quoted shall be for the works including glazing, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

14.13. STEEL ROLLING SHUTTERS

14.13.1. MATERIALS AND WORKMANSHIP

Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS 6248.

The type of rolling shutter viz. self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto 50 sq.m shall be as specified in the respective items of work. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the drawings.

Shutters shall be built-up of interlocking laths 75mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS 6248 for various clear width of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90mm thick and of approved shape.

Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conforming to IS 2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective Items of work. Painting shall be carried out as per clause 36.

In case of galvanised rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc

coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating per sq.m shall be as specified in the item of work.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

14.13.2. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal of the clear area of the opening. Quoted rate shall be inclusive of painting as specified in the item of work.

14.14. RUBBLE SUB-BASE

14.14.1. MATERIALS

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS 1597 (Part-I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of + 10mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the ENGINEER.

14.14.2. WORKMANSHIP

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other-. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be tarried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

14.14.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

14.15. BASE CONCRETE

The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

Before placing the blinding concrete of 1:4:8 mix, 50/75mm thick as per the item of work, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

14.15.1. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

14.16. TERRAZZO AND PLAIN CEMENT TILING WORK

14.16.1. MATERIALS

Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS 1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm^2.

The type, quality, size, thickness colour etc, of the tiles for flooring/dado/ skirting shall be as specified in the respective items of work.

The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either Ordinary Portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm upto 6mm or from 1mm upto 12mm. This shall be 6mm for tiles with chips varying from 1mm upto 25mm. The minimum thickness of wearing layer of cement/coloured cement tiles shall he 5mm. This shall be 6mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix.

14.16.2. WORKMANSHIP

Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS 1443.

Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.

The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

A layer of 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than l0mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS 2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.

Neat cement slurry using 4.4 kg of cement per one sq.m of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the Joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade on the colour of the matrix of the tile. For this purpose white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.

About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those laid earlier, it is necessary that the CONTRACTOR shall procure sufficient quantity of extra tiles to meet this contingency.

Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed

shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish.

Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

CONTRACTOR shall note that the unit rate quoted for skirting shall also include for any chipping of the brick work required to be carried out for this item.

Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

Machine grinding and polishing shall be commenced only after a gap of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS 1443.

Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept l0mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localised deviation of ±3 mm in any 3m length is acceptable in a nominally flat floor.

14.16.3. MEASUREMENT

Measurement for floor tiling and dado shall be in sq.m correct to two places of decimal. Actual quantity of tiling work as laid shall be measured for payment as per the respective items of work after making deductions for openings etc. Measurement for skirting shall be in running metres correct to two places of decimal for the specified height as per the item of work.

14.17. IN-SITU TERRAZZO WORK

14.17.1. MATERIALS

The requirements of marble aggregates for terrazzo topping shall be as per clause 15.1.3.

Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement working to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

14.17.2. WORKMANSHIP

The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado skirting shall be as specified in the respective items of work. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS 2114.

In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The under layer shall be of cement concrete of mix 1:2:4 using l0mm down graded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to l0mm. If chips larger than l0mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

Both the under layer and later the topping shall he divided into panels not exceeding 2 Sq.m. for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividing strips are not provided, the bays shall be laid alternately, allowing an interval of atleast 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminium, brass or other material as indicated in the item of work. Aluminium strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work.

Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreading the underlayer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided, shall be fixed on the base and levelled to the correct height to suit the thickness of the finish. Just before spreading the underlayer the surface shall be smeared with cement slurry at 2.75 Kg/sq.m. Over this slurry, the underlayer shall be spread and levelled with a screeding board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo topping shall be laid while the underlayer is still plastic and normally between 18 to 24 hours after the underlayer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of trowelling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

Machine grinding and polishing shall be commenced only after a gap of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS 2114.

14.17.3. MEASUREMENT

Measurement shall be as per clause 16.3.1.

14.18. SHAHABAD/TANDUR/KOTA STONE SLAB WORK

14.18.1. MATERIALS

The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS 1124.

The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100 mm shall be ±5mm. This shall be +2mm on dimensions less than 100mm.

Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

14.18.2. WORKMANSHIP

The type, size, thickness and colour/shade etc. of the slabs for flooring/dado/ skirting shall be as specified in the respective items of the work.

Preparation of the concrete base, laying and curing shall be as per clause 15.2.3 to clause 15.2.5.

Dado/skirting work shall be as per clause. 15.2.8. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

Grinding and polishing shall be as per clause 15.2.11 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

14.18.3. MEASUREMENT

Measurement shall be as per clause 16.3.1.

14.19. CARBORUNDUM TILE FINISH

14.19.1. MATERIALS

Carborundum tiles shall generally conform in all respects to the standards stipulated in IS:1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm2.

The topping shall be uniform and of thickness not less than 6mm. The quantity of carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60mm mesh.

The size, thickness, colour and plain or chequered etc. of the tiles for flooring/skirting shall be as specified in the respective items of work.

14.19.2. WORKMANSHIP

Requirements as detailed for terrazzo/cement tile finish under clause 15.2 shall be applicable for carborunclum tile flooring.

14.19.3. MEASUREMENT

Measurement shall be as per clause 16.3.1.

14.20. GLAZED TILE FINISH

14.20.1. MATERIALS

Glazed earthenware tiles shall conform to the requirements of IS:777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS 777.

14.20.2. WORKMANSHIP

The size, thickness, colour, with or without designs etc of the tiles for flooring/dado/skirting shall be as specified in the respective items of work.

The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and l0mm for dado/skirting work.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modules of 1.5.

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

Coloured tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good band for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

Neat cement slurry using 3.3 kg cement per one sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than l mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

All the joints shall be cleaned of grey cement with wire brush to a depth of atleast 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

Specials consisting of caves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

14.20.3. MEASUREMENT

Measurement shall be as per Clause 16.3.1.

14.21. IN-SITU CEMENT CONCRETE FLOOR TOPPING

14.21.1. MATERIALS

The mix proportion for the in-situ concrete floor topping shall be 1:2½ :3½ (one part cement : two and half parts sand : three and half parts coarse aggregates) by volume unless otherwise specified in the item of work.

The aggregates shall conform for the requirements of IS:383.

Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS 2571.

Grading of the sand shall be within the limits indicated in IS 2571.

14.21.2. WORKMANSHIP

The thickness of the floor topping shall be as specified in the item of work. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per clause 15.2.3. The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.

Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of atleast one day. Construction joints shall be plain vertical butt joints.

Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities from that specified in the drawings and these shall be made good immediately.

Finishing of the surface by trowelling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be retrowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerance, is achievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finishes which are difficult to repair satisfactorily.

14.21.3. MEASUREMENT

Measurement shall be in sq.m correct upto two places of decimal.

14.22. IN-SITU GRANOLITHIC CONCRETE FLOOR TOPPING

14.22.1. MATERIALS AND WORKMANSHIP

The requirements of materials and workmanship shall be all as per clause 20 for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement:sand:coarse - aggregates) by volume.

The thickness of the floor topping shall be as specified in the item of work. The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

14.22.2. MEASUREMENT

Measurement shall be in sq.m correct upto two places of decimal.

14.23. FLOOR HARDENER TOPPING

14.23.1. MATERIALS & WORKMANSHIP

Floor hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid monolithically with the concrete/granolithic floor finish at top of hardened concrete base.

Floor hardener of the metallic or non-metallic type suitable for the performance of normal/medium/heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work.

For monolithic application with the floor finish/slab, the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid and it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate band for the topping. Laitance shall be removed before placing the topping. The topping shall be screeded and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 20.2.6. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 10 days.

The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

14.23.2. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

14.24. PVC SHEET/TILE FLOORING

14.24.1. MATERIALS

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS 3462 or homogeneous PVC asbestos tiles conforming to IS 3461.

The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS codes. CONTRACTOR shall submit the test certificates, if so desired by the ENGINEER.

Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark and batch number.

The adhesive to be used for laying the PVC flooring shall be rubber based and of the make on recommended and approved by the manufacturer of PVC sheets/tiles.

The type, size, thickness, colour, plain or mottled and the pattern shall be as specified in the respective items of work.

14.24.2. WORKMANSHIP

PVC floor covering shall be provided over an underbed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-flour and the underbed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS 5318.

The surface of the underbed shall have trowelled finish without any irregularities which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the underbed until the A/C units have been in operation for atleast 7 days. During this period, the temperature range shall be between 200C and 300C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout.

The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slided on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring in thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the Joints shall be carried out, if specified in the item of work, using special equipment as per manufacturer's instructions.

14.24.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. The item could be either separate or as a combined item with the floor finish as specified in the respective items of work.

14.25. ACID RESISTING BRICK/TILING WORK

14.25.1. MATERIALS

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS 4457. Acid resistant bricks shall conform to the requirements of IS 4860.

The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in the dimensions shall be within the limits specified in the respective IS.

The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS 4832 (Part II). Method of usage shall generally be as per the requirements of IS 4443.

14.25.2. WORKMANSHIP

The size and thickness of tiles/size and class of bricks for use in the flooring/skirting/dado shall be as specified in the respective items of work.

The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS 3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS 1530. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall he pressed into the bed and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work an walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.

The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not

be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively if heat treatment is given with infrared lamp.

14.25.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal for flooring/dado. Measurement shall be in running metres correct to two places of decimal for skirting of height as specified in the item of work.

14.26. EPOXY LINING WORK

14.26.1. MATERIALS

The epoxy resin and hardener formulation for laying of Pointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS 9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

a) Hydrochloric acid upto 30% concentration

b) Sodium hydroxide upto 50% concentration

c) Liquid temperature upto 60"C

d) Ultraviolet radiation

e) Alternate wetting and drying

Sand shall conform to grading zone lll or IV of IS 383.

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

CONTRACTOR shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the ENGINEER.

14.26.2. WORKMANSHIP

The minimum thickness of epoxy lining shall he 4 mm. The thickness and areas of application shall be as specified in the respective items of work. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall

then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.

Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

14.26.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal.

14.27. WATERSTOPS

14.27.1. MATERIAL

The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS 8543.

a)	Tensile strength		:	11.6 N/mm2 minimum
b)	Ultimate elongation		:	300% minimum
c)	Tear resistance		:	4.9 N/mm2 minimum
d)	Stiffness in flexure		:	2.46 N/mm2 minimum
e)	Accelerated extraction			
	i)	Tensile strength	:	10.50 N/mm2 minimum
	ii)	Ultimate elongation	:	250% minimum
f)	Effect of Alkali		:	7 days
	i)	Weight increase	:	0.1% maximum
	ii)	Height decrease	:	0.10% maximum
	iii)	Hardness change	:	$\pm$ 5 points
g)	Effect of Alkali		:	28 days
	i)	Weight increase	:	0.40% maximum
	ii)	Weight decrease	:	0.30% maximum
	iii)	Dimension change	:	$\pm$ 1%

PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use. The width, type, minimum thickness and safe hydraulic head requirements shall be as specified in the individual items of work.

PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the ENGINEER before procurement for incorporation in the works.

14.27.2. WORKMANSHIP

Waterstops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregate shall be used for concreting in this region also.

14.27.3. MEASUREMENT

Measurement shall be in running metres correct to two places of decimal. No separate payment shall be made for joints or intersection pieces.

14.28. PREFORMED FILLERS AND JOINT SEALING COMPOUND

14.28.1. MATERIALS

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS 1838 (Part I).

Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS 702. Bitumen primer shall conform to IS 3384.

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS 1834.

14.28.2. WORKMANSHIP

The thickness of the preformed bitumen filler shall be as specified in the respective items of work. CONTRACTOR shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS 702 shall be applied hot by brushing at the rate of 1.20

kg/sq.m. When the bitumen is still hot, the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS 3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with l00mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6 provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

14.28.3. MEASUREMENT

Measurement for the preformed joint filler shal1 be in sq.m correct to two places of decimal for the specified thickness as per the items of work. Measurement for applying the bitumen coat to concrete/masonry surfaces shall be in sq.m correct to two places of decimal. Measurement for the joint sealing compound shall be in running metres correct to two places of decimal for the specified width and thickness as per the items of work. Measurement for the mild steel corner angle and plate shall be by weight as per the item of work.

14.29. WATER-PROOFING OF ROOFS WITH BITUMEN FELTS

14.29.1. MATERIALS

Bitumen felt shall be either Hessian-base self-finished felt Type 3 Grade I conforming to IS 1322 OR glass fibre base self-finished felt Type 2 Grade-1 conforming to IS 7193.

Bitumen primer shall conform to IS 3384.

Bitumen used as bonding material shall be Industrial blown type bitumen of Grade 85/25 conforming to IS 702.

Pea sized gravel shall be hard, round, of size 6mm and down, free from fine sand, dust etc.

14.29.2. WORKMANSHIP

Water-proofing treatment to roofs shall be either normal, heavy or extra heavy depending upon the requirements. The type of treatment and the type of bitumen felt to be used shall be as specified in the item of work.

Normal treatment which provides for one layer of felt shall comprise of five courses as under.

a) Bitumen primer at the rate of 0.27 litre/sq.m (min)

b) Bitumen bonding material hot applied at the rate of 1.20 kg/sq.m (min).

c) One layer of bitumen felt.

d) Bitumen bonding material hot applied at the rate of 1.20 kg/sq.m (min).

e) Pea sized gravel at the rate of 0.006 cu.m/sq.m.

Heavy treatment which provides for two layers of felt shall comprise of seven courses as under.

a) Bitumen primer at the rate of 0.27 litre/sq.m (min)

b) Bitumen bonding material hot applied at the rate of 1.20 kg/sq.m (min)

c) One layer of bitumen felt.

d) Bitumen bonding material hot applied at the rate of 1.20 kg/sq.m (min)

e) Second layer of bitumen felt.

f) Bitumen bonding material hot applied at the rate of 1.20 kg/sq.m (min)

g) Pea sized gravel at the rate of 0.006 cum/sq.m.

Extra heavy treatment provides for three layers of felt and comprises of nine courses laid in the same procedure as above.

The roof slope shall be at least 1 in 100. Concrete or mortar screed to achieve the specified slope as per drawings shall be executed and properly cured before taking up water-proofing treatment.

The surfaces over which water-proofing treatment is to be carried out, shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated In IS:3067. Bitumen primer shall then be applied uniformly.

Each length of felt shall be prepared by brushing them clean and laid out flat on the roof for softening to eliminate curls. Bitumen bonding material shall be heated to the correct working temperature for pouring across the full width of the rolled felt and the felt steadily rolled out and pressed down. Excess bonding material squeezed out at the ends shall be removed as the laying proceeds.

Felts shall be laid in lengths at right angles to the direction of the run-off gradient, commencing at the lowest level and working upto the crest. Minimum overlaps of l00mm at the ends and 75mm at the sides of the felt strip shall be provided. All

overlaps shall be firmly bonded with hot bitumen. Laying of the second layer of felt shall be so arranged that the joints are staggered with those of the layer beneath it.

It shall be ensured that a concave fillet 75mm in radius is provided in cement mortar 1:4 at the junction of the roof and vertical face of masonry or RCC parapet wall or column projections.

Water-proofing treatment shall be taken up on the brick masonry wall/parapet/column projection by a minimum of 150 mm. Felts shall be laid as flashing with minimum overlap of 100mm. The lower edge of the flashing shall overlap the felt laid on the flat portion of the roof and the upper edge shall be tucked into the groove. Each layer shall be arranged so that the joints are staggered with those of the layer beneath it. For the vertical portion of the felt, two coats of bituminous paint at the minimum rate of 0.10 litres/sq.m shall be provided in lieu of pea size gravel finish. Groove 75mm wide and 65mm deep shall be left for tucking in the waterproofing treatment and the groove filled with cement mortar 1:4 for securing it satisfactorily. Curing of the mortar shall be carried out properly for atleast 4 days to avoid shrinkage cracks.

Water-proofing treatment for gutters shall normally contain 2 layers of felt corresponding to heavy treatment. The sixth course of hot bitumen shall however be at the rate of 1.50 kg/sq.m (minimum). Pea sized gravel finish shall however be replaced by 2 coats of bituminous paint at the minimum rate of 0.1 litre/sq.m. The felt layers shall be carried down the outlet pipes for a minimum depth of l00mm.

Expansion joints shall be treated with water-proofing treatment in a manner as illustrated in IS 1346 in accordance with the type and details specified in the construction drawings.

In order to avoid damage to water-proofing treatment where it is subjected to traffic, additional surface treatment by provision of cement concrete flooring tiles conforming to IS:1237 or machine made burnt clay flat terracing tiles conforming to IS:2690 (Part 1) shall be made if so specified in the item of work. Execution of these works shall be as specified in clauses 29.2.11 or 29.2.12.

14.29.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the plan area where the treatment is executed. No separate payment will be made for the overlapping of the felts, fillets and work as specified on vertical faces. Screed on top of roof, cement concrete tiling work or machine pressed clay tile work shall be paid for separately unless they are specifically included in the item of work.

14.30. WATER-PROOFING OF ROOFS WITH LIME CONCRETE

14.30.1. MATERIALS

Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25mm and shall generally conform to IS 3068.

Lime shall be class "C lime (fat lime)" or factory made hydrated lime conforming to IS 712.

14.30.2. WORKMANSHIP

Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 ½ (two and a half) parts of brick aggregates to 1 part of slaked lime by volume. Water shall be added just adequate to obtain the desired workability for laying.

Washing soap and alum shall be dissolved in the water to be used. The quantity of these materials required per cum of lime concrete shall be 12kg of washing soap and 4kg of alum. Brick aggregates shall be soaked thoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing.

The roof surface over which the water-proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS: 3067.

The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer or otherwise as indicated in the drawings.

The average thickness of lime concrete, slope and the finish on top of machine made burnt clay flat terracing tiles conforming to IS:2690 (part 1) shall be as specified in the item of work. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the item of work, duly considering the traffic the terrace will be subjected to.

The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not he less than l00mm. In case, the thickness is more than l00mm, it shall be laid in layers not exceeding 100mm to 125mm.

Laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards centre and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points.

Lime concrete fillet for a minimum height of 150mm shall be provided all along the junction of the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished an top with provision of clay terracing tiles/cement concrete tiles.

After the lime concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done using wooden THAPIES with rounded edges. The beating will normally have to be carried an for atleast seven days until the THAPI makes no impression on the surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column projections.

During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothened with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the ENGINEER

a) By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 litres of water.

b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small pieces and allowed to soak in water), 200 gm of Jaggery and 40 litres of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.

The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously.

Machine made flat terracing tiles shall be of the size and thickness as specified in the item of work. Tiles shall be soaked in water for at least one hour before laying. Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction of run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by atleast 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instructions. Curing shall be carried out for a minimum period of seven days.

Finishing on top with cement concrete tiles if specified shall be carried out in similar fashion as described for clay tiles in clause 30.2.11. Tiles to be used shall be supplied after the first machine grinding of the surface.

14.30.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the plan area where the treatment is executed. No separate payment shall be made for the fillets.

14.31. CEMENT PLASTERING WORK

14.31.1. MATERIALS

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand) unless otherwise specified under the respective item of work. Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS. The quality and grading of sand for plastering shall conform to IS:1542.

The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. If so desired by the ENGINEER sand shall be screened and washed to meet the specification requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall he rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

14.31.2. WORKMANSHIP

Preparation of surfaces and application of plaster finishes shall generally confirm to the requirements specified in IS:1661 and IS:2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of l0mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean-water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the ENGINEER. Rate quoted for plaster work shall be deemed to include for plastering of all these surfaces.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in clause 31.2.4.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated in clause 31.2.4 except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be

as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in clause 31.2.6.

Exterior Sand Faced Plaster - This plaster shall be applied in 2 coats. The first coat shall be 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated in clause 31.2.6. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the ENGINEER duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the ENGINEER.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for atleast 7 days.

When the specification items of work calls for waterproofing plaster the CONTRACTOR shall provide the waterproofing compound as specified while preparing the cement mortar. Payment for water-proofing compound will be made separately if it is not included as a combined item of work.

Where lath plastering is specified, it shall be paid for at the same rate as for plaster work except that separate payment for metal lath will be made.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 3.2.6.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adapted.

Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement. This steel item shall be measured and paid for separately.

Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

14.31.3. MEASUREMENT

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

14.32. CEMENT POINTING

14.32.1. MATERIALS

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand) unless otherwise specified in the respective items of work. Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER and if so directed it shall be washed/screened to meet specification requirements.

14.32.2. WORKMANSHIP

Where pointing of joints in masonry work is specified on drawings/respective items of work, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for atleast 7 days after the pointing is completed. Whenever coloured pointing is to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the ENGINEER.

14.32.3. MEASUREMENT

The quantity of work to be paid for under this Item shall be measured in sq.m correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

14.33. METAL LATH & WIRE FABRIC

14.33.1. MATERIALS

Welded steel wire fabric shall conform to IS:4948

Expanded metal shall conform to IS:412

Galvanised wire mesh shall be of approved quality.

14.33.2. WORKMANSHIP

The type and details of the steel material to be used for metal lath plastering work and at the junctions of brick masonry/concrete before wall plastering shall be as specified in the respective items of work.

For metal lath plastering work, the weight of steel material shall be not less than 1.6 kg/sq m.

Steel material for use at the Junction of brick masonry/ concrete shall have the mesh dimensions not greater than 50 mm.

Steel material shall be obtained in maximum lengths as manufactured to restrict joints to the minimum. Overlap at the joints shall be minimum 25 mm which shall be securely tied with wires of diameter not less than 1.25 mm at spacings not more than 100 mm for lath plastering work. Nailing to wall shall be at spacing not exceeding 200 mm. The material shall be straightened, cut and bent to shape if required for fixing as per the details indicated in the drawings.

14.33.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal for the type as specified in the respective items of work.

14.34. WATER-PROOFING ADMIXTURE

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer. Payment shall be

made for the actual quantity of such admixture used unless it is already covered in the rate for the relevant item of work.

14.35. PAINTING OF CONCRETE MASONRY & PLASTERED SURFACES

14.35.1. MATERIALS

Oil bound distemper shall conform to IS 428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS 5410. The primer shall be a thinned coat of cement paint.

Acrylic emulsion paint shall be of an approved manufacture.

Plastic emulsion paint shall conform to IS 5411.

Lead free acid, alkali and chlorine resisting paint shall conform to IS 9862.

White wash shall be made from good quality fat lime conforming to IS 712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the ENGINEER.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

14.35.2. WORKMANSHIP

CONTRACTOR shall obtain the approval of the ENGINEER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata.

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS:2395.

Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

WHITE WASH

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified in the item of work. The dry surface shall present a uniform finish without any brush marks.

COLOUR WASH

Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied unless otherwise specified in the item of work. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

CEMENT PAINT

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water- proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 2 coats of the same colour shall be applied unless otherwise specified in the item of work. Atleast 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for atleast 2 days after the application of final coat. The operations for brushing each coat shall be as detailed in 35.2.5.

OIL BOUND DISTEMPER

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for atleast 48 hours. A minimum of two coats of oil bound distemper shall be applied unless otherwise specified in the item of work. The first coat shall be of a lighter tint. Atleast 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed in 35.2.5.

PLASTIC EMULSION PAINT

The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paint shall be laid an evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied unless otherwise specified in the item of work. Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.

ACRYLIC EMULSION PAINT

Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified in the item of work.

ACID, ALKALI RESISTING PAINT

A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

14.35.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter's cradle etc.

14.36. PAINTING & POLISHING OF WOOD WORK

14.36.1. MATERIALS

Wood primer shall conform to IS 3536.

Filler shall conform to IS 110.

Varnish shall conform to IS 337.

French polish shall conform to IS 348.

Synthetic enamel paint shall conform to IS 2932.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTCIR shall obtain prior approval of the ENGINEER for the brand of

manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

14.36.2. WORKMANSHIP

The type of finish to be provided for woodwork shall be either painting or polishing and the number of coats, etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid, cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

Painting shall be either by brushing or spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS 2338 (Part I).

All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work. Any slight irregularities of the surface shall then be made up by applying an optimum coat of filler conforming to IS 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS 2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. Atleast 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER. The number of coats of paint to be applied shall be as specified in the item of work.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off.

Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS 337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the ENGINEER. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flatting varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as per the item of work. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions.

The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as per the item of work.

14.36.3. MEASUREMENT

Measurement shall be in sq.m correct to two place of decimal. Measurement shall be for the projected area between out to out of frames and no multiplying factor is allowed on any account. Rate shall be inclusive of enabling works such as scaffolding, etc. Measurement and payment is applicable only if a separate item is specified and not if it is already made as part of a combined item.

14.37. PAINTING OF STEEL WORK

14.37.1. MATERIALS

Red oxide - zinc chrome primer shall conform to IS 2074.

Synthetic enamel paint shall conform to IS 2932.

Aluminium paint shall conform to IS 2339.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

14.37.2. WORKMANSHIP

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS 1477 (Part 2).

The type of paint, number of coats etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS 1477 (Part-1) and as indicated in the item of work.

It is essential to ensure that immediately after preparation of the surfaces; the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the

undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER.

14.37.3. MEASUREMENT

Measurement shall be as per clause 36.3.1.

14.38. FLASHING

14.38.1. MATERIALS

Anodised aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

Bitumen felt shall be either Hessian base self finished bitumen felt Type-3 Grade I conforming to IS 1322 or glass fibre base self finished felt Type-2 Grade I conforming to IS 7193.

14.38.2. WORKMANSHIP

The type of the flashing and method of fixing shall be as specified in the respective items of work.

Flashing shall be of the correct shape and size as indicated in the construction drawings and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be l00mm.

Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide X 65 mm deep in masonry/concrete along with cement mortar 1:4 filleting as indicated in the drawings. Curing of the mortar shall be carried out for a minimum period of 4 days.

Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 litre/sq.m after the installation.

14.38.3. MEASUREMENT

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the actual area of the flashing material provided and the rate shall include for all the incidental works of bending to shape and fixing details as per the construction drawings.

15. SPECIFICATIONS FOR PRECOATED SHEETS, SIDE SHEETING AND ACCESSORIES

15.1. SCOPE

This specification covers the general requirements for supply, delivery and erection of all precoated sheeting for roofing and side cladding including all accessories and fixtures necessary to provide weather exposed surfaces of roof and building walls for industrial, residential and commercial types of buildings, complete with openings for doors, windows, roof lights, ventilators, pipes, etc.

15.2. APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes, including all official amendments and revisions and other specification referred to therein shall be considered as a part of this specification. In all cases the latest issue/edition revision shall apply. In case of discrepancy between the guidelines given in the codes, & this specification shall govern:

A IS : 277 Specification for galvanized steel sheets.
B IS : 513 Cold rolled low carbon steel sheets & strips.
C IS : 12093 Code of practice for laying & fixing of sloped roof covering using plain & corrugated galvanized steel sheets.

15.3. MATERIALS

Precoated sheets shall be procured by the CONTRACTOR from approved suppliers of OWNER/ENGINEER. The colour & shade shall be approved by the OWNER/ENGINEER.

The base material shall be cold rolled steel with yeild strengths of 240 Mpa or 550 Mpa profiled to suit a purlin spacing as shown on the drawings.

The metallic coating on the substrate shall be 180 grams per sqm zinc mass or 150 grams per sqm zinc+aluminium alloy coating.

The organic coating shall be by coil coating (prepainted) with a polyester coating system applied over a corrosion inhibiting primer. The weathering side shall have a finish coat; a minimum of 20 microns of polyester/SMP/PVF2/XRW/XPD/XSE paint system and the rear side a backing coat in neutral colour nominal minimum 5 microns.

The coating shall be tested in accordance with ASTM or equivalent standards and shall have minimum performance requirements as below. A test certificate from a recognized institute/manufacturer shall be produced prior to the delivery of the sheets.

SR.NO.	PROPERTY	REQUIREMENT
1	Scratch & Mar resistance	Fair
2	Impact resistance	Greater than 10 Joules
3	Pencil hardness	F minimum
4	Bend test	6 T
5	Heat resistance	Suitable for continuous service upto 100

SR.NO.	PROPERTY	REQUIREMENT
		deg. C
6	Corrosion resistance	
i	Salt spray	No more than (8) density size A blisters, less than 2mm undercutting from a score & no visible loss of adhesion after 1000 hrs.
ii	Humidity resistance	No more than (8) density size A blisters, no visible loss of adhesion after 1000 hrs.
iii	QAV weatherometer	A chalk rating of 8-10 after 1000 light hours.
7	Outdoor durability	The sheets in standard colours under normal well washed conditions of exposure should show no cracking, flaking or peeling of the paint film in 10 years. Colour change during service determined according to ASTM D2244, should not exceed 5 E Hunter lab. Units on light colours.
8	Surface spread of flame	Class 1

The sheets shall have a protective film at the time of delivery which shall be removed after erection.

The accessories like flashings, cappings, barge boards etc. shall be of the same material as sheets.

Sealants shall be of silicon non-hardening type.

Screws used for fixing shall be hot dip zinc coated steel, hexahead self drilling screws with EPDM washer & colour heads, colour matched to sheeting.

15.4. STORAGE OF MATERIALS

Sheets shall be stacked to a height of not more than one metre on firm and level ground, with timber or other packing beneath them.

Materials of same variety and size shall be stacked together.

All materials shall be protected from damage while stored on site preferably in sheltered store. If they are to be placed in an exposed position, they shall be protected from damage by wind and rain by providing a suitable cover.

Contractor shall exercise great care in handling the sheets and accessories. damaged materials shall not be stacked with sound materials. All damaged or rejected materials shall be removed from site immediately.

Manufacturer’s instructions regarding delivery, stacking and storing shall be followed.

15.5. LAYING

The sheets shall be laid on the purlins/other roof members and side girts as indicated on the approved fabrication drawings or as instructed by Engineer.

Before the actual laying of sheets is started, the purlin spacing and the length of the sheets shall be checked to ensure proper laps and the specified overhang at the eaves. The end lap of the sheets shall always fall over a purlin/side girt.

The bearing surfaces of all purlins /other roof members and side girts shall be in one plane so that the sheets being fixed shall not be required to be forced down to rest on the purlins/ side girts. The finished roof shall present a uniform slope and the lines of corrugations shall be straight and true and the completed work shall present a neat and uniform appearance and be leak proof. For side sheeting, corrugations shall be vertical and in one plane.

The sheets shall be laid with a minimum lap of 150 mm at the ends and 2 ridges of corrugations at each side. In the case of roofs with pitch flatter than 22 degrees, minimum end laps shall be 200 mm. The side laps shall be laid on the side facing away from the prevailing monsoon winds. The minimum lap of sheets with ridges, hips and valleys shall be 200 mm measured at right angles to the line of ridge, hip & valley respectively. The free overhang of the sheets at the eaves shall not exceed 300 mm.

The sheets shall be cut to suit the dimensions or shape of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge and chiselled to give a smooth and straight finish. The sheets shall not generally be built into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course covering the junction by at least 75 mm.

15.6. FIXING

Sheets shall be secured to the purlins and other roof members by means of self fixing hexahead screws with EPDM washers (Buildex or equivalent). The instructions of the manufactures shall be strictly followed.

Where sheets are laid on tubular purlins, the fixing bolts shall be designed to encompass at least half the tube circumference and precautions should be taken to prevent its rotation.

No bolt shall be nearer than 40 mm to any edge of a sheet or an accessory. Sheets with holes drilled wrongly shall be rejected.

15.7. GENERAL

All work shall proceed in a diligent and systematic manner.

Contractor shall not allow access to any person other than workmen employed for laying and fixing sheeting while the above work is in progress. If, however, it is not

possible to keep the area clear, suitable safety measures shall be taken by contractor during the progress of the work.

Contractor shall use roof ladders or planks while laying and fixing the sheets, to avoid damage to sheets and to provide security to the workmen.

Contractor shall arrange any staging or other temporary structures required for the purpose of installing the roof and side sheeting at his own cost.

At no time shall the sheets or accessories be laid and left unfixed. Temporary fixing /supporting shall not be acceptable. In case of any loss or damage due to infringement of these conditions by contractor, the same shall be made good by Contractor at no extra cost to Owner.

15.8. ACCESSORIES

15.8.1. Ridges and hips.

Ridges and hips of precoated galvanised roofs shall be covered with ridge and hip sections of precoated sheets with a minimum 200 mm lap on either side over the precoated sheets. The end laps at the ridges and hips and between ridges and hips shall also be not less than 200 mm. The ridges and hips shall be fixed as shown on the drawings.

Ridges and hips shall be fixed to the purlins below with the same bolts and nuts and washers which fix the sheets to the purlins. At least one of the fixing bolts shall pass through the end laps of ridges & hips, on either side. If this is not possible, extra bolts shall be provided.

The edges of the ridges and hips shall be straight from end to end and their surfaces shall be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets and shall be leak proof.

15.8.2. Valleys and Flashings

Valleys shall be as per drawing and fixed as shown on the drawings or as directed by Engineer. Laps with sheets shall not be less than 250 mm on either side. The end laps of valleys shall also not be less than 250.

Flashing shall be of precoated sheet having required girth, bent to shape and fixed as shown on the drawings. They shall lap not less than 150 mm over the roofing sheets. The end laps between flashing pieces shall not be less than 250 mm.

Laying and fixing shall be in the same manner as sheets for ridges and Hips.

15.8.3. Eaves and Valley Gutters & Fixed Louvers.

Gutters shall be fabricated from MS sheets 3.12mm thick or as specified.

Eaves or valley gutters shall be of the shapes and section as shown on the drawings or as directed by the Engineer. The overall width of the sheets referred to therein

shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm, and beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

Gutters shall be laid with a minimum fall of 1 in 120. Gutters shall be true to line and slope and shall be supported on and fixed to MS flat iron brackets bent to shape. Where the brackets are to be fixed to the purlins, the brackets shall consist of 50 mm x 3 mm flats bent to shape with one end turned at right angle and fixed to face of purlins with 10 m dia. bolt, nut & washer. The requisite slope in the gutters shall be given in the line of brackets. The brackets shall be placed at a spacing of not more than 1.2 m. The connecting bolts shall be above the water line of the gutters.

For connections to downtake pipes, Contractor shall fabricate a proper drop end or funnel-shaped connecting piece, stop ends, etc. and flat iron brackets and bolts and nuts required for fixing the latter to the roof members.

The gutter shall be sand blasted. It shall be painted with one coat of protective paint and one coat of synthetic enamel paint of approved colour & shade prior to erection. It shall then receive one coat of rubberised waterproof paint on the exposed side & one coat of synthetic enamel paint on the underside after erection

The fixed louvers shall be 100 mm deep of the similar material as sheets with all necessary framing & fixtures.

15.9. MEASUREMENT & PAYMENT

The measurement shall be taken for the finished work on the flat in the plane of the roof/ side measured in sq.m without allowance for laps and corrugations and payment shall be effected based on the rates quoted by Contractor after making necessary deductions for openings.

The laps between the sheets both at the ends and at the sides shall not be measured. However, the overlaps of the sheets over valley gutters, ridge, hip and flashing pieces shall be included in the measurement.

No deduction shall be made for opening less than 0.4 sq. m in area and nothing extra shall be paid for forming such openings. For openings exceeding 0.4 sq. m in area, deductions shall be made separately. Cutting across corrugations shall be measured flat and not girthed. No additions shall be made for laps cut through.

If separate rates are called for accessories in the Schedule of Quantities, these shall be measured and paid for separately or else the rate quoted for roof/side sheeting shall be deemed to include for all accessories.

Where called for separately the accessories shall be measured for the finished work taken along the centre line. The measured length of the finished work shall include the length over accessories and the rate for the same shall include the cost of accessories. Laps shall not be measured.

The rate shall include the cost of all materials and labour involved in all the operations described in these specifications and as may be necessary for the work.

The rate quoted shall also include providing any staging or any temporary structure required for the purpose of installing the roof and side sheeting.

The supplier shall submit complete, detailed fabrication drawings fifteen days prior to the start of erection for approval of the Engineer. The erection shall commence based on the approved drawings only.

16. SPECIFICATIONS FOR WATER SUPPLY, SANITARY AND DRAINAGE WORK

16.1. SCOPE

This specification covers the general requirements for providing and laying water mains and water supply piping, providing and fixing sanitary fixtures and piping and providing and laying drainage lines including sewage disposal facilities.

16.2. APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to:

a) IS 1172 - Code of basic requirements for Supply drainage and sanitation.
b) IS 1742 - Code of practice for building drainage.
c) IS 2064 - Code of practice for selection, Installation and maintenance of Sanitary appliances.
d) IS 2065 - Code of practice for water supply in buildings.
e) IS 3114 - Code of practice for laying cast Iron pipes.
f) IS 4127 - Code of practice for laying Glazed stone ware pipes.
g) IS 5329- Code of practice for sanitary Pipe work above ground for Buildings.
h) IS 404 (All parts) - Lead pipes.
i) IS 651 - Salt glazed stoneware pipes and fittings.
j) IS 771 (All parts) - Glazed fire clay sanitary appliances.
k) IS 2556 (All parts) - Vitreous sanitary appliances (Vitreous China).
l) IS: 778 - Copper alloy gate, globe check valves for water purposes.
m) IS 781 - Cast copper alloy screw bib taps and stop valves water services.
n) IS 1230- Cast iron rainwater pipe fittings.
o) IS 1239- Mild steel tubes, tubular other Wrought steel fittings.
Part I - Mild steel tubes
Part II- Mild steel tubular and other wrought pipe Fittings.
p) IS 1536- Centrifugally cast (spun) iron Pressure pipes for water, gas, Sewage.
q) IS 1538- (All parts) Cast iron fittings for pressure pipes for water, gas and sewage
r) IS 1729 - Sand cast iron spigot and soil, Waste and ventilating pipe Fittings and accessories.
s) IS 1795 - Pillar taps for water supply purposes.
t) IS 3989- Centrifugally cast (spun) iron Spigot and socket soil, waste and Ventilating pipes, fittings and Accessories.
u) IS 4827- Electroplated coatings of Nickel and Chromium on copper and copper Alloys.

v) IS 5455 - Cast iron steps for manholes.
w) IS 5961 - Cast iron gratings for drainage Purpose.

16.3. DRAWINGS

Checked and approved drawings showing locations of sanitary and water supply fixtures will be furnished to the CONTRACTOR and all drawings so furnished shall form a part of this specification. The CONTRACTOR shall refer his drawings for all information contained thereon which pertains to and is required for his work. He is; however, not to commence detailed plumbing, water supply and drainage drawings unless such drawings or parts of such drawings are officially released as "Released for Construction". Revisions to drawings and any new drawings made to include additional work by the CONTRACTOR shall be considered a part of this specification and contract.

Unless otherwise specified, the plans and specifications are intended to include everything obviously requisite and necessary for the proper and entire completion of the work and accordingly the job shall be carried out for completeness as required whether each item is mentioned here or not.

Based on the line diagrams/drawings furnished by the ENGINEER, the CONTRACTOR will have to prepare detailed working drawings indicating the positions of fittings, valves, joints, nature, type and location of supports, connections to main lines, etc. These drawings will have to be made by a licensed plumber, in Contractor's employment or otherwise. Four prints of each of these detailed drawings shall be submitted to the ENGINEER for approval and got approved before proceeding with the execution of the work. The CONTRACTOR shall obtain permission from all local statutory authorities for all proposed works prior to commencement of execution and necessary expenses, etc. shall be borne by him. The CONTRACTOR should, after completion of all works, give as-built drawings incorporating all field changes made, for reference and use by the OWNER. The final payment due to the CONTRACTOR shall be effected only after such drawings are finalized.

Construction shall not be started until the CONTRACTOR has received copies of his drawings upon which the ENGINEER has endorsed approval. The approval of the ENGINEER of any of the CONTRACTOR'S drawing shall not relieve the CONTRACTOR from his responsibility for correctness of engineering, workmanship, fit of parts, details, materials, errors or omissions of any and all work shown thereon. The ENGINEER`s approval shall constitute approval of the design, sizes of pipes and layout only. The approval shall not invalidate any claim by the OWNER on account of faulty construction.

No drawings will be accepted for examination by the ENGINEER unless entirely complete, first checked and approved by the CONTRACTOR.

The ENGINEER will return one copy of the CONTRACTOR's drawings marked with his approval/comment. The CONTRACTOR shall furnish the ENGINEER 2 prints and one reproducible of all final drawings for record purpose.

All civil works will be measured and paid items of work.

16.4. CAST IRON PIPES AND FITTINGS

All cast iron pipes and fittings (except those for rain water, and venting, which shall be of rain water variety) shall be of the best approved Indian Make confirming to IS 3989 of soil variety and shall be truly cylindrical and of uniform thickness with strong and deep sockets free from flaws, air holes, cracks, sand holes and other defects. The diameter specified shall be internal diameter of pipe. All pipes and fittings shall be properly cleaned of all foreign material. Flanged joints shall be provided near meters, valves, etc. All the joints in the pipes shall be cement caulked with a gasket of hemp or spun yarn, sealed with white putty and neatly finished cement mortar. Joints shall be perfectly air and watertight. The soil pipes shall be of the longest length available and shall be fixed to the walls on timer plugs embedded in the stone or brick walls, by means of special WI clamps and round headed nails so as to keep the pipe clear of the surface of the walls. Pipes shall be fixed to the wall by WI clamps, unless projecting ears with fixing holes are provided at socket end of pipe. They shall be fixed in perfectly vertical straight lines with all necessary fittings. All cast iron pipes below floor level shall be lead jointed as per IS 3114.

All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers for which shall be fixed with nuts and screws wit washers to ensure there is no leakage of polluted air/gases and water.

GI pipes and fittings, which are exposed, shall be first cleaned and then painted with a coat of red oxide. Remaining two coats shall be of white zinc base and have approved colour.

Nahani traps and floor traps shall be cast iron and of 75mm diameter conforming to IS: 3989 with C.I. grating and shall be fixed in the floor with C.I. soil variety plug bend conforming to IS: 3989 upto outside face of wall or horizontal C.I. pipe below floor level. All holes in the walls and floors made for its installation shall be made good in C.M. (1:4).

The connections between cast iron pipes and stone ware pipes/earthenware pipe and/or fittings shall be made in C.M. (1:1).

16.5. WATER PIPES AND FITTINGS

All water supply pipes for exposed work shall be `B` class galvanized MS pipes of the specified internal diameters conforming to IS: 1239. Similarly for concealed works they shall be ‘C’ class galvanised MS pipes of the specified internal diameters conforming to IS: 1239. All pipes shall be fixed in longest possible lengths with all necessary heavy duty bends, tees, couplings, unions, elbows, sockets, flanges, checknuts, plug bends, reducers, etc. in perfect straight lines vertically and horizontally. All GI pipes shall remain clear of walls by at least 12 mm and shall be fixed to the walls by galvanized malleable iron bat clamps. For jointing pipes, threads of tubes and fittings shall be smeared with white lead and screwed down together with jute threads also smeared with white lead. Pipes exposed on the surface shall be coated with 3 coats of oil paint. GI pipes shall be embedded in a chase cut on walls/floors and the chase shall be filled with cement and mortar 1:4 after fixing and painting of pipe at no extra cost.

All brass or chromium plated fittings shall be of approved make and of the best quality, heavy cast or drawn brass, thoroughly annealed and shall be seamless. The thickness of chromium plating shall not be less than service grade No. 2 of IS 4827.

16.6. GLAZED STONEWARE PIPES

The pipes shall be salt glazed stoneware pipes of the best quality and approved make, conforming to IS 601.

The pipes shall be laid to the required alignment in accordance with the requirements of IS 4127 and as per levels and slopes indicated in the drawings. Pipes shall be laid with sockets facing upstream towards the flow. The bottom of the trench shall be properly trimmed and present a plain surface and all irregularities shall be levelled. Excavation at joints shall be to such dimensions as will allow the joints to be conveniently made and thoroughly caulked. The pipes shall be jointed as per IS 4127.

The backfiring of trenches shall not be undertaken until the joints of the pipes are thoroughly set and have been inspected, tested and approved by the ENGINEER. Backfiring shall be done in 200 mm layers thoroughly rammed. Excess watering shall be avoided. The first 300 mm layer shall be of the finest materials, free of any hard material. Care shall be taken not to disturb the joints during backfiring.

16.7. VALVES

Valves shall be best quality gun metal sluice valves unless specified otherwise, of screw down type with cast iron hand wheel. Valves upto and including 15mm diameter shall have threaded sockets. Valves shall conform to IS 778.

Cast copper alloy chromium plated screw-down bib taps shall conform to IS 781 and shall be of approved make and specified size with all necessary fittings, etc. Cast copper alloy chromium plated pillar taps shall conform to IS 1795. Stop cocks to be provided before cisterns, wash basins, etc. shall be cast copper alloy conforming to IS 781.

16.8. SUPPORTS

Supply pipes, ladders, soil, drain, rain water and waste pipes, etc. installed in a vertical position shall be held firmly in place by WI clamps unless projecting ears with fixing holes are provided at socket end of pipes or by approved inserts well fastened to the walls or structural framing.

Sleeves shall be provided for all pipes passing through walls, floors and partitions, except at locations specifically forbidden by the ENGINEER. All sleeves shall be painted steel pipes. Pipe hangers, where provided, shall not be wider apart than 1.5m on centers for cast iron pipes. General scheme for support arrangement shall be got approved by the ENGINEER before it is erected in position. The ENGINEER shall have the right to increase the number or strengthen or modify the supports at site.

All piping, where not concealed and where location is not specifically fixed by drawings shall run parallel to and as close as possible to walls.

16.9. INSPECTION CHAMBER

Inspection chamber shall be of size 900 length x 450 width and depth as shown on drawings, in brick masonry in CM (1:4) including 250 mm thick (1:4:8) P.C.C. bedding with necessary 1:2:4 concrete channel and fitted with CI light duty air and watertight cover and frame and CI rungs as per drawing. When depth of invert of inspection chambers and anaerobic filters exceeds 80 cm below the surface of ground, cast iron steps of approved pattern shall be built in the brick work as indicated on drawings. 20 mm thick cement plaster (1:3) shall be applied on both faces of walls in two coats as shown on drawings.

Cast iron frames and covers for chamber shall be of Grey cast iron conforming to Grade 15 to IS 210. Castings shall be straight, regular and true in every respect. They shall be clean, sound and free from porous space sand/air holes and plugging. Total weight of Cast Iron frame and cover shall be a minimum of 110 kg.

16.10. SANITARY WARE

All glazed porcelain fixtures, such as wash basin sinks, drain boards, etc. shall conform to relevant Indian Standards and shall have hard durable glazed finish. They shall be free from cracks, indentations or other glazing defects. No chipped porcelain fixture shall be used. Joints between iron and earthenware pipes shall be made perfectly air and watertight with neat cement mortar (1:1).

All care shall be taken to handle the sanitary fixtures while fitting them in position so as to ensure no breakage etc. The final setting shall be in strict conformity with the finished floor and wall lines. The deviation from the desired positions shall be not more than 6 mm.

Wash basins shall be vitreous China flat back type of size 630 mm x 450 mm conforming to IS 2556 (Part IV) of approved make. These shall be fitted to CI brackets fixed to the wall with rawl plugs and screws and painted with two coats of enamel paint over one coat of zinc rich primer. Wash basins shall have 12 mm dia. GI supply pipes, overflow chase, 15 mm dia. chrome plated brass (CP) pillar tap and brass stop cock as per IS:1795 and IS:781 respectively, rubber plug with C.P. chain, C.P. bottle trap with C.P pipe piece upto wall plus 40 mm dia lead waste pipe upto floor level connected to 32 mm dia. C.I. pipe below floor and connected to nearby floor trap complete with brass unions, and plumber's wiped soldered joints with necessary cleaning eyes, etc. complete. All chases cut in wall for fixing pipes shall be made good in CM (1:4).

Towel rail shall be 12 mm round chromium plated brass (CP) mm long with suitable CP brackets fixed with screws in the wall.

Liquid soap holders shall be of best quality plastic variety of approved make with CP brackets and CP screws in the wall.

Mirrors shall be best quality with bevelled edges and of approved make of size 450 mm x 600 mm with masonite backing and fixed to the wall with CP brass screws.

Glazed stoneware gully traps shall conform to IS:651 and shall be of 150mm x 150mm size with necessary brick masonry chamber in CM 1:6 and C.I. cover and 100 mm dia outlet.

16.11. PLUMBING WORK

The pipes before being laid shall be thoroughly cleaned specially the inside of the pipes if required by ENGINEER. Socket ends of pipes shall always face upstream towards effluent flow. The drains shall run in perfect straight lines between manholes/inspection chambers. The trenches shall not be filled in until the joints have been tested and alignment of drains and connections into and from the manholes/inspection chambers and their positions have been examined and certified by the ENGINEER, if required. The whole of sanitary work comprising provision of drainage and water supply arrangements including sanitary and water fittings and fixtures complete in all respects shall be carried out in accordance with the rules and regulations of the legal authority through the agency of a licensed plumber. If required, the CONTRACTOR shall have to get all materials, brought on site for incorporation in the work, approved by the local authority at his own expense.

16.12. PROTECTIVE PAINTING

All exposed cast iron spigot and socket pipes shall be painted with one coat of red oxide primer and two coats of zinc based paint of approved make and shade.

All exposed wrought iron clamps, steel suspenders or brackets for fixing the cast iron pipes to the wall face in case of vertical pipes and suspending the horizontal run of pipes shall be painted with one coat of red oxide primer and two coats of paints of approved make and shade.

16.13. TEST OF AND GUARANTEE FOR WATER SUPPLY, SOIL, VENT AND CHAMBERS SYSTEMS

Water supply shall be tested to a hydrostatic pressure of 1.5 times the design water pressure at any point over a period of 24 hours. All soil, waste, storm water pipes, vents and chambers shall be tested under a pressure of 3 meters of water. Rain water pipes shall be tested to a height of water equivalent to the height of the building plus 3 meters to ensure there is no leakage in case of choking of sections, by first installing test plugs in all openings, erecting 3 meters stand pipe, filling the system with water or by hydrostatic plus air. Test pipes shall be deemed to have passed the test, if water in the stand pipe remains reasonably constant for a period of one hour.

The CONTRACTOR shall deliver to the OWNER upon completion of his work under this Contract a written guarantee:

A) That for a period of one (1) year after acceptance by the ENGINEER; plumbing and drainage work shall be free from defective material and workmanship.

B) That for a period of one (1) year after acceptance by the ENGINEER, the CONTRACTOR shall be responsible for the tightness of all joints made by him.

C) That he will at his own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the above term of guarantee.

D) After the completion of the work, the CONTRACTOR shall obtain and handover to the OWNER necessary certificates from the local authority/ authorities concerned, at no extra cost to the OWNER.

16.14. MEASUREMENTS FOR PIPES

AC, cast iron and SW drainage pipes shall be measured along the centre lines of pipes including all fittings such as junctions, plug bends, etc. for which no separate payment shall be made.

GI pipes with fittings completely fixed in position shall be measured and paid for the finished centre line lengths, including all fittings such as tees, bends, couplings, etc. for which no separate payment shall be made.

In measuring the lengths of sewer pipes laid, length between faces of manholes shall be measured. Inspection chambers shall only be measured omitting lengths of channels between inside faces of walls of manholes of chambers.

17. SPECIFICATIONS FOR ANTI-TERMITE, PRE-CONSTRUCTION CHEMICAL TREATMENT IN BUILDINGS

17.1. SCOPE

This specification covers the general requirements for Anti-termite Constructional Measures, chemical treatment of soils for the protection of buildings from attack by subterranean termites, chemicals to be used with their minimum rates of application and procedure to be followed while the building is under construction.

17.2. APPLICABLE CODES AND SPECIFICATIONS

The following codes, standards and specifications are made a part of this specification. All specifications, standards, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern:

a) IS 6313 Part I : Code of Practice for Anti-termite Measures in Buildings Constructional Measures

b) IS 6313 Part II : Pre-constructional Chemical Treatment Measures

c) IS 8944 : Specification for Chloropyrifos Emusifiable Concentrates

d) IS 4015 Part I : Guide for handling cases of Pesticide Poisoning First Aid Measures

e) IS 4015 Part II : Symptoms, Diagnosis and Treatment

17.3. GENERAL

Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, Labour, materials, any temporary works, consumables, any and everything necessary whether or no such items are specifically stated herein for completion of the job in accordance with specification requirements.

All work shall be done in the order of progress required by Owner's construction programme.

Contractor shall take all necessary precautions to prevent any accident in connection with the performance of the work.

On final completion of all work, Contractor shall leave the entire premises within the site of his operation clean and free from all rubbish resulting from his operation.

Owner reserves the right to inspect, check and direct any or all operations at any stage of the work and to require unsatisfactory work to be remedied at Contractor's expense.

No work shall be carried out under unsuitable weather conditions viz. when raining or when the soil is wet due to rain or sub-soil water.

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

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

Examples:

Chloropyrifos 20	1 litre is diluted to 20 litres to give 1.0% emulsion.

17.4. PRE-CONSTRUCTIONAL CHEMICAL TREATMENT

17.4.1. Essential Requirements

Hand operated pressure pump with graduated containers shall be used to ensure uniform spraying of the chemical. Continuous check shall be kept to ensure that the specified quantity of chemical is used for the required area during the operation.

Condition of Formation

The treated soil barrier shall be complete and continuous under the whole of the structure to be protected. All foundations shall be fully surrounded by and in close contact with the barrier of treated soil. Each part of the area treated shall receive the specified dosage of chemical.

Time of Application

Soil treatment shall start when the foundation trenches and pits are ready to receive mass concrete in foundations. Laying of mass concrete shall start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment shall not be carried out when it is raining or soil is wet with rain or sub-soil water. The foregoing also applies in the case of treatment to the filled earth surface within the plinth before laying the subgrade for the floor.

Disturbance

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

17.4.2. Chemicals, Method and Rate of Application

a) Mound Treatment

Termite mounds within the plinth and contingent apron area shall be destroyed by means of insecticides in the form of water suspension or emulsion which shall be poured into the mounds at several places after breaking open the earthen structure and making holes with crow bars. For a mound volume of about one (1) cum., four (4) litres of an emulsion in water of one of the following shall be used:

i) 0.50 percent Chloropyrifos

b) Soil Treatment

Any one of the following chemicals (conforming to Indian Standards) in water emulsion shall be applied uniformly over the area to be treated.

Chemical	Concentration by weight percent
Chloropyrifos	1.0

Treatment of Column-pits, Wall-trenches and Basement excavations

a) The bottom surface and the sides (up to a height of about 300 mm) of the excavations made for column pits, wall trenches and basements shall be treated with the chemical at the rate of 5 litres per sq.m of the surface area.

b) After the column foundations and the retaining walls of the basement come up, the backfill in immediate contact with the foundation structure shall be treated at the rate of 15 litres per sq.m of the vertical surface of the sub-structure for each side. If water is used for ramming the earth- fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical with the above dose. The earth shall be returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

c) In the case of R.C.C. framed structures with columns and plinth beams and R.C.C. basements, with concrete mix 1:2:4 or richer, the treatment shall start at the depth of 500 mm below ground level for columns and plinth beams. From this depth the back-fill around the columns, beams and R.C.C basement walls shall be treated at the rate of 15 litres/sq.m of vertical surface. The other details of treatment shall be as laid down in clause (b) above.

Treatment of Top Surface of Plinth Filling

The top surface of the filled earth within plinth beams/walls shall be treated with chemical emulsion at the rate of 5 litres per sq.m of the surface before the sand bed/subgrade is laid. Holes upto 50 to 70 mm deep at 150 mm centres bothways shall be made with 12 mm dia. crow-bar on the surface to facilitate saturation of the soil with chemical emulsion.

Treatment of Junction of Wall and Floor

To achieve continuity of vertical chemical barrier to inner wall surfaces from the ground level, small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade) and rod holes made in the channel upto ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 15 litres/sq.m of the vertical wall or column surface so as to soak the soil right to the bottom. The soil shall be tamped back into place after this operation.

Treatment of Soil under Apron along External Perimeter of Building

The top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litres/sq.m of the surface before the apron is laid, by making rod holes 75 mm deep at 150 mm centres both ways.

Treatment of Soil along External Perimeter of Building

After the building is complete, holes shall be made in the soil with iron rods along the external perimeter of the building at interval of about 150 mm and depth 300 mm and these holes filled with chemical emulsion at the rate of 7.5 litres/metre of perimeter of the external wall. If the earth outside the building is graded on completion of building, this treatment shall be carried out on completion of such grading. If the filling is more than 300 mm the external perimeter treatment shall extend to the full depth of filling upto the original ground level so as to ensure continuity of chemical barrier.

Treatment for Expansion Joints

Anti-termite treatment shall be supplemented by treating through the expansion joint after the sub-grade has been laid at the rate of 2 litres per linear meter of expansion joint.

Treatment of Soil Surrounding Pipes and Conduits

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe or conduit for a distance of 150 mm and to a depth of 75 mm before treatment is commenced. Whey they enter the soil external to the foundations, they shall be similarly treated for a distance of over 300 mm unless they stand clear of the walls of the building by about 75 mm.

17.5. SAFETY PRECAUTIONS

All chemicals used for anti-termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed. Person using or handling these chemicals should be warned of these dangers and advised that absorption through the skin is most likely source of accident poisoning. They should be cautioned to observe carefully the safety precautions given below.

These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labelled and should be stored carefully so that children and pet cannot get at them. They shall be kept securely closed.

Particular care shall be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions shall also be avoided. Workers shall wear clean clothing and wash thoroughly with soap and water, especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemicals splash into eyes they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames shall not be allowed during mixing.

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

17.6. MEASUREMENTS

The measurements shall be made in sq.m on the basis of plinth area of the building at ground floor only for all operations described above. Nothing extra shall be measured.

17.7. RATE

The rate shall include the cost of all materials and labour involved in all the operations described above including making holes and refilling and making good the same.

18. SPECIFICATIONS FOR GROUTING

18.1. GROUTING

Grouts are generally classified into 3 types:

1) Standard grouts
2) Plain cement grouts
3) Special grouts.

The type of grout shall be as specified in the drawings.

18.1.1. Standard Grout

Standard grouts are the normally used grouts, which are prepared by mixture of cement and sand. The proportions of standard grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage.

The grout proportions shall be limited as follows:

Use	Grout thickness	Mix Proportions	W/C Ratio (Max)
a) Fluid Mix	Under 25mm	One part Portland Cement to one part sand	0.44
b) General	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand.	0.53
c) Stiff Mix.	50mm and above.	One part Portland Cement to 3 parts of sand.	0.53

a) Sand shall be such as to produce a flowable grout without any tendency to segregate.

b) Sand, for general grouting purposes, shall be graded within the following limits:

Passing IS 2.36 mm sieves	95 to 100%
Passing IS 1.18 mm sieves	65 to 95%
Passing IS 300 micron sieves	10 to 30%
Passing IS 150 micron sieves	3 to 10%

c) Sand for fluid grouts shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.

d) Sand, for stiff grouts, shall meet the usual grading specifications for concrete.

18.1.2. Plain Cement Grouts

Cement grout shall be prepared using ordinary Portland cement along with an approved admixture to overcome operated shrinkage. It is recommended to use plasticised expanding grout admixture. Proportion or admixture quantity or water and type of mixing shall be as per manufacturer's instructions. Compatibility of admixture with the type of cement used shall be ascertained before use of any admixture with cement.

18.1.3. Special Grout

Ready mixed special grout shall be used wherever they are specified or called for in the drawing or as advised by the engineer. The type of grout to be used shall be as per their strength requirements and as per manufacturer's recommendation depending on the type of load they will be subjected to - light, heavy or dynamic. Generally, the type of grout selected shall have twice the strength of the base concrete. The thickness of grout shall generally vary depending on the situation and shall be in the range of 15mm to 50mm.

The grouts shall be prepared only to the extent it can be used within the specified potlife by the manufacturer. Any leftover grout or grouts not consumed with the potlife time shall not be used and shall be discarded. The shelf life of the grouts shall also be checked before they are used. Expired date grouts shall not be used under any circumstances.

The grouts shall be chloride free.

They shall be used following strictly the manufacturer's specification.

a) Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter.

b) Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material.

a) Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

b) Water in anchor bolt holes shall be removed before grouting is started.

Forms around base plates shall be reasonably tight to prevent leakage of the grout. When the base is to be flow grouted, forms shall be built and securely anchored outside the base plate so as to completely confine and withstand the pressure of liquid grout under working and rodding condition without leaking and high enough to ensure the grout is in contact with the underside of the base plate, and provide a head of minimum 100 mm above the underside of the base plate. Provisions of grout holes in base plates, rodding, arrangements shall be checked prior to commencement of grouting.

Adequate clearances shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and break down of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release of entrapped air, link chains or doubled over flexible steel strappings may be used to work the grout into place.

Grouting through holes in base plates shall be by pressure grouting. The pressure to be used for grouting shall be as directed by the ENGINEER.

Forms and shims shall not be removed and the anchor bolts shall not be tightened for at least twenty four hours after placing the grout. After the removal of forms and peripheral shims, area occupied by shims shall be filled and the area between the base and the edge of the foundation shall be finished smooth to allow drainage away from the base. Interconnecting piping and machinery shall not be attached to the machinery before anchor bolts are tightened. It is desirable to make these connections atleast after a minimum of seven days from the date of grouting. During this period, the grout shall be properly cured.

18.2. INSPECTION

All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of ENGINEER.

All materials supplied by CONTRACTOR and all works or construction performed by CONTRACTOR and rejected - as not in conformity with the specifications and drawings - shall be immediately replaced at no additional expense to the OWNER.

Preliminary approvals of any materials or phase of work shall in no way relieve the CONTRACTOR from the responsibility of supplying grouting materials and or producing finished grout in accordance with the specifications and drawings.

All grouting shall be protected against damage until final acceptance by OWNER or his representative.

Upon the completion of grouting work, all forms, equipment, construction tools, protective coverings and any debris shall be removed from the area as directed by the ENGINEER.

19. SPECIFICATIONS FOR GALVANISING OF STRUCTURAL STEEL

19.1. SCOPE

This specification covers the general requirement of hot dipped galvanising, Electroplated, Sheardized and Sprayed Zinc coating of the structural steelwork. It covers the supply of all materials, labour, tools, plant, equipment, necessary to galvanise the structures in accordance with specifications.

19.2. APPLICABLE CODES AND SPECIFICATIONS

The following Specifications and Codes of Practice are made a part of this specification. All Specifications and Codes of Practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this Specification shall govern.

1) IS 1367 - (Part-13) Hot-dip Galvanized Coatings on Threaded Fasteners.
2) IS 1573 - Electroplated Coatings of Zinc on Iron and Steel.
3) IS 2629 - Recommended Practice for Hot-dip Galvanising on Iron and Steel.
4) IS 2633 - Methods of Testing Uniformity of Coating on Zinc Coated Articles.
5) IS 4736 - Hot-dip Zinc Coatings on Mild Steel Tubes.
6) IS 4759 - Hot-dip Zinc Coatings on Structural Steel and Other Allied Products.
7) IS 5905 - Sprayed Aluminium and Zinc Coatings on Iron and Steel.
8) IS 6158 - Recommended Practice for Safeguarding Against Embrittlement of Hot-dipped Galvanised Iron and Steel Products.
9) IS 6159 - Recommended Practice for Design and Fabrication of Material Prior to Galvanising.
10) IS 6745 - Method for Determination of Mass of Zinc Coating on Zinc Coated Iron and Steel Articles.

19.3. GALVANISING PLANT

The BIDDER shall indicate in his bid the galvanising plant where galvanising work will be carried out. Prior approval shall be obtained from OWNER/ ENGINEER if galvanising proposed to be carried out outside Contractor's plant.

19.4. WORKMANSHIP

After all shop work is complete, all structural material shall be punched with the erection mark to be hot-dip galvanized. Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process or with the quality and durability of the zinc coating as specified in clause 4 of IS 2629. Pickling followed by Rinsing shall be carefully and properly done as specified in IS 2629.

Zinc conforming to any grade specified in IS 209 shall be used for galvanising. Mass of zinc coating under specified otherwise shall be at least 0.610 kg/sq. m. of total surface area for normal or rural atmosphere. In case of industrial atmosphere, minimum mass of coating shall be increased as agreed to between the Galvanizer and Purchaser. Stub members and members for grillage type footing shall have heavier zinc coating of not less than 0.80 kg/sqm. Where required by Purchaser, Post Treatment such as Chromating or Phosphating may be applied to reduce risk of wet storage staining or to assist subsequent painting, respectively.

The galvanized surface shall consist of continuous & uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface be cleaned & smooth & be free from imperfections as flux, ash and bare patches, black spots, pimples, lumpinch, runs, mist stains, bulky white deposits and blisters. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable for rejection. Sampling and nos. of test for coating characteristics shall be as specified in IS 4759. Mass of zinc coating may be determined in accordance with IS 6745.

There shall be no flanking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four no of one minute successive dips in copper sulphate solution kept at temp. of $18 \pm 2\ ^{0}C$ as per IS 2633 unless specified otherwise. If at anytime during the test, there is any doubt as to presence of exposed base metal as determined by visual inspection, one or more of supplementary tests as specified in Cl.6.1 or 6.2 of IS 2633 should be performed. Where practicable, uniformity of galvanized coating shall be determined by Preece test as described in IS 2633 Use of Preece test should be agreed to between Purchaser and Galvanizer. For Hot dipped galvanized steel members, coating shall withstand the Pirotted hammer and Knife tests as prescribed in IS 2633 for testing adhesion of zinc coating on fabricated steel and hardware respectively.

All galvanized members shall be treated with Sodium Dichromate solution or an approved equivalent after galvanising; so as to prevent white storage stains.

Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However in case of members over 7.5m long, the Contractor shall take prior approval of Engineer for double dipping. When the steel section is removed from the galvanising kettle, excess spelter shall be removed only by ‘bumping’.

Whenever galvanized bolts, nuts, locknuts, washers, accessories etc. are specified, these shall be hot-dip galvanized. Spring washers shall be electro-galvanized. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Rechasing of bolt threads after galvanising shall not be permitted. Nuts however may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications or lack of quality control

in any manner in the galvanising plant, shall render the entire production in the relevant shift liable to rejection.

Sufficient care should be exercised while storing, packing and handling. Contractor shall ensure that galvanising is not damaged in transit. While storing and transporting, adequate ventilation should be provided as otherwise 'White rust' or 'Wet storage stain' may result with humidity and atmospheric gases. In the event of occurrence of any damage, contractor shall at its own cost adopt scrapping & regalvanizing the member to satisfy the specific requirements. In many cases, it will be advisable to give a Post-treatment like Chromatting to minimise chances for formation of white rust.

19.5. METHOD OF MEASUREMENT

Galvanising work shall not be measured separately if galvanising is already included in the scope of item of work of fabrication/erection of steel.

In case the galvanising is to be carried out on already fabricated steel work, a separate rate for galvanising shall be quoted as called for in the Schedule of Quantity. The weight of the actual completed structures including weight of bolts, nuts and washers shall be calculated from the approved drawings for different items of work and NO ALLOWANCE in weight will be made for weight of zinc added due to galvanising.