



## TENDER DOCUMENT

NEW MANGALORE PORT AUTHORITY

CIVIL ENGINEERING DEPARTMENT

NIT No. CIVIL/CE(C)/EE(C)/89/2022-23

E-Tender Event No.2023\_NMPT\_740493

Tender for

**"CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW  
MANGALORE PORT"**

**THROUGH E-TENDERING MODE**

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Tender Amount	:	Rs.1,90,00,979/-
E.M.D.	:	Rs.4,48,500/-
Tender Fee	:	Rs.1,120/-(Including GST @ 12%)

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**TENDER DOCUMENT**

**NEW MANGALORE PORT AUTHORITY**

**CIVIL ENGINEERING DEPARTMENT**

**Tender for**

**“CONSTRUCTION OF CRUISE TERMINAL GATE AT  
NEW MANGALORE PORT”**

Volume - 1

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**NEW MANGALORE PORT AUTHORITY  
PANAMBUR, MANGALORE -575010**

**NIT No: CIVIL/CE(C)/EE(C)/89/2022-23 Date: 24-03-2023**

**TENDER ID: 2023\_NMPT\_740493**

**i) NOTICE INVITING TENDER**

(Through E-Procurement only)

E-Tenders are invited by New Mangalore Port Authority, Panambur, Mangalore-575010 through <https://www.eprocure.gov.in/eprocure/app> of CPP portal from the reputed Contractor fulfilling the Minimum Eligibility Criteria stipulated in this notice in two cover bidding procedure for the work of "Construction of Cruise Terminal Gate at New Mangalore Port".

Minimum Eligibility Criteria:

- a) The tenderers must have experience of having successfully completed \*similar works during last 7 (seven) years ending last day of month previous to the one in which applications are invited shall be either of the following

At least three similar completed works costing not less than the amount equal to Rs.76.05lakhs each

or

At least two similar completed works costing not less than the amount equal to Rs.95.050 lakhs each

or

At least one similar completed works costing not less than the amount equal to Rs.152.05lakhs

Note1:\*\*\*\***Similar work(s) means Any Civil Construction work or Renovation Work of Buildings.**

Note2: Documentary evidence for successful completion of the work shall be furnished along with work order and work completion certificate.

- b) Average Financial turnover of the tenderer over the last three financial years 2019-20, 2020-21 and 2021-22 shall be at least Rs.57.05lakhs.

The financial capacity of bidders would be evaluated considering the works in hand at NMPA. The port would award the work not exceeding the remaining financial capacity of the bidder. The financial capacity to be 3.33 times of the average financial turnover of last three years of the bidder

minus works in hand at NMPA. The bidder must fill the annexure-6.

Pertinent information is given in the following table:

i)	Estimated Amount put to Tender	Rs.1,90,00,979/-
ii)	Earnest Money Deposit (EMD)	<p>Rs.4,48,500/- (Rupees Four Lakh Fourty Eight Thousand Five Hundred Only.)</p> <p>The EMD shall be in the form of Insurance Surety Bonds, Account Payee Demand draft, Fixed Deposit Receipt, Bankers Cheque, Bank Guarantee as per Annexure 9 or shall be paid by RTGS in favour of F.A. &amp; C.A.O., NMPA. Scanned copy should be uploaded along with bid.</p> <p>The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or UDYAM Registration Certificate or any other body specified by Ministry of MSME.</p>
iii)	Cost of Tender (Tender fee)	<p>Rs.1120/- (Rupees One Thousand One Hundred Twenty Only) Payment of Tender fee by NEFT in favour of F.A. &amp; C.A.O., NMPA. Scanned copy should be uploaded along with bid. The benefit of Exemption of Tender Fees to all Micro and small enterprises (MSE) registered with district industries center (DIC) or Khadhi and village industries</p>

		commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or any other body specified by Ministry of MSME, will be considered.
iv)	Document download start date and time	24-03-2023 at 15.00 HRS
v)	Seek clarification start date and time	30-03-2023at 10.00 HRS
vi)	Seek clarification end date and time	31-03-2023at 15.00 HRS
vii)	Bid submission start date and time	07-04-2023 at 10.00 HRS
vii)	Bid submission closing date and time	14-04-2023 at 15.00 HRS
ix)	Date & time of opening of Cover -I : Technical Part - II : Financial	17-04-2023 at 15.30 HRS Shall be communicated separately.
x)	Completion period	12 (Twelve Months excluding monsoon)
xi)	Validity of Tender	120 days from the date of closing of online submission of e-tender.

Tenderer shall have to pay the prescribed cost of tender i.e., Rs.1120/- (Rupees One Thousand One Hundred Twenty Only) by NEFT in favour of F.A. & C.A.O., NMPA.

NMPA Bank Details.

1. Name of the Bank: State Bank of India, Panambur, Mangalore - 575 010.

2. Bank A/C No. 10205649448

3. IFSC Code: SBIN0002249

4. MICR Code: 575002011

Contact Nos. 0824-2887306 and 0824-2407149

Email id: [praveenkumar.kn@nmpt.gov.in](mailto:praveenkumar.kn@nmpt.gov.in) and [chiefengineer@nmpt.gov.in](mailto:chiefengineer@nmpt.gov.in) Amendments / further information etc. pertaining to the tender, if any shall be uploaded only on websites <https://www.eprocure.gov.in/eprocure/app> of CPP portal, may have to be referred by the prospective Tenderer from time to time.

-sd-

Executive Engineer (Civil)

**NEW MANGALORE PORT AUTHORITY**  
**PANAMBUR, MANGALORE -575010**  
**NIT No: CIVIL/CE(C)/EE(C)/89/2022-23**  
**E-Tender event No. 2023\_NMPT\_740493**

ii) INSTRUCTIONS TO TENDERERS

**A. Instructions for E-Tendering**

**INSTRUCTION TO E-TENDERING**

**1. SPECIAL INSTRUCTIONS TO THE BIDDERS FOR THE E-SUBMISSION OF THE BIDS ONLINE THROUGH THIS E-PROCUREMENT PORTAL**

This is an e-procurement event of NMPA. The e-procurement service provider is <https://www.eprocure.gov.in/eprocure/app> of CPP portal. You are requested to read the terms & conditions of this tender before submitting your online tender. Tenderers who do not comply with the conditions with documentary proof (wherever required) will not qualify in the Tender.

1. Bidder should do Online Enrolment in the Portal using the option Click Here to Enroll available in the Home Page. Then the Digital Signature enrollment has to be done with the e-token, after logging into the portal.
2. Bidder then logs into the portal giving user ID / password chosen during enrollment.
3. The e-token that is registered should be used by the bidder and should not be misused by others.
4. DSC once mapped to an account cannot be remapped to any other account. It can only be inactivated.
5. The Bidders can update well in advance, the documents such as certificates, purchase order details etc., under My Documents option and these can be selected as per tender requirements and then attached along with bid documents during bid submission. This will ensure lesser upload of bid documents.
6. After downloading / getting the tender schedules, the Bidder should go through them carefully and then submit the documents as per the tender document; otherwise, the bid will be rejected.

7. The BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for that tender. Bidders are allowed to enter the Bidder Name and Values only.
8. If there are any clarifications, this may be obtained online through the e-Procurement Portal, or through the contact details given in the tender document. Bidder should take into account of the corrigendum published before submitting the bids online on the portal or on [www.newmangaloreport.gov.in](http://www.newmangaloreport.gov.in) Bidder, in advance, should prepare the bid documents to be submitted as indicated in the tender schedule and they should be in PDF formats.
9. Bidder should arrange for the EMD and tender fee as specified in the tender. The benefit of Exemption of EMD and Tender Fees to all Micro and small enterprises (MSE) registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or any other body specified by Ministry of MSME, will be considered. Necessary document for having registered with similar category should be submitted along with Technical Bid.
10. The bidder should read the terms and conditions and accepts the same to proceed further to submit the bids.
11. The bidder has to submit the tender document(s) online well in advance before the prescribed time to avoid any delay or problem during the bid submission process.
12. There is no limit on the size of the file uploaded at the server end. However, the upload is decided on the Memory available at the Client System as well as the Network bandwidth available at the client side at that point of time. In order to reduce the file size, bidders are suggested to scan the documents in 75-100 DPI so that the clarity is maintained and the size of file gets reduced. This will help in quick uploading even at very low bandwidth speeds.
13. It is important to note that, the bidder has to click on the Freeze Bid Button, to ensure that, he/she completes the Bid Submission Process.

Bids, which are not frozen, are considered as Incomplete/Invalid bids and are not considered for evaluation purposes.

14. The Tender Inviting Authority (TIA) will not be held responsible for any sort of delay or the difficulties faced during the submission of bids online by the bidders due to local issues.
15. The bidder may submit the bid documents online mode only, through this portal. Offline documents will not be handled through this system.
16. At the time of freezing the bid, the e-Procurement system will give a successful bid updating message after uploading all the bid documents submitted and then a bid summary will be shown with the bid no., date & time of submission of the bid with all other relevant details. The documents submitted by the bidders will be digitally signed using the e-token of the bidder and then submitted.
17. After the bid submission, the bid summary has to be printed and kept as an acknowledgement as a token of the submission of the bid. The bid summary will act as a proof of bid submission for a tender floated and will also act as an entry point to participate in the bid opening event.
18. Successful bid submission from the system means, the bids as uploaded by the bidder is received and stored in the system. System does not certify for its correctness.
19. The bidder should see that the bid documents submitted should be free from virus and if the documents could not be opened, due to virus, during tender opening, the bid is liable to be rejected.
20. The time that is displayed from the server clock at the top of the tender Portal, will be valid for all actions of requesting bid submission, bid opening etc., in the e-Procurement portal. The Time followed in this portal is as per Indian Standard Time (IST) which is GMT+5:30. The bidders should adhere to this time during bid submission.
21. The bidders are requested to submit the bids through online e-Procurement system to the Tender Inviting Authority (TIA) well before the bid submission end date and time (as per Server System Clock).
22. Tender form Fee and EMD shall be submitted with the Part I- Technical BID. BID submitted without fees, as mentioned above will not be considered for evaluation and shall be rejected summarily. The benefit

of Exemption of EMD to all Micro and small enterprises (MSE) will be considered. The bidders shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or any other body specified by Ministry of MSME. The bidder/tenderer/contractor shall file the applicable returns with Tax departments in time and submit the same as documentary proof.

23. The bidder/tenderer/contractor shall file the applicable returns with Tax departments in time and submit the same as documentary proof.
24. The GST applicable shall be shown as a separate line items in the Tax invoices to avail in put credit to Port.

## **2. Cover - I Details (Technical)**

The following documents shall be uploaded online only.

1. Scanned copy of NEFT Payment details for cost of tender or exemption certificate.
2. Scanned copy of RTGS/NEFT Payment details for EMD (bid security) / documentary evidence for exemption of EMD. The original document to be submitted by post or by hand immediately after the closing date for submission of online e-tender)
3. Scanned copy of documents as per Annexure 1 to 13 of section I(iii) of volume-I (Original power of attorney i.e. Annexure 2 to be submitted by post or by hand immediately after the closing date for submission of online e-tender).
4. The tenderer shall attach Scanned copy of Pre-contract, Integrity Pact agreement executed as per Appendix II The Original copy to be submitted by post or by hand so as to reach the Executive Engineer (Civil) immediately after closing date for submission of online tender
5. Scanned copy of valid Pan card, EPF, ESI and GST Registration certificate.
6. List of Ongoing works in hand at NMPA should be indicated in the prescribed form
7. Scanned copy of Form of Tender as per Section VI(iii) of volume -III
8. Technical bid document – Cover I (Volume I to Volume III) along with

amendments and clarifications.

### **3. Cover – II Detail (Finance)**

#### **PRICE BID (Bill of Quantities)**

Price should be quoted in the BOQ template available in the portal. The BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for that tender. The Bidder shall fill in the percentage of Excess or Less in the Bill of Quantities through CPP e-portal Bidders are allowed to enter the Bidder Name and Values only.

Any indication of 'Quoted price' in the online technical bid documents shall lead to rejection of the bid outright.

The price bid submitted through e-portal mode only will be taken up for the purpose for evaluation.

### **4. Opening of bids**

A. Part I Techno-Commercial bid will be opened electronically on specified date and time as given in the NIT. Bidder(s) can witness electronic opening of bid.

B. Part II Price bid will be opened electronically of only those bidder(s) whose Part I Techno-Commercial Bid is found to be Techno-Commercially acceptable by NMPA. Such bidder(s) will be intimated, the date of opening of Part II Price bid, through valid email confirmed by them

Note: The tenderers are advised to offer their best possible rates. There would generally be no negotiations hence most competitive prices may be quoted while submitting the price bid. However in case the lowest rate appears to be reasonable taking into account the prevailing market conditions, the work may be awarded to the lowest bidder and if the rate is still considered high, action as per prevailing instructions / guidelines shall be taken. All entries in the tender should be entered in online Technical & Commercial Formats without any ambiguity.

### **5. Evaluation process:**

A proposal shall be considered responsive if –

- a. It is received by the proposed Due Date and Time.
- b. It is Digitally Signed.
- c. It contains the information and documents as required in the Tender Document.



- d. It contains information in formats specified in the Tender Document.
- e. It mentions the validity period as set out in the document.
- f. It provides the information in reasonable detail. The Port Authority reserves the right to determine whether the information has been provided in reasonable detail.
- g. There are no significant inconsistencies between the proposal and the supporting documents.
- h. The Technical qualification conforms to as specified in the qualification criteria.
- i. A Tender that is substantially responsive is one that conforms to the preceding requirements without material deviation or reservation. A material deviation or reservation is one (1) which affects in any substantial way, the scope, quality, or performance of the Tenderer or (2) which limits in any substantial way, inconsistent with the Tender document, or (3) whose rectification would affect unfairly the competitive position of other Qualified Applicant presenting substantially responsive bids.
- j. The Port Authority reserves the right to reject any tender which in its opinion is non-responsive and no request for alteration, modification, substitution or withdrawal shall be entertained by the Port Authority in respect of such Tenders.
- k. The Port Authority would have the right to review the Technical Qualification and seek clarifications wherever necessary.
- l. Since the tender involves selection based on pre-qualification criteria and technical specification, the Chief Engineer will examine and seek clarification if any and list out the firms, which are found technically suitable and Cover-II Price Bid of such tenderers only will be opened and EMD will be returned to the unsuccessful tenderers
- m. The date and time will be intimated to tenderers whose offers are found suitable and Cover – II of such tenderers will be opened on the specified date and time
- n. The cost of stamping Agreement must be borne by the successful Tenderer
- o. The Fax/E-Mail offers will be treated as defective, invalid and rejected. Only detailed complete offers received through online prior to closing time

and date of the tenders will be taken as valid.

## **B. Instructions To Tenderers (General)**

### **1. Introduction:**

This work essentially comprises of "Construction of Cruise Terminal Gate at New Mangalore Port"

### **2. Applicants:**

Contractors who wish to bid for the tender for the contract work should apply for the tender document. The successful bidder will be expected to complete the works by the intended completion date specified in the Contract document.

### **3. Invitation for Bids:**

The online Invitation for Bids is open to all eligible bidders meeting the eligibility criteria. The bidders may submit bids for the works detailed in the NIT through e-tender mode only.

### **4. Purchase of Tender Documents:**

Tender document can be downloaded from NMPA website [www.newmangaloreport.gov.in](http://www.newmangaloreport.gov.in), [www.tender.gov.in](http://www.tender.gov.in) & <https://www.eprocure.gov.in/eprocure/app> of CPP portal

### **5. One Bid per Bidder:**

Each bidder shall submit only one bid for one package. Bidder who submits or participates in more than one Bid will cause all the proposals with the Bidder's participation to be disqualified.

### **6. Cost of Bidding:**

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

### **7. Site visit:**

The Bidder, at the Bidder's own responsibility and risk is encouraged to visit and examine the work site and its surroundings and obtain all information that may be necessary for preparing the Bid and entering into a contract for construction of the Works. The costs of visiting the site shall be at the Bidders' own expense.

### **8. Content of Bidding Documents:**

Tender Document will consist of:

Volume I	Section I	Notice Inviting Tenders Instructions to Tenderers Annexure (1 to 12)
	Section II	Form of Agreement
	Section III	Conditions of Contract: Part A - E: General Conditions Conditions of Contract : Part F: Special Conditions Contract Data Form of Securities (A & B) Appendix – I and Appendix - II
Volume II	Section IV	Technical Specifications
	Section V	Drawings
Volume III	Section VI	Preamble Bill of Quantities For of tender
	Section VII	Schedules (A & B)

Any indication of "Quoted price" in the technical bid, shall lead to rejection of the bid outright. For evaluation purpose the uploaded offer documents will be treated as authentic and final. No hard copy shall be submitted, upload the entire document on the CPP portal only.

#### 9. Clarification of the Bidding Documents:

The Tenderers are advised to examine the Tender Document carefully and if there be or appear to be any ambiguity or discrepancy in the documents, or any clarifications needed on the Tender Documents; these shall be referred to the Chief Engineer (Civil) in writing, so as to reach at least three days before start date of submission of bid. It is to be noted that queries asked after closing date of pre bid meeting will not be answered. Employer's clarifications shall be furnished in the CPP e-portal or shall be issued a corrigendum in the web site after closing date of online pre-bid meeting without identifying the source.

A provision is made in the CPP e-portal for online pre-bid meeting during the date mentioned in the NIT. The bidders can ask queries if any during the period of pre-bid meeting through online. The queries of the bidders shall be answered online or a separate consolidated list of queries and clarifications

shall be uploaded in web sites after closing date of online pre-bid meeting.

**10. Amendment of Bidding Documents:**

Any modification of the tender documents as a result of any ambiguity shall be shall be made exclusively through the issue of an Addendum. Any addendum thus issued shall be part of the tender documents and will be uploaded in CPP e-portal and Port website to all the bidders. Prospective bidders shall acknowledge receipt of each addendum to the Employer. Such addenda will be numbered and it shall be submitted by the Tenderers as part of Part I of their bid. The Addendum can also be downloaded from NMPA official website from 'Ongoing Project link'. The responsibility of downloading such addendum / amendment from NMPA website and CPP e-portal fully lies with the bidder

**11. Preparation of bids:**

All documents relating to the bid shall be in the English language.

**12. Minimum Eligibility Criteria:**

a) The tenderers must have experience of having successfully completed similar works during last 7 (seven) years ending last day of month previous to the one in which applications are invited shall be either of the following

At least Three similar completed works costing not less than the amount equal to Rs.76.05 lakhs each

or

At least Two similar completed works costing not less than the amount equal to Rs.95.050 lakhs each

or

At least One similar completed works costing not less than the amount equal to Rs.152.05 lakhs

Note1:\*\*\***Similar work(s) means Any Civil Construction work or Renovation Work of Buildings.**

Note2: Documentary evidence for successful completion of the work shall be furnished along with work order and work completion certificate.

b) Average Financial turnover of the tenderer over the last three financial years 2019-20, 2020-21 and 2021-22 shall be at least Rs.57.05lakhs.

c) The financial capacity of bidders would be evaluated considering the

works in hand at NMPA. The port would award the work not exceeding the remaining financial capacity of the bidder. The financial capacity to be 3.33times of the average financial turnover of last three years of the bidder minus works in hand at NMPA. The bidder must fill the annexure-6.

In case the average turnover is Rs.3.00crores,the financial capacity of the contractor will considered as  $(3 \times 3.333)$  Rs.10.00crores.

Illustration:- Average turnover for 3 years is the Financial capacity or construction will be  $3.00cr(3 \times 3.33)$  i.e10.0crores.

The turnover means sales/ contract receipts excluding taxes other income shall not be considered for calculation of turnover. Copy of the work order, Client's satisfactory work completion Certificate, along with any other documentary proof certifying the year of completion, brief Description of the project and project completion cost shall be submitted in support of the assignments performed and claimed by the tenderer to fulfill the eligibility criteria for qualification. **Work completion certificate issued by a private organization shall be considered, only if Tax Deducted at Source Certificate with respect to referred work, issued by Competent Authority is enclosed along with the tender. In case work executed on subcontract, only approved or authorized subcontract shall be considered for eligible assignment.**

A statement duly certified by the Chartered accountant showing the average annual Financial Turnover over the last 3 financial years shall be submitted.

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

- i) made misleading or false representations in the forms, statements and attachments submitted in proof of the qualification requirements; and/or
- ii) record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completion, litigation history, or financial failures etc.,

### **13. Bid Prices:**

The contract shall be for the whole works as described in based on the priced Bill of Quantities submitted through CPP e-portal by the Bidder .The

Bidder shall fill in the percentage of Excess or Less in the Bill of Quantities through CPP e-portal. Items for which no rate or price is entered 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.

**14. Currencies of Bid and Payment:**

The Unit rates and the prices shall be quoted by the bidder entirely in Indian Rupees.

**15. Bid Validity:**

Bids shall remain valid for a period not less than one hundred twenty days (120 days) after the last date for online bid submission. A bid valid for a shorter period shall be rejected by the Employer as non-responsive. In exceptional circumstances, prior to expiry of the original bid validity period, the Employer may request that the bidders may extend the period of validity for a specified additional period. The request and the bidders' responses shall be made in writing or by cable. A bidder agreeing to the request will not be permitted to modify his bid and also shall submit an extension for EMD, if it is in the form of Bank Guarantee

**16. Bid Security / EMD:**

- i. The EMD shall be in the form of Insurance Surety Bonds, Account Payee Demand draft, Fixed Deposit Receipt, Bankers Cheque or Bank Guarantee as per Annexure 9 or shall be paid by RTGS/NEFT in favour of Financial Adviser & Chief Accounts Officer, New Mangalore Port Authority, Mangalore

NMPA Bank Details:-

1. Name of the Bank: State Bank of India, Panambur, Mangalore - 10.
2. Bank A/C No. 10205649448
3. IFSC Code: SBIN0002249
4. MICR Code: 575002011.

The Techno Commercial Bid shall be accompanied by the Bank Guarantee or RTGS/NEFT deposit details towards Earnest Money Deposit of Rs.448500/- (Rupees Four Lakh FourtyEight Thousand Five Hundred Only) as stipulated in the tender. The tender without EMD shall be treated invalid. The benefit of Exemption of EMD to all Micro and

- small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udyam Registration Certificate or any other body specified by Ministry of MSME.
- ii. In the event of Bidder withdrawing his Bid before the expiry of tender validity period of 120 days from the last date for online bid submission, the tender shall be cancelled and EMD shall be forfeited.
  - iii. The Earnest Money Deposit of unsuccessful bidder shall be returned without interest on conclusion of contract. The Earnest Money Deposit of the successful bidder shall be refunded (without interest) after he has signed the agreement and furnished required performance security.
  - iv. The Bid Security of a successful bidder will be forfeited in the following cases:
    - a) If the bidder withdraws his Tender during the period of bid validity.
    - b) In case of a successful tenderer fails
      - i) to commence the work, apart forfeiture of other claims
      - ii) Within the specified time limit to sign the Agreement or furnish the required Performance Security. In the event of forfeiting the EMD / SD / LD and while imposing penalty GST as applicable will be collected.

#### **17. No Alternative Proposals by Bidders:**

Bidders shall submit offers that comply with the requirements of the bidding documents, including the basic technical design as indicated in the drawing and specifications. Alternatives will not be considered.

#### **18. Format and Signing of Bid:**

The Bid shall be in online mode. The Bid shall contain no alterations or additions, except those comply with instructions issued by the Employer

#### **19. Bid Submission:**

Tender document including quoted bid price have to be submitted online only through CPP Portal before deadline for online submission of bid.

For evaluation purpose the uploaded offer documents will be treated as

authentic and final.

The Tender shall be submitted in Two Bids.

- I. Technical Bid: Shall contain the following.
    - i) Techno Commercial Bid: Shall contain all the documents. Techno Commercial Bid should not contain Price Bid. "Disclosure/indication of Price in the Techno Commercial Bid shall render the tender disqualified and rejected.
    - ii) The details of payment of EARNEST MONEY DEPOSIT for Rs.448500/- (Rupees Four Lakh FourtyEight Thousand Five Hundred Only) by RTGS/NEFT to NMPA Bank Account, failing which the Techno commercial Bid shall not be considered).
    - iii) Transaction details of payment towards the COST OF TENDER Fee: Rs.1120/-(Rupees One Thousand One Hundred Twenty Only) (To be paid by RTGS/NEFT to NMPA Bank Account).
    - iv) List of Ongoing works in hand at NMPA should be indicated in the prescribed form.
  - II. FINANCIAL BID: shall contain only the Price. The Bidder shall fill in the percentage of Excess or Less in the Bill of Quantities
  - III. LAST DATE FOR SUBMISSION OF ONLINE TENDER: is as per the date mentioned in the NIT
- NMPA may at its sole discretion reserves the right to extend the date for receipt of Bid. Bid after the aforesaid time and date or the extended time and date, if any, shall not be accepted by the portal.
- The following details pertaining to Techno Commercial Bid shall be uploaded online.
- a) Letter of Submission- Covering letter (vide Annexure – 1)
  - b) Power of Attorney in favour of signatory/s to the Tender,,(vide Annexure-2) (Original power of attorney i.e. Annexure 2 to be submitted by post or by hand so as to reach the Executive Engineer (Civil) immediately after the closing date for submission of online e-tender).
  - c) Organization Details (vide Annexure-3)
  - d) Details of "Minimum eligibility criteria" as per Clause 12 of instruction to Tenderers and certificates (Client Certificates / work completion certificates or any other documentary evidences with respect to the



eligibility work) (vide Annexure-4) of condition of contract. The following specific instruction may be noted ;

- i) Bidders are expected to provide information in respect of Eligible Assignments in this Section. The assignments cited must comply with the criteria specified in Clause No. 12 (a) for "Minimum eligibility".
  - ii) A separate sheet should be filled for each of the eligible assignments.
  - iii) the details are to be supplemented by documentary proof from the respective client for having carried out such assignment duly certified by client's completion certificates and work orders etc.
- e) A statement duly certified by Chartered Accountant showing Average Financial turnover of the tenderer over the last three financial years (vide Annexure-5) with balance sheet.
- f) List of Ongoing works in hand at NMPA should be indicated in the prescribed form (Annexure-6).
- g) A list of Plant and equipment proposed to be engaged for work. (Vide Annexure-7). The equipment indicated in the Annexure-7 will form part of contract agreement and as such the bidders are requested to indicate the availability of the equipment at site at what stage of the construction period the equipment would made available.
- h) A declaration to the effect that (vide Annexure -8):-
- a. All details regarding construction plant and machinery, temporary work and personnel for site organization considered necessary and sufficient for the work have been furnished in the Annexure to Conditions of Contract in Volume I and that such plant, temporary works and personnel for site organization will be available at appropriate time of relevant works for which the equipment have been proposed at site till the completion of the respective work.
  - b. No conditions are incorporated in the financial bid. In case any conditions are specified in the financial bid, the tender will be rejected summarily without making any further reference to the bidder.
  - c. We have not made any payment or illegal gratification to any

persons/ authority connected with the bid process so as to influence the bid process and have not committed any offence under PC Act in connection with the bid.

- d. We disclose with that we have made / not made payments or propose to be made to any intermediaries (agents) etc. in connection with the bid.
- i) NEFT Payment details towards cost of tender.
- j) RTGS/NEFT Payment details towards EMD / documentary evidence of exemption of EMD.
- k) The tenderer shall attach Scanned copy of Pre-contract, Integrity Pact agreement executed as per Appendix II. The Original copy to be submitted by post or by hand so as to reach the Executive Engineer (Civil) immediately after closing date for submission of online tender.
- l) Tenderer should submit copy of Permanent Account Number. (PAN), ESI, PF and GST Registration (GSTIN) Number along with certificates issued by the authority as applicable.

**20. Deadline for Submission of the Bids:**

- i) The completed bid shall be submitted in the electronic form by the date and time mentioned in NIT only through CPP e-portal.
- ii) The Employer may extend the deadline for submission of bids by issuing an amendment in accordance with Clause 10, in which case all rights and obligations of the Employer and the bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.
- iii) Price should be quoted in CPP e-portal. Any indication of 'Quoted price' in the online technical bid documents shall lead to rejection of the bid outright. For evaluation purpose the uploaded offer documents will be treated as authentic and final. No hard copy shall be submitted for reference purpose. The bid submitted through e-tendering mode only will be taken up for the purpose for evaluation.
- iv) The uploaded Port Tender Document will be treated as authentic tender and if any discrepancy is noticed at any stage between the Port's tender document and the one submitted/uploaded by the tenderer, the conditions mentioned in the Port's uploaded document shall prevail. Besides, the tenderer shall be liable for legal action for

the lapses.

### **21. Late Bids:**

The tenderer should ensure that their tender is received online at NMPA before the deadline prescribed in Clause 20

The time that is displayed from the server clock at the top of the CPP e-portal, will be valid for all actions of requesting bid submission, bid opening etc., The bidders should adhere to this time during bid submission.

### **22. Modification and Withdrawal of Bids:**

- i) Bidders may modify the offers by deleting their already freezed bids in online only through CPP e-portal (after submission of bid) and resubmit/upload the revised offer before the deadline prescribed in Clause 20.
- ii) No bid shall be withdrawn and resubmitted through CPP e-portal by the bidder after the deadline for submission of bids.
- iii) Withdrawal of a Bid between the deadline for submission of bids and the expiration of the original period of bid validity specified in Clause 15 may result in the forfeiture of the Bid Security pursuant to Clause 16.
- iv) Bidders may only modify the prices and other required details of their Bids by Resubmitting Bid only in accordance with this clause through CPP e-portal.

### **23. Bid Opening - Technical Bid:**

- a. On the due date and time as specified in Clause 20, the Employer will On the due date and time as specified in Clause 20, the Employer will first open Techno Commercial bids of all bids received online in presence of the Bidders or their representatives who choose to attend. In the event of specified date for bid opening is declared as holiday by the Employer, the bid will be opened at the appointed time and location on the next working day.
- b. In the first instance the Techno Commercial Bid containing the RTGS/NEFT payment details of EMD & Cost of tender document will be verified. If EMD and Tender Fee is in line with the Tender Condition there after the Techno Commercial Bid will be considered for evaluation.

The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udyam Registration Certificate or any other body specified by Ministry of MSME

- c. If all Bidders have submitted unconditional Bids together with requisite Bid security, then all Bidders will be so informed then and there. If any Bid contains any deviation from the Bids documents and / or if the same does not contains Bid security in the manner prescribed in the Bid documents, then that Bid will be rejected and the Bidder informed accordingly.

#### **24. Bid Opening – Financial Bid:**

The date and time of opening of price bid (cover-II) shall be intimated to the qualified bidders based on the evaluation of the technical bid. The price bid (cover-II) of such eligible bidders shall be opened on the specified date and time.

If bidder withdraws his tender after opening of price bid the bidder will be disqualified for participating in NMPA tender for a period of two years.

#### **25. Clarification of Bids:**

To assist in the examination and comparison of Bids, the Employer may, at his discretion, ask any Bidder for clarification of his Bid, including breakdown of unit rates. The request for clarification and the response shall be in writing, but no change in the price or substance of the Bid shall be sought, offered, or permitted.

No Bidder shall contact the Employer on any matter relating to his bid from the time of the bid opening to the time the contract is awarded. If the Bidder wishes to bring additional information to the notice of the Employer, he should do so in writing.

Any effort by the Bidder to influence the Employer's bid evaluation, bid comparison or contract award decisions, may result in the rejection of his bid. **Employer reserves the right to reject any Bid, if the Bidder does not provide the clarification sought for by the Employer, within the time**

specified by the Employer, for proper evaluation of the Bid.

**26. Examination of Bids and Determination of Responsiveness:**

Prior to detailed evaluation of Bids, NMPA will determine whether each Bid

- a) meets the eligibility criteria as defined in Clause 12.
- b) has been properly signed by an authorised signatory (accredited representative) holding Power of Attorney in his favour. The Power of Attorney shall inter alia include a provision to bind the Bidder to settlement of disputes clause;
- c) is accompanied by the requisite Bid security and;
- d) is responsive to the requirements of the Bidding documents.

A responsive Bid is one which conforms to all the terms, conditions and specification of the Bidding documents, without material deviation or reservation. A material deviation or reservation is one

- i. which affects in any substantial way the scope, quality or performance of the Works;
- ii. which limits in any substantial way, the Employer's rights or the Bidder's obligations under the Contract; or
- iii. whose rectification would affect unfairly the competitive position of other Bidders presenting responsive Bids.

The tenderer shall submit a certificate in the tender schedule in the Technical Bid that he has not incorporated any conditions in the Financial Bid and in case any conditions are specified in the financial bid his tender will be rejected without making any further reference to him.

If a Bid is not substantially responsive, it shall be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

**27. Correction of Errors: (Not Applicable)**

**28. Evaluation and Comparison of Bids:**

The Employer will evaluate and compare only the Bids determined to be responsive in accordance with Clause 26. In evaluating the Bids, the Employer will determine for each Bid the evaluated Bid Price by adjusting the Bid Price as follows:

- a) making appropriate adjustments to reflect discounts or other price

modifications offered in accordance with Clause 22.

**29. Alteration of tender documents:**

No alteration shall be made in any of the tender documents or in the Bill of Quantities and the tender shall comply strictly with the terms and conditions of the tender document. The Employer may however ask any tenderer for clarifications of his tender if required. Nevertheless, no tenderer will be permitted to alter his tender price after opening of the tender.

**30. Alternative conditions and Proposal:**

The Tenderer shall note that alternative or qualifying tender conditions, or alternative design proposal for whole or part of the work will not be acceptable. Tenders containing any qualifying conditions or even Bidder's clarifications in any form will be treated as non-responsive and will run the risk of rejection. Part II: Price Bid of such Bidder's will not be opened.

**31. Award of Contract:**

The Employer will award the Contract to the bidder whose bid has been determined to be responsive to the bidding documents and who has offered the lowest evaluated bid price, provided that such bidder has been determined to be

- a) Eligible in accordance with the provisions of Clause 12, and
- b) Qualified in accordance with the provisions of Clause 12.

**32. Notification of Award:**

- i) The Bidder whose Bid has been accepted will be notified about the award by the Employer prior to expiration of the Bid validity period by, fax or e-mail and confirmed by registered 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").
- ii) The notification of award will constitute the formation of the Contract subject only to the furnishing of a performance security in accordance with the provisions of Clause 33.

- iii) The Agreement will also incorporate all correspondence exchanged between the employer and the successful bidder. Within 21 days of receipt of Letter of Acceptance, the successful bidder will furnish the performance security and sign the Agreement with the Employer. The contractor shall make 20 copies of the Agreement and submit to the employer within 7 days following the date of **signing of Agreement**.

### **33. Release of Bid Security / EMD:**

The Earnest Money Deposit of unsuccessful bidder shall be returned (in case of BG) or refunded without interest by RTGS/NEFT on conclusion of Contract. The Earnest Money Deposit of the successful bidder shall be refunded (without interest) after he has signed the agreement and furnished required performance security.

### **34. Performance Security:**

- i) Within 21 days of receipt of the Letter of Acceptance, the successful Bidder shall deliver to the Employer a Performance Security in the form Insurance Surety Bonds, Account Payee Demand draft, Fixed Deposit Receipt from a commercial bank, remittance by RTGS or Bank Guarantee (BG) or for an amount equivalent to 3% of the Contract price including GST, as applicable rounded off to the nearest 1000.
- ii) If the performance security is provided by the successful Bidder in the form of a Bank Guarantee, it shall be issued by a Nationalized /Scheduled Indian bank having its branch at Mangalore acceptable by NMPA and cashable at Mangalore. The BG shall be issued in favor of FA&CAO, New Mangalore Port Authority in the Format enclosed in Volume I as Annexure-A.

### **35. Fraud and Corrupt Practices:**

The bidder and their respective officers, employees, agents and advisers shall observe the highest standard of ethics during the Selection Process. Notwithstanding anything to the contrary contained in this document, the Port shall reject the tender without being liable in any manner whatsoever to the bidder, if it determines that the bidder has, directly or indirectly or through an agent, engaged in corrupt practice, fraudulent practice, coercive

practice, undesirable practice or restrictive practice (collectively the "Prohibited Practices") in the Selection Process. In such an event, the Port shall, without prejudice to its any other rights or remedies, forfeit and appropriate the Bid Security or Performance Security, as the case may be, as mutually agreed genuine pre-estimated compensation and damages payable to the Port for, inter alia, time, cost and effort of the Authority, in regard to the Tender, including consideration and evaluation of such Bidder's Proposal. Such Bidder shall not be eligible to participate in any tender or RFP issued by the Authority during a period of 2 (two) years from the date such Bidder is found by the Authority to have directly or through an agent, engaged or indulged in any corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice, as the case may be.

For the purposes of this Clause, the following terms shall have the meaning hereinafter respectively assigned to them:

(a) "corrupt practice" means

- i) the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the action of any person connected with the Selection Process (for avoidance of doubt, offering of employment to or employing or engaging in any manner whatsoever, directly or indirectly, any official of the Authority who is or has been associated in any manner, directly or indirectly with the Selection Process or the LOA or has dealt with matters concerning the Agreement or arising there from, before or after the execution thereof, at any time prior to the expiry of one year from the date such official resigns or retires from or otherwise ceases to be in the service of the Authority, shall be deemed to constitute influencing the actions of a person connected with the Selection Process; or
- ii) engaging in any manner whatsoever, whether during the Selection Process or after the issue of the LOA or after the execution of the Agreement, as the case may be, any person in respect of any matter relating to the Project or the LOA or the Agreement, who at any time has been or is a legal, financial or technical consultant/ adviser of the Authority in relation to any matter concerning the Project;

(b) "fraudulent practice" means a misrepresentation or omission of facts or disclosure of incomplete facts, in order to influence the Selection Process;



- (c) "coercive practice" means impairing or harming or threatening to impair or harm, directly or indirectly, any persons or property to influence any person's participation or action in the Selection Process;
- (d) "undesirable practice" means
  - i) establishing contact with any person connected with or employed or engaged by the Authority with the objective of canvassing, lobbying or in any manner influencing or attempting to influence the Selection Process; or
  - ii) having a Conflict of Interest; and
- (e) "restrictive practice" means forming a cartel or arriving at any understanding or arrangement among Applicants with the objective of restricting or manipulating a full and fair competition in the Selection Process.

**36. Rejection of Tender:**

Any Tender not conforming to the foregoing instructions will not be considered. The Employer does not bind himself to accept the lowest or any tender and has the right to reject any tender without assigning any reason thereof. No representation whatsoever will be entertained on this account.

**37. Additional Information:**

The "Instructions to Tenderers" shall not form part of the Contract. They are intended only to aid the Tenderers in the preparation of their tender.

**38. Compliance of Local Content as per Make in India Policy:**

Bidder shall comply with DPIIT Order No. P-45021/2/2017-PP(B-II) dtd. 16-09-2020 in respect of Local Content and furnish an undertaking in the prescribed format as per Annexure 13, to that effect, failing which, the bid may be liable for cancellation.

**LETTER OF SUBMISSION - COVERING LETTER  
(ON THE LETTER HEAD OF THE BIDDER)**

Date:

To,

The Executive Engineer (Civil),  
New Mangalore Port Authority,  
Administration Building,  
Panambur, Mangalore – 575 010

Sir,

Sub: The work of “Construction of Cruise Terminal Gate at New Mangalore Port”

Being duly authorized to represent and act on behalf of .....  
(Hereinafter referred to as “the Bidder”) and having reviewed and fully understood all of the requirements of the bid document and information provided, the undersigned hereby apply for the project referred above.

We are submitting our Bid enclosing the following, with the details as per the requirements of the Bid Document, for your evaluation.

- i. Tender Document along with Addendum No -----
- ii. Power of Attorney - (Annexure - 2)
- iii. Organization Details - (Annexure - 3)
- iv. Details to fulfill the “Minimum Eligibility Criteria” and certificates - (Annexure 4)
- v. Average Financial turnover over the last three financial year - (Annexure 5)
- vi. List of ongoing works at NMPA-(Annexure-6)
- vii. List of plant and equipment – (Annexure - 7)
- viii. Declaration – (Annexure – 8)
- ix. Bid Security / EMD Paid by RTGS/NEFT vide UTR No.....dtd. .... of (name and address of the branch).
- x. Banker’s Details – Annexure 10 & 11
- xi. Tender fee paid by NEFT vide vide UTR No.....dtd. .... of (name and address of the branch).
- xii. Pre-Integrity pact agreement executed as per Appendix II
- xiii. Copy of valid ESI, PF & GST Registration certificate.

Signature  
(Authorised Signatory)

**Annexure – 2**

ON STAMP PAPER of Rs.100/-  
 “CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
 PORT”

-----

FORMAT OF POWER OF ATTORNEY (in original)

In favour of signatory/s to the Tender, duly authenticated by Notary Public.

POWER OF ATTORNEY IN FAVOUR OF -----  
 (Name, Designation, Company name)

TO ALL TO WHOM THESE PRESENTS shall come, I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors) do hereby sub-delegate/delegate, in terms of the powers delegated to me by the Board of Directors, ----- (name of the Co.) to Shri ----- (name, designation & address of the Attorney) the following:

NOW KNOW YE AND THOSE PRESENTS that I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors), do hereby authorize and empower Shri ----- (name, designation & address of the Attorney) to do severally amongst others, for the purpose of carrying on our business, the following:

- a) To represent lawfully the (name of the Co.) for obtaining bid/tender documents, prepare, sign, execute and submit tenders for execution of (Name of work) or any other works incidental to such construction works.
- b) To discuss the technical and financial matters, negotiate and accept prices and take decisions regarding terms and conditions and sign agreements and contracts and also to bind the (name of the Co.) to the arbitration clause included in the contract.
- c) For all or any of the purposes here of to sign and deliver or otherwise execute such deed or deeds, transfer or transfers, endorsement or endorsements and to perform such other acts, matters, things as the Attorney shall consider requisite or advisable as full and effectively as the Company could do, if present and acting there.

I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors) in terms of the powers delegated to me by the Board of Directors of (name of the Co.), do hereby agree that all acts, deeds and things done by the said Attorney by virtue of this power of attorney, shall be construed as acts, deeds and things done by the Company.

I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors), further undertake to ratify and confirm whatever our said attorney shall do or cause to be done for the Company, the said Company, in the premises, by virtue of the powers hereby given.

WHEREAS, this sub-delegation is signed and delivered to Shri ----- (name & designation of the Attorney), on this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_ (Two thousand \_\_\_\_\_).

WHEREAS, even though this sub-delegation is signed on this \_\_\_\_\_ day of \_\_\_\_\_ 20\_\_\_\_ (Two thousand \_\_\_\_\_ ), will have effect from the date he signs and receives this delegation.

IN WITNESS WHEREOF, I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors) has, this \_\_\_\_\_ day of \_\_\_\_\_ 20\_\_\_\_ (Two thousand \_\_\_\_\_) set my hands and subscribed my signature unto this instrument.

SIGNED AND DELIVERED ON

\_\_\_\_\_ BY

(Name of authorized person to delegate powers)

WITNESS:

SIGNED AND RECEIVED ON

\_\_\_\_\_ BY

(Name & designation of Attorney)

“CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
PORT”

--

**ORGANIZATION DETAILS**

CONTACT No.:

NAME OF APPLICANT:

1. Name of the Owner:
2. Address:  
Telephone No. :  
Fax No.
3. Description of Applicant  
(for e.g. General, Civil Engineering  
Contract or Joint Venture/Consortium etc.)
4. Registration and Classification of Contractors:
5. Name and address of bankers:
6. Number of years of experience as a general contractor:-  
In own Country:  
Internationally:
7. Number of years of experience as a sub-contractor:  
Name and Address of partners or associated companies to be involved in the  
project and whether Parent/Subsidiary/other:
8. Name and address of any associates knowledgeable in the procedures of  
customs, immigration and local experience in various aspect of the project  
etc.
9. Name and address of the companies / Sub-contractors who will be involved  
in the execution of works, namely:

Signature  
(Authorised Signatory)

NEW MANGALORE PORT AUTHORITY  
 "CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
 PORT"

Tenderer shall furnish Details of "eligibility works experience" as per Clause 12(a) of Minimum Eligible Criteria (MEC) of Instruction to Tenderer and certificates in the following format (Client Certificates/work completion certificates or any other documentary evidences with respect to the eligibility work)

ELIGIBLE ASSIGNMENT DETAILS FOR MEC

Assignment Number:

Description	Bidder to fill up the details here
Name and Address of the Client	
Title of the Eligible Assignment	
Date of completion of the Eligible Assignment	
Project Cost	
Reference No of the enclosed work order	
Reference No of the enclosed Client work Completion Certificate	
Reference No of any other documentary evidence; if enclosed.	
Name, telephone no, telefax no and email address of the client's representative	
Description and Scope of Work	

Instructions:

- i. Bidders are expected to provide information in respect of Eligible Assignments in this Section. The assignments cited must comply with the criteria specified Clause No. 12.0(a) Minimum eligibility of the "Instructions to Tenderers".
- ii. A separate sheet should be filled for each of the eligible assignments.
- iii. The details are to be supplemented by documentary proof (Work order and work completion certificate) from the respective client for having carried out such assignment duly certified by clients.

Signature  
(Authorised Signatory)

NEW MANGALORE PORT AUTHORITY  
 “CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
 PORT”  
 FINANCIAL CAPABILITY

(A) Net worth & Average Annual Turnover of the Bidder

Net Worth	Turnover			
Year 1	Year 1	Year 2	Year 3	Average

Instructions:

Net Worth = (Subscribed and Paid-up Equity + Reserves) - (Revaluation reserves + Miscellaneous expenditure not written off + depreciation not provided for). Year 1 will be the Financial Year 2020-21. Year 2 shall be the year immediately preceding Year 1 and Year 3 shall be the year immediately preceding Year 2. The Bidder shall provide audited Annual Reports as required under this Bid Document.

Net worth & Annual turnover of the bidder shall be submitted duly verified by Chartered Accountant or Competent Authority.

(B) (Here specify proposed sources of credit line to meet the Cash flow demand for the work)

Source of Credit line	Amount

There should be a letter from the Bank mentioning that line of credit offered is specifically for this work/contract.

NOTE: If the Tenderer intends to meet the “Cash Flow Demand” for the project through their internal resources without availing the loan of credit, a specific mention to be made to this effect and proof for such resources shall be enclosed.

Certified by C.A Signature  
 (Authorised Signatory)

NEW MANGALORE PORT AUTHORITY  
 "CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
 PORT"

LIST OF ONGOING WORKS IN HAND AT NMPA

The Tenderer shall furnish in the format given below details of works being carried out by him at the time of bidding in NMPA.

Sl. No.	Name of work	Work order No. and Date	Value of Work Order in Rs.	Average annual financial turnover as per MEC for the work

**Contractor**



NEW MANGALORE PORT AUTHORITY  
"CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
PORT"

DETAILS OF PROPOSED APPROACH & METHODOLOGY

Bidder shall furnish a detailed method statement (Technical Note) for carrying out of the works, along with a construction programme showing sequence of operation and the time frame for various segments of temporary and permanent works.

Signature

(Authorised Signatory)

NEW MANGALORE PORT AUTHORITY  
 "CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
 PORT"

-----

PLANT AND EQUIPMENT PROPOSED FOR THE WORK

Please indicate the main plant and equipment considered to be necessary for undertaking the work and whether this plant is ready in ownership or will be purchased or hired.

Description of equipment	Requirement no. / capacity	Owned / leased / to be procured	Nos / capacity	Age / condition	Remarks (from whom to be purchased)	At what stage of contract period the equipment will be available

Note: The equipment indicated in the above statement will form part of contract agreement and as such the bidders are requested to indicate the availability of the equipment at site and at what stage of the construction period in a separate column.

Signature  
(Authorised Signatory)

NEW MANGALORE PORT AUTHORITY  
"CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
PORT"  
DECLARATION

We M/s. (Name & address of the bidder) hereby declare that:-

- i. I have read the tender document Vol. I (Section I to III) Vol. II (Section IV and V) and Vol. III (Section V and VII) and agreed to the terms and conditions mentioned therein.
- ii. All details regarding construction plant, temporary work and personnel for site organization considered necessary and sufficient for the work have been furnished in the Annexures to Conditions of Contract in Volume I and that such plant, temporary works and personnel for site organization will be available at the site till the completion of the respective work.
- iii. No conditions are incorporated in the financial bid. In case any conditions are specified in the financial bid, the tender will be rejected summarily without making any further reference to the bidder.
- iv. We have not made any payment or illegal gratification to any persons/ authority connected with the bid process so as to influence the bid process and have not committed any offence under PC Act in connection with the bid.
- v. We shall undertake that, the Employer i.e. NMPA is indemnified against all damages or compensation payable at Law in respect of or in consequence of any accident or injury to any workman or other person in the employment of the Contractor or Sub-Contractor against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto and the Employer shall be at liberty to deduct or adjust from the Contactor's bills an amount that Employer may be called upon to pay towards claims, demands, proceedings, costs, charges and expenses Whatsoever in respect of or in relation to any accident or injury referred to above without any reference to the Contractor.

- vi. We shall comply with all the Central State and Municipal Laws and Rules and we shall be solely responsible for complying with the provisions of the Contract Labour (Regulations & Abolition) Act, 1970 & the contract labour (Regulation & Abolition) Karnataka Rules 1974 and rules there under and the enactments that may be applicable including ESI Act, the payment of wages act, Provident Fund Act, the Minimum Wages Act, the Factory's Act. The Workmen Compensation Act or any other applicable legislation and the Municipal by-laws or other statutory Rules and Regulations whatsoever in force if these are applicable. Any obligations finding or otherwise missed under any statutory enactments, rules & regulations there under shall be the responsibility of the Contractor and the NMPA will take no responsibility for the same. The Contractor should take Workmen's Compensation Policy for his Workers, who are not covered under ESI and submit the same to the EIC immediately after commencement of the work.
- vii. We undertake that, we are liable to pay all Statutory Compensation to the Labourers/persons engaged by him for the satisfactory execution of the works. If any claim is made against New Mangalore Port Authority on this work, the Port Authority shall have the right to deduct the same from the bill amount payable to the contractor after verification of the validity and if admissible as per rules
- viii. \*We disclose with that we have made / not made payments or propose to be made to any intermediaries (agents) etc., in connection with the bid.

\* Note: Delete whichever is not applicable.

Signature  
(Authorised Signatory)

## BID SECURITY (BANK GUARANTEE) (Not applicable to this Contract)

WHEREAS, \_\_\_\_\_ [Name of Bidder] (hereinafter called "the Bidder") has submitted his bid dated \_\_\_\_\_ [date] for the Construction of Cruise Terminal Gate at New Mangalore Port (hereinafter called "the Bid").

KNOW ALL PEOPLE by these presents that We \_\_\_\_\_ [name of bank] of \_\_\_\_\_ (name of country) having our registered office at \_\_\_\_\_ (hereinafter called "the Bank") are bound unto \_\_\_\_\_ [name of Employer] (hereinafter called "the Employer") in the sum of \_\_\_\_\_ i\* for which payment well and truly to be made to the said Employer the Bank binds itself, his successors and assigns by these presents.

SEALED with the Common Seal of the said Bank this \_\_\_\_\_ day of \_\_\_\_\_ 20 \_\_\_\_\_

THE CONDITIONS of these obligations are:

- (1) If after Bid opening the Bidder withdraws his Bid during the period of bid validity specified in the Form of Bid;
- or
- (2) If the Bidder having been notified of the acceptance of his Bid by the Employer during the period of bid validity:
    - (a) fails or refuses to execute the Form of Agreement in accordance with the Instructions to Bidders, if required; or
    - (b) fails or refuses to furnish the Performance Security, in accordance with the Instructions to Bidders, or
    - (c) does not accept the correction of the Bid Price pursuant to Clause 27;

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the Employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him owing to the occurrence of one or any of the three conditions, specifying the occurred condition or conditions.

This Guarantee will remain in force up to and including the date \_\_\_\_\_ ii\* days after the deadline for submission of Bids as such deadline is stated in the Instructions to Bidders or as it may be extended by the Employer, notice of which

extension(s) to the Bank is hereby waived. Any demand in respect of this Guarantee should reach the Bank not later than the above date.

Notwithstanding anything mentioned above,

Our liability against this guarantee is restricted to Rs ..... (Rupees ..... only) and unless a claim in writing is lodged with us within 3 months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharges.

IN WITNESS WHEREOF this guarantee has been duly executed on this ..... day of ..... 20 .....

DATE\_\_\_\_\_ SIGNATURE OF THE BANK\_\_\_\_\_

WITNESS\_\_\_\_\_SEAL\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

[Signature, name and address]

\_\_\_\_\_

\_\_\_\_\_

i \*The Bidder should insert the amount of the guarantee in words and figures denominated in Indian Rupees. This figure should be the same as shown in Clause 16 of the Instructions to Bidders.

ii \*30 days after the end of the validity period of the Bid. Date should be inserted by the Employer before the Bidding documents are issued.

**Annexure-10**

## DETAILS OF THE PARTY OPTING FOR REFUND OF EMD THROUGH E-PAYMENT SYSTEM FROM NEW MANGALORE PORT Authority

Name of the Party :

Bank A/c No :

Account type : (Savings / Current / Overdraft)

Bank Name :

Branch :

IFSC Code Number : (11 digit code)

Centre (Location) :

FAX No. :

E-Mail ID : (For forwarding information of remittance)

Mobile No :

Signature of the Party

**Annexure-11**

## FORMAT FOR FURNISHING BANK INFORMATION FOR e-PAYMENT

1	Name and full address of the beneficiary	
2	Credit Account No. (Should be full 14 digit)	
3	Account Type (SB or CA or OD)	
4	Name of the Bank	
5	Branch (Full address with telephone No.)	
6	IFSC Code Number (11 digit)	
7	MICR code (Should be 9 digit)	
8	Telephone/Mobile/Fax No. of the beneficiary	Telephone:
		Mobile :
		Fax :
9	Photostat copy of a Cheque	

Signature of the party with seal

Verified the details furnished by the party and it is ascertained that the information furnished are in full shape as required. Xerox copy of a Cheque is also enclosed.

Signature of the HOD/HOO with seal



**INDEMNITY BOND**

(To be furnished in Stamp paper not less than Rs.100 e-Stamp paper)

This deed of indemnity is executed by ..... herein after referred to as 'Indemnifier' which expression shall unless repugnant to the context or meaning thereof, include its successors, Administrator, representatives and assignees in favour of New Mangalore Port Authority, Panambur, Mangalore 575010, herein after referred to as 'Indemnified' which expression shall unless repugnant to the context or meaning thereof include its representatives and assignees witnesses as to.

Whereas the indemnified herein as awarded to the indemnifier herein a Tender/Contract or for ..... on terms and conditions set out interalia in the work order No..... valued at Rs.....

AND Whereas, the clauses No..... of the above mentioned work order provides for indemnifying the indemnified by the indemnifier for any accident, damage or compensation payable to any workmen or other person in the employment of the contractor or any sub-contractor during the period of tender/contract.

AND Whereas, the Indemnifier hereby irrevocably agrees to indemnify the indemnified against all damages or compensation payable at law in respect of or in consequence of any accident or injury to any workmen or other person in the employment of the contractor or sub-contractor against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto and the indemnified shall be at liberty to deduct or adjust from the bills payable to the indemnifier by the indemnified for an amount that the indemnified may be called upon to pay towards claims, demands, proceedings, costs, charges and expenses whatsoever in respect of or in relation to any accident or injury referred to above without any reference to the indemnifier.

The Indemnifier shall comply with all the Central State and Muncipal Laws and Rules and shall be solely responsible for complying with the provisions of the Contract Labour (Regulations & Abolition) Act, 1970 & the contract

labour (Regulation & Abolition) Karnataka Rules 1974 and rules there under and the enactments that may be applicable including ESI Act, the payment of wages act, Provident Fund Act, the Minimum Wages Act, the Factory's Act, the Workmen Compensation Act or any other applicable legislation and the Municipal by-laws or other statutory Rules and Regulations whatsoever in force if these are applicable. Any obligations finding or otherwise missed under any statutory enactments rules & regulations there under shall be the responsibility of the Indemnifier and the Indemnified will have no responsibility for the same. The Indemnifier shall obtain Workmen's Compensation Policy for his workers, who are not covered under ESI and submit the same to the ESIC immediately after commencement of the work.

The Indemnifier is liable to pay all Statutory Compensation to the Labourers / persons engaged by him for the satisfactory execution of the works. If any claim is made against Indemnified arising out of this work, the Port shall have the right to deduct the same from the bill amount payable to the Indemnifier after verification of the validity and if admissible as per rules.

The Indemnifier shall ensure the use of PPE such as helmets, safety shoes, nose masks, hand gloves, safety harness or any other equipment as required depending on nature of work by his staff at site.

In addition to complying of the above, the Indemnifier hereby undertakes to indemnify the indemnified against any unforeseen incidents / accidents, which may lead to fatality including death, permanent/ partial disablement, injury, financial loss, legal issues or any other etc of the labourers / workmen's/ staffs of the contractor / sub-contractor for which the indemnified and its officers / representation are in no way responsible.

For.....

INDEMINIFIER

(Signature with Name and  
Designation)

Company Seal

Station:

Date:

**Annexure-13**

Format for Self Certification under Preference to "MAKE IN INDIA" Policy  
(Refer Clause No. 38 of ITT)

**CERTIFICATE**

In line with Government Public Procurement Order No. P-45021/2/2017-PP(B-II) dtd. 16-09-2020, as amended from time to time and as applicable on the date of submission of tender, we hereby certify that we M/s\_\_\_\_\_ (name of the Bidder) are local supplier meeting the requirement of minimum Local content (50%) as defined in above orders for the material against Tender NIT No\_\_\_\_\_ for the work \_\_\_\_\_ of \_\_\_\_\_

\_\_\_\_\_

Details of location at which local value addition will be made is as follows:

-----  
-----

We also understand, false declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rule for which for which a bidder or its successors can be debarred for up two years as per Rule 151 (iii) of the General Financial Rules along with such other actions as may be permissible under law. Seal and Signature of Authorized Signatory

Signature of the Bidder

Date :

Place :

## SECTION - II

## iii) FORM OF AGREEMENT

THIS AGREEMENT made the \_\_\_\_\_ day of \_\_\_\_\_  
 20\_\_ BETWEEN New Mangalore Port Authority (hereinafter called "the Employer")  
 of the one part and \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

(hereinafter called "the Contractor") of the other part WHEREAS the Employer is desirous that certain works should be executed by the Contractor, Viz----- and has accepted a Tender by the Contractor for the execution and Completion of such works and the remedying of any defects therein at a contract price of Rs .....

NOW THIS AGREEMENT WITNESSETH as follows:

- 1 In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the General Conditions hereinafter referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.-
  - a) The Letter of Acceptance;
  - b) The Said Tender (Technical Bid);
  - c) The Conditions of Contract (Parts I and II)
  - d) The Specifications;
  - e) The Drawings;
  - f) The Bill of Quantities and
  - g) The Addenda
  - h) Letters exchanged between the Employer and the Tenderer up to the issue of Letter of Acceptance as separately listed and annexed here to.
3. 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 respect with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the works and the remedying of defects therein the Contract Price or and such other sum as may become payable under the Provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed the day and year first above written in accordance with their respective laws.

This document contains ..... pages in all. This agreement is assigned No. CEA ..... /20XX-XX.

The Common Seal of

\_\_\_\_\_  
\_\_\_\_\_

was hereunto affixed in the presence of :

**SECTION - III****iv) CONDITIONS OF CONTRACT****A. General****1. Definitions**

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

Bill of Quantities means the priced and completed Bill of Quantities forming part of the Bid.

Compensation Events are those defined in Clause 44.

The Completion Date is the date of completion of the Works as certified by the Engineer or his nominee in accordance with Sub Clause 54

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 2.3 below.

The Contract Data defines the documents and other information which comprise the Contract.

The Contractor is a person or corporate body whose Bid to carry out the Works has been accepted by the Employer.

The Contractor's Bid is the completed Bidding documents 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 Engineer or his nominee by issuing an extension of time.

Materials are all supplies, including consumables, used by the contractor for incorporation in the Works.

The Engineer or his nominee is the person named in the Contract Data (or any other competent person appointed and notified to the contractor to act in replacement of the Engineer or his nominee) who is responsible for supervising the Contractor, administering the Contract, certifying payments due to the Contractor, issuing and valuing Variations to the Contract, awarding extensions of time and valuing the Compensation Events.

Plant is any integral part of the Works which is to have mechanical, electrical, electronic or chemical or biological function.

The Site is the area defined as such in the Contract Data.

Site Investigation Reports are those which are included in the Bidding

documents and are factual interpretative reports about the surface and sub-surface conditions at the site.

Specification means the Specification of the Works included in the Contract and any modification or addition made or approved by the Engineer or his nominee.

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 Date.

A Subcontractor is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract which includes work on the Site.

Temporary Works are works designed, constructed, installed and removed by the Contractor which are needed for construction or installation of the Works.

A Variation is an instruction given by the Engineer or his nominee 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.

The Trained Work Person are those employed / proposed to be employed by the Contractor at the Project Site, who have participated and are in possession of a valid Competency Certificate through a programme run under the auspices of a University, State Technical Board, Ministry of Government of India.

## **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 Engineer or his nominee will provide instructions clarifying queries about the Conditions of Contract.



2.2 If sectional completion is specified in the Contract Data, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion date for the whole of the Works).

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

- (1) Agreement
- (2) Letter of Acceptance and notice to proceed with works
- (3) Contractor's Bid
- (4) Contract Data
- (5) Conditions of Contract including Special Conditions of Contract
- (6) Specifications
- (7) Drawings
- (8) Bill of quantities and
- (9) any other documents listed in the Contract Data as forming part of the Contract.

### **3. Language and Law**

3.1 The language of the Contract and the law governing the Contract are stated in the Contract Data.

### **4. Engineer or his nominee's Decisions**

4.1 Except where otherwise specifically stated, the Engineer or his nominee will decide contractual matters between the Employer and the Contractor in the role representing the Employer.

### **5. Delegation**

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

## 6. Communications

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 1872).

## 7. Contract Agreement

A suitable form is annexed as "FORM OF AGREEMENT" to the Contract Document. Upon signing the Contract Agreement, the Contractor shall make 20 copies of Contract Documents in hardbound cover which shall cover documents used in Contract/Agreement and provide the same to the Employer at no extra cost.

Data made available by the Employer in accordance with provisions of the Condition of Contract shall be deemed to include data listed elsewhere in the Contract and open for inspection at the office of the Deputy Chief Engineer (Civil) of the New Mangalore Port Authority (by prior appointment with the Engineer). **Within 21 days of receipt of Letter of Acceptance, the successful bidder shall furnish the performance security and sign the Agreement with the Employer. However No work shall be commenced before signing of contract Agreement.**

## 8. Subcontracting

8.1 The Contractor may subcontract with the approval of the Engineer or his nominee but may not assign the Contract without the approval of the Employer in writing. Subcontracting does not alter the Contractor's obligations.

### Other Contractors

8.2 The Contractor shall co-operate and share the site with other contractors, public authorities, utilities, and the Employer between the dates given in the Schedule of other contractors. The Contractor shall as referred to in the Contract Data, also provide facilities and services for them as described in the Schedule. The employer may modify the schedule of other contractors and shall notify the contractor of any such modification.

## 9. Personnel

9.1 The Contractor shall employ the key personnel named in the Schedule of Key Personnel as referred to in the Contract Data to carry out the functions stated in the Schedule or other personnel approved by the Engineer or his nominee. The Engineer or his nominee will approve

any proposed replacement of key personnel only if their qualifications, abilities, and relevant experience are substantially equal to or better than those of the personnel listed in the schedule.

- 9.2 If the Engineer or his nominee asks the contractor to remove a person who is a member of the contractor's staff of his work force stating the reasons, the contractor shall ensure that the person leaves the site within seven days and has no further connections 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 Employers risks are
- (a) in so far as they directly affect the execution of the Works in the country where the Permanent Works are to be executed:
- i) war and hostilities (whether war be declared or not), invasion, act of foreign enemies;
  - ii) rebellion, revolution, insurrection, or military or usurped power, or civil war;
  - iii) ionizing radiations, or contamination by radioactivity from any nuclear fuel, or from any nuclear waste, from the combustion of nuclear fuel, radioactive toxic explosive or other hazardous properties of any explosive nuclear assembly or nuclear component thereof;
  - iv) pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds; and
  - v) riot, commotion or disorder, unless solely restricted to the employees of the Contractor or of his Subcontractors and arising from the conduct of the Works;
  - vi) Unforeseen Rains (Rains if any; during the period other than the Monsoon period as stated in the Tender), floods, tornadoes, earthquakes and landslides.

- b) loss or damage due to the use or occupation by the Employer of any Section or part of the Permanent Works, except as may be provided for in the Contract;
- c) loss or damage to the extent that it is due to the design of the Works, other than any part of the design provided by the Contractor or for which the Contractor is responsible; and
- d) any operation of the forces of nature (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.

## **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 provide in the joint names of the Employer and the Contractor, insurance cover from the Start Date to the end of the Defects Liability Period, in the amounts and deductibles stated in the Contract Data for the following events which are due to the Contractors risks.
- a) loss of or damage to the Works, Plant and Materials
  - b) loss of or damage to Equipment;
  - c) loss of or damage of property (except the Works, Plant, Materials and Equipment) in connection with the Contract; and
  - d) personal injury or death.
- 13.2 Policies and certificates for insurance shall be delivered by the contractor to the Engineer or his nominee for the Engineer or his nominee's approval before the start date. All such insurances shall provide for compensation to be payable in the types and proportions

of currencies required to rectify the loss or damage incurred.

- 13.3 If the contractor does not provide any of the policies and certificates required, the Employer may affect the insurance which the contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the contractor or, if no payment is due, the payment of the premiums shall be a debt due.
- 13.4 Alterations to the terms of insurance shall not be made without the approval of the Engineer or his nominee.
- 13.5 Both parties shall comply with all conditions of the insurance policies.

#### **14. Site Investigation Reports**

The Contractor, in preparing the Bid, shall rely on the Site Investigation Report referred to in the Contract Data, supplemented by any information available to the Bidder.

#### **15. Queries about the Contract Data**

The Engineer or his nominee will clarify queries on the Contract Data.

#### **16. Contractor to Construct the Works**

The Contractor shall construct and install the works in accordance with the Specification and Drawings.

#### **17. The Works to Be Completed by the Intended Completion Date**

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 Engineer or his nominee, and complete them by the Intended Completion Date.

#### **18. Approval by the Engineer or his nominee**

- 18.1 The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Engineer or his nominee, who is to approve them if they comply with the specifications and Drawings.
- 18.2 The Contractor shall be responsible for design of Temporary Works.
- 18.3 The Engineer or his nominee's Approval shall not alter the contractor's responsibility for design of the Temporary Works.
- 18.4 All Drawings prepared by the contractor for the execution of the

temporary or permanent Works, are subject to prior approval by the Engineer or his nominee before their use.

#### **19. Safety**

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

#### **20. Discoveries**

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 Engineer or his nominee of such discoveries and carry out the Engineer or his nominee's instructions for dealing with them.

#### **21. Possession of the Site**

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

#### **22. Access to the Site**

The Contractor shall allow the Engineer or his nominee and any person authorized by the Engineer or his nominee 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 and/or assembled for the works.

#### **23. Instructions**

The Contractor shall carry out all instructions of the Engineer or his nominee which comply with the applicable laws where the Site is located.

#### **24. Disputes**

If the Contractor believes that a decision taken by the Engineer or his nominee was either outside the authority given to the Engineer or his nominee by the Contract or that the decision was wrongly taken, the decision shall be referred to the Dispute Review Board (DRB) within 28 days of the notification of the Engineer or his nominee's decision.

## 25. Settlement of Disputes

25.1 If a dispute of any kind whatsoever arises between the Employer and the Contractor in connection with, or arising out of the Contract or the execution of the Works, whether during the execution of the Works or after their completion and whether before or after repudiation or after termination of the Contract, including any disagreement by either party with any action, inaction, opinion, instruction, determination, certificate or valuation of the Engineer or his nominee, the matter in dispute shall, in the first place be referred to the Disputes Review Board [DRB] established pursuant to Appendix 1 hereto.

Unless the Contract has already been repudiated or terminated or frustrated the Contractor shall in every case, continue to proceed with the Works with all due diligence and the Contractor and the Employer shall give effect forthwith to every decision of the Engineer or his nominee unless and until the same shall be revised, as hereinafter provided, in a Dispute Review Board Recommendation / Arbitral Award.

### 25.2 Arbitration

Any dispute in respect of in respect of contracts where party is dissatisfied by the Dispute Review Board's (DRB) decision shall be decided by arbitration as set forth below:

- i) A dispute with contractor shall be finally settled by arbitration in accordance with the Indian Arbitration and Conciliation Act, 1996, or any statutory amendment thereof. The arbitral tribunal shall consist of 3 arbitrators, one each to be appointed by the Employer and the contractor, and the third to be appointed by the mutual consent of both the arbitrators, failing which by making a reference to CIDC-SIAC Arbitration Center from their panel.
- ii) Neither party shall be limited in the proceedings before such arbitrators to the evidence or arguments already put before the Engineer or his nominee or the Board, as the case may be, for the purpose of obtaining said recommendations/decision. No such recommendations/decision shall disqualify the Engineer or his nominee or any of the members of the Board, as the case may be,

from being called as a witness and giving evidence before the arbitrators or any matter whatsoever relevant to the dispute.

- iii) The reference to arbitration shall proceed notwithstanding that the works shall not then be or be alleged to be complete, provided always that the obligations of the Employer, the Engineer or his nominee and the Contractor shall not be altered by reason of the arbitration being conducted during the progress of the works. Neither party shall be entitled to suspend the works to which the dispute relates, and payment to the Contractor shall be continued to be made as provided by the contract.
- iv) If one of the parties fails to appoint its arbitrators in pursuance of sub-clause [i], within 14 days after receipt of the notice of the appointment of its arbitrator by the other party, then President/Chairman of the nominated Institution shall appoint arbitrator within 14 days of the receipt of the request by the nominated institution. A certified copy of the President's/ Chairman's order, making such an appointment shall be furnished to both the parties.
- v) Arbitration proceedings shall be held at Mangalore, and the language of the arbitration proceedings and that of all documents and communications between the parties shall be 'English
- vi) The Arbitration shall be conducted by the experts from the panel of CIDCSIAC Arbitration Center.
- vii) The decision of the majority of arbitrators shall be final and binding upon both parties. The expenses of the arbitrators as determined by the arbitrators shall be shared equally by the Employer and the Contractor. However, the expenses incurred by each party in connection with the preparation, presentation, etc. of its case prior to, during and after the arbitration proceedings shall be borne by each party itself.
- viii) All arbitration awards shall be in writing and shall state the reasons for the award.
- ix) Performance under the contract shall continue during the arbitration proceedings and payments due to the contractor by the Employer shall not be withheld, unless they are subject matter of the arbitration



proceedings.

**26. Replacement of Conciliator (Deleted)**

**B. TIME CONTROL****27. Program**

- 27.1 Within the time stated in the Contract Data the Contractor shall submit to the Engineer or his nominee for approval a Program showing the general methods, arrangements, order, and timing for all the activities in the works along with monthly cash flow forecast.
- 27.2 An update of the Program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work including any changes to the sequence of the activities.
- 27.3 The Contractor shall submit to the Engineer on the first day of each week or such longer period as the Engineer may from time to time direct, a progress report in an approved form showing up-to-date total progress, progress achieved against planned progress, during the previous week and progress forecast for the following week for all important items in each section or portion of the Works, in relation with the approved Program.
- 27.4 The Contractor shall submit to the Engineer or his nominee, for approval an updated Program at intervals no longer than the period stated in the Contract Data. If the Contractor does not submit an updated Program within this period, the Engineer or his nominee may withhold the amount stated in the Contract Data from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Program has been submitted.

**28. Revised Program**

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

**29. Extension of the Intended Completion Date**

- 29.1 The Engineer or his nominee 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 without the Contractor taking steps to accelerate the remaining work and which would cause the Contractor to incur additional cost.

- 29.2 The Engineer or his nominee shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Engineer or his nominee for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.

### **30. Delays Ordered by the Engineer or his nominee**

The Engineer or his nominee may instruct the Contractor to delay the start or progress of any activity within the Works.

### **31. Management Meetings**

- 31.1 Either the Engineer or his nominee or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.
- 31.2 The Engineer or his nominee shall record the business of management meetings and is to provide copies of his record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken is to be decided by the Engineer or his nominee either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.

### **32. Early Warning**

- 32.1 The Contractor is to warn the Engineer or his nominee at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price or delay the execution of works. The Engineer or his nominee may require the Contractor to provide an estimate of the expected effect of the event or circumstance on the Contract Price and Completion Date. The estimate is to be provided by the Contractor

as soon as reasonably possible.

- 32.2 The Contractor shall cooperate with the Engineer or his nominee in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Engineer or his nominee.

## C. QUALITY CONTROL

### 33. Identify Defects

The Engineer or his nominee 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 Engineer or his nominee may instruct the Contractor to search for a Defect and to uncover and test any work that the Engineer or his nominee considers may have a Defect.

### 34. Tests

If the Engineer or his nominee 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.

### 35. Defect Liability

35.1 The Engineer or his nominee 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.

35.2 Every time notice of a Defect is given, the Contractor shall correct the notified defect within the length of time specified by the Engineer or his nominee's notice. To the intent that the works shall, at or as soon as practicable after the expiration of the Defects Liability Period, be delivered to the Employer in the condition required by the Contract, fair wear and tear excepted, to the satisfaction of the Engineer, the Contractor shall :

- (a) Complete the work, if any, outstanding on the date stated in the Taking-Over Certificate within the date to be intimated by the engineer and
- (b) execute all such work of amendment, reconstruction, and remedying defects, shrinkages or other faults as the Engineer may, during the Defects Liability Period or within 14 days after its expiration, as a result of an inspection made by or on behalf of the Engineer prior to its expiration, instruct the Contractor

to execute.

### 35.3 Cost of Remedying Defects

All work referred to in Sub-Clause 35.2 shall be executed by the contractor at his own cost if the necessity thereof is, in the opinion of the Engineer, due to:

- a) The use of materials, Plant or workmanship not in accordance with the Contract, or
- b) Where the Contractor is responsible for the design of part of the Permanent Works, any fault in such design, or the neglect or failure on the part of the Contractor to comply with any obligation, expressed or implied, on the Contractor's part under the Contract.

### 35.4 Defects Liability Certificate

The Contract shall not be considered as completed until a Defects Liability Certificate shall have been signed by the Engineer and delivered to the Employer, with a copy to the Contractor, stating the date on which the Contractor shall have completed his obligations to execute and complete the Works and remedy any defects therein to the Engineer's satisfaction. The Defects Liability Certificate shall be given by the Engineer within 28 days after the expiration of the Defects Liability Period, or, if different defects liability periods shall become applicable to different Sections or parts of the Permanent Works, the expiration of the latest such period, or as soon thereafter as any works instructed, pursuant to Clauses 35, have been completed to the satisfaction of the Engineer.

### 35.5 Unfulfilled Obligations

Notwithstanding the issue of the Defects Liability Certificate the Contractor and the Employer shall remain liable for the fulfillment of any obligation incurred under the provisions of the Contract prior to the issue of the Defects Liability Certificate which remains unperformed at the time such Defects Liability Certificate is issued and, for the purposes of determining the nature and extent of any such obligation, the Contract shall be deemed to remain in force between the parties to the Contract.

## **36. Uncorrected Defects.**

If the Contractor has not corrected a Defect within the time specified

in the Engineer or his nominee's notice the Engineer or his nominee will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

**D. COST CONTROL****37. Bill of Quantities**

37.1 The Bill of Quantities shall contain items for the construction, supply, installation, testing and commissioning work to be done by the Contractor.

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

**38. Changes in the Quantities**

38.1 If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than +25 % provided the change exceeds +10% of initial Contract Price, the Engineer or his nominee shall adjust the rate(s), to allow for the change.

38.2 The Engineer or his nominee shall not adjust rates from changes in quantities if thereby the Initial Contract Price is exceeded by more than 15 percent except with the Prior approval of the Employer.

38.3 If requested by the Engineer or his nominee where the quoted rate(s) of any item(s) is abnormally high, the Contractor shall provide the Engineer or his nominee with a detailed cost breakdown of such rate in the Bill of Quantities.

**39. Variations**

39.1 The Engineer shall make any variation of the form, quality or quantity of the Works or any part thereof that may, in his opinion, be necessary and for that purpose, or if for any other reason it shall, in his opinion, be appropriate, he shall have the authority to instruct the Contractor to do and the Contractor shall do any of the following:

- a) increase or decrease the quantity of any work included in the Contract,
- b) omit any such work,
- c) change the character or quality or kind of any such work,
- d) change the levels, lines, position and dimension of any part of the Works,
- e) execute additional work of any kind necessary for the completion of



the Works,

- f) change any specified sequence or timing of construction of any part of the Works.

No such variation shall in any way vitiate or invalidate the Contract, by the effect, if any, of all such variations shall be valued in accordance with Clause 40. Provided that where the issue of an instruction to vary the works is necessitated by some default of or breach of contract by the contractor or for which he is responsible, any additional cost attributable to such default shall be borne by the contractor. All Variations shall be included in updated Programs produced by the contractor.

#### 39.2 Instructions for Variations

The Contractor shall not make any such variation without an instruction of the Engineer. Provided that no instruction shall be required for increase or decrease in the quantity of any work where such increase or decrease is not the result of an instruction given under this clause, but is the result of the quantities exceeding or being less than those stated in the Bill of Quantities.

### **40. Payments for Variations**

- 40.1 Variation permitted shall not exceed +25% in quantity of each individual item, and +10% of the total contract price. Within 14 days of the date of instruction for executing varied work, extra work or substitution, and before the commencement of such work, notice shall be given either (a) by the contractor to the Employer of his intention to claim extra payment or a varied rate or price, or (b) by the Employer to the contractor of his intention to vary rate or price.

- 40.2 For items not existing in the Bill of Quantities or substitution to items in the Bill of Quantities, rate payable should be determined by methods given below and in the order given below:

- i) Rates and prices in Contract, if applicable plus escalation as per contract.
- ii) Rates and prices in the Schedule of Rates applicable to the Contract plus ruling percentage.
- iii) Market rates of materials and labor, hire charges of plant and machinery used, plus 10% for overheads and profits of

contractor.

40.3 For items in the Bill of Quantities but where quantities have increased beyond the variation limits, the rate payable for quantity in excess of the quantity in the Bill of Quantity plus the permissible variation should be:

- i) Rates and prices in contract, if reasonable plus escalation, failing which (ii) and (iii) below will apply
- ii) Rates and prices in the schedule of Rates applicable to the contract plus ruling percentage.
- iii) Market rates of material and labor, hire charges of plant and machinery used plus 10% for overheads and profits of contractor.

40.4 If there is delay in the Employer and the Contractor coming to an agreement on the rate of an extra item, rates as proposed by the Employer shall be payable provisionally till such time as the rates are finally determined or till date mutually agreed.

40.5 If the Engineer or his nominee decides that the urgency of varying the work prevent a quotation being given and considers not delaying the work, no quotation shall be given and the Variation shall be treated as a Compensation Event.

#### **41. Cash flow forecasts**

41.1 When the Program is updated, the contractor is to provide the Engineer or his nominee with an updated cash flow forecast.

#### **42. Payment Certificates**

42.1 The Contractor shall submit to the Engineer or his nominee monthly statements of the estimated value of the work completed less the cumulative amount certified previously.

42.2 The Engineer or his nominee shall check the Contractors' monthly statement within 14 days and certify the amount to be paid to the Contractor after taking into account any credit or debit for the month in question in respect of materials for the works in the relevant amounts and under conditions set forth in sub-clause 51.6 of the Contract Data (Secured Advance).

42.3 The value of work executed shall be determined by the Engineer or his nominee.

- 42.4 The value of work executed shall comprise the value of the quantities of the items in the Bill of quantities completed.
- 42.5 The value of work executed shall include the valuation of variations and Compensation Events.
- 42.6 The Engineer or his nominee may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.

### **43. Payments**

- 43.1 Bills /Tax invoice shall be prepared and submitted by the Contractor. Joint measurements shall be taken continuously and need not be connected with billing stage. System of 4 copies of measurements, one each for Contractor, Employer and Engineer or his nominee, and signed by both Contractor and Employer shall be followed.
- 43.2 75% of bill amount shall be paid within 14 days of submission of the bill. Balance amount of the verified bill shall be paid within 28 days of the submission of the bill.
- 43.3 Contractor shall submit final Bill within 60 days of issue of defects liability certificate. Client's Engineer or his nominee shall check the bill within 60 days after its receipt and return the bill to Contractor for corrections, if any. 50% of undisputed amount shall be paid to the Contractor at the stage of returning the bill.
- 43.4 The contractor should re-submit the bill, with corrections within 30 days of its return by the Engineer or his nominee. The re-submitted bill shall be checked and paid within 60 days of its receipt.
- 43.5 If an amount certified is increased in a later certificate as a result of an award by the DRB or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.
- 43.6 Items of the 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.

### **44. Compensation Events**

- 44.1 The following mutually agreed Compensation Events unless they are

caused by the Contractor would be applicable:

- (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 modifies the schedule of other contractors in a way which affects the work of the contractor under the contract.
- (c) The Engineer or his nominee orders a delay or does not issue drawings, specifications or instructions required for execution of works on time.
- (d) The Engineer or his nominee instructs the Contractor to uncover or to carry out additional tests upon work which is then found to have no Defects.
- (e) The Engineer or his nominee unreasonably does not approve for a subcontract to be let.
- (f) Ground conditions are substantially more adverse than could reasonably have been assumed before issuance of Letter of Acceptance from the information issued to Bidders (including the Site Investigation Reports), from information available publicly and from a visual inspection of the site.
- (g) The Engineer or his nominee gives an instruction for dealing with an unforeseen condition, caused by the Employer, or additional work required for safety or other reasons.
- (h) Other contractors, public authorities, utilities or the Employer does not work within the dates and other constraints stated in the Contract that cause delay or extra cost to the Contractor.
- (i) The effect on the Contractor of any of the Employer's Risks.
- (j) Other Compensation Events listed in the Contract Data or mentioned in the contract.

Whenever any compensation event occurs, the contractor will notify the employer, within 14 days and provide a forecast cost of the compensation event.

44.2 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 shall be extended. The Engineer or his nominee

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.

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

#### **45. Tax**

- 45.1 The rates quoted by the Contractor to be inclusive of Taxes if any excluding GST 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 sources as per applicable law. Any new Taxes, levies, duties imposed after signing the Contract shall be reimbursed by the employer on production of documentary evidence.

The GST shall be quoted separately in tax invoice.

The Contractor shall file the applicable returns with tax department in time and submit the same as documentary evidence.

#### **46. Currencies**

- 46.1 All payments shall be made in Indian Rupees unless specifically mentioned.

#### **47. Price Adjustment. (Not Applicable)**

- 47.1 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 formula given below:

- (a) The price adjustment shall apply for the work done from the start date given in the contract data up to end of the initial intended completion date or extensions granted by the Engineer or his nominee and shall not apply to the work

carried beyond the stipulated time for reason attributable to the contractor.

- (b) The price adjustment shall be determined during each quarter from the mutually agreed formula given in the contract data based on the following premises.

I (A) Formula for Labour Component

V1	=	0.85	x	(R-C)	x	K1	x	I - IO
						100		IO

Where V1 = Amount of variation payable for a value R of work done.

R = Value of work done during the period under consideration.

C = Cost of Cement & steel calculated on star rates for quantity as per design, incorporated in to the work during the period under consideration to be taken from II A and II B.

K1 = Percentage of Labour Component to be taken as 25%.

IO = Basic Consumer Price Index for Bangalore Centre (Base 2001 = 100) for industrial workers declared as per the Labour Bureau, Ministry of Labour & Employment, Government of India as prevailing on the Base Date (28 days prior to the latest date for submission of the Bid).

I = Average Consumer Price Index for Bangalore Centre (Base 2001 = 100) for industrial workers declared by the Labour Bureau, Ministry of Labour & Employment, Government of India for the period in which the value R of work is done. If the period covered by a bill does not coincide with a calendar month, then weighted time average for the period will be taken for I.

I (B) Formula for Balance Material Component (excluding cement, steel).

V2	=	0.85	x	(R-C)	x	K2	x	M - MO
						100		MO

Where V2 = Amount of variation payable for a value R of work done on account of material.

R = Value of work done during the period under consideration.

C = Cost of Cement and steel at Star rate calculated on star rates for quantity as per design, incorporated in to the work during the period under consideration to be taken from II A and II B.

K2 = Percentage of Material Component to be taken as 70%.

M0= Wholesale price index for all commodities prepared by the office of Economic Advisor, Ministry of Industry, Government of India as prevailing on the Base Date (28 days prior to the latest date for submission of the Bid).

M = Average wholesale price index for all commodities prepared by the office of Economic Advisor, Ministry of Industry, Government of India, during the period under consideration. If the period covered by a bill does not coincide with a calendar month, then weighted time average for the period will be taken for M.

I (C) Formula for Petrol, Oil and Lubricant (POL) Component

$$V3 = 0.85 \times (R-C) \times \frac{K3}{100} \times \frac{P - PO}{PO}$$

Where V3 = Amount of variation payable for a value R of work done on account of POL component.

R= Value of work done during the period under consideration.

C =Cost of Cement & steel calculated on star rates for quantity as per design/specification, incorporated in to the work during the period under consideration to be taken from II A and II B .

K3 = Percentage of POL Component to be taken as 5%.

PO=The price (average of the prices declared by IOC/HPCL/BPCL) of HSD for Mangalore on the Base Date (28 days prior to the latest date for submission of the Bid).

P = Average Price (average of the prices declared by IOC/HPCL/BPCL) of HSD-RSP (Rs/litre) for Mangalore during the period under consideration.

After removal of actual cost of cement & steel for B above, price adjustment for the cost of cement and steel will be made as follows:

Price Adjustment

(II) (A) For Cement

$$Pc = Rc \times Qcc \times \frac{Ic - IOc}{IOc}$$

Where Pc = Price adjustment for cement

R c= Rate per MT of cement prevailing on the Base Date (28 days prior to the latest date for submission of the Bid) i.e. Star Rate.

Ic = Average Index for cement published by the Reserve Bank of India

(source: office of the economic advisor, Ministry of commerce & Industry Government of India) under "Index numbers of Wholesale Prices by Group and Sub-Groups (Monthly data) under Group (1) – Non Metallic Mineral Products Sub-Group (C) – Cement and Lime, " or Monthly whole sale price index published by the office of economic advisor, government of India under cement & Lime forming the base forming the base of calculation for index of wholesale prices during the period under consideration.

loc = Index for cement published by the Reserve Bank of India (source: office of the economic advisor, Ministry of commerce & Industry Government of India) under Index numbers of Wholesale Prices by Group and Sub-Group (Monthly data) under Group (1) – Non Metallic Mineral Products Sub-Group (C) – Cement & Lime or Monthly whole sale price index published by the office of economic advisor, government of India under cement & Lime forming the base of calculation for index of wholesale prices on the date 28 days preceding the latest date prescribed for the receipt of the Bid.

Qcc= Quantity in MT of cement as per design incorporated in to the work during the period under consideration.

II (B) For Steel

Ps	=	Rs	x	Qsc	x	Is - I0s
						I0s

Where Ps = Price adjustment for steel

Rs= Rate per MT of steel prevailing on the Base Date (28 days prior to the latest date for submission of the Bid). i.e. Star rate.

Is = Average Index for iron and steel published by the Reserve Bank of India (source: office of the economic advisor, Ministry of commerce & Industry Government of India) under "Index numbers of Wholesale Prices by Group and Sub-Groups (Monthly data) under Group (J) – Basic Metals, Alloys & Metal Products, Sub-Group (a) Ferrous metals – (a1) Iron & Semis" or Monthly whole sale price index published by the office of economic advisor, government of India under Iron & Semis forming the base of calculation for index of wholesale prices during the period under consideration.

a. Ios = Average Index for Iron and Steel published by the Reserve Bank of India (source: office of the economic advisor, Ministry of commerce & Industry Government of India) under "Index numbers of Wholesale Prices



by Group and Sub-Groups (Monthly data) under Group (J) – Basic Metals, Alloys & Metal Products, Sub-Group (a) Ferrous metals – (a1) Iron & Semis” or Monthly whole sale price index published by the office of economic advisor, government of India under Iron & Semis forming the base forming the base of calculation for index of prices on the date 28 days preceding the latest date prescribed for the receipt of the Bid.

Qsc = Quantity in MT of steel as per design incorporated in to the work during the period under consideration.

Notes:

- (i) The quantities of cement and steel considered for working out price variation shall be certified by the Engineer based on approved designs and as consumed in the work excluding wastage.
  - (ii) The time for completion of the contract shall mean the period commencing from the date of the commencement of the contract and ending on the date when the time allowed for the work specified expires, taking into consideration the extension of time, if any, for completion of the work granted by the Engineer under the relevant clause or the conditions of contract in cases other than those where such extension is necessitated on account of default of the contractor. The decision of the Engineer as regards the time of completion of the contract shall be final, conclusive and binding on the contractor, where compensation for delay is levied on the contractor on account of delay in completion or inadequate progress under the relevant contract provision the escalation amount for the balance work from the date of levy of such compensation shall be worked out as follows:
 

Indices I, M, P, Ic, & Is will be pegged to the levels corresponding to the date from which such compensation for delay is levied.
- b. Pegged indices as well as actual indices prevailing at the time of calculation of escalation for the period under consideration will be compared and lower of the two will be taken for calculating actual escalation amount.
- (iii) Price variation shall be calculated in accordance with the formulae mentioned at (I)(A)(B) above, separately for labour, material and POL components, as well as for price adjustment for cement and

steel in accordance with formulae mentioned at (II) (A) and(B) above. The relevant websites for ascertaining the various indices are as follows:

<http://www.iocl.com/Products/HighSpeedDiesel.aspx>

[http://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/38T\\_BUL110610.pdf](http://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/38T_BUL110610.pdf)

<http://labourbureau.gov.in/indtab.pdfindiabudget.nic.in/es2006-07/chapt2007/tab53.pdf>

<http://www.eaindustry.nic.in/default.html>

<http://labourbureau.nic.in/indnum.htm>

- (iv) The price variation under clause 47.1 shall not be payable for the extra items required to be executed during the progress of the work and where the rates payable for the extra items have been fixed as per the current market rates provided under Clause of General Conditions of Contract or mutually agreed.
- (v) The clause No.47.1 is operative both ways, i.e. if the price variation in the said Wholesale Price Index for all commodities, Consumer Price Index (New Series) or price of HSD of Bangalore or cost of cement or steel or bitumen is on the plus side, payment on account of the price variation shall be allowed to the Contractor and if it is on the negative side, the NMPA shall be entitled to recover the same from the contractor and the amount shall be deductible from the Contractor's bill for the respective period in which there are fluctuation.
- (vi) In order to facilitate computation of price variation to be made under clause 47.1 the contractor shall keep such books of accounts and other documents as are necessary. The contractor shall allow inspection of the same by an Engineer or his nominee and shall at the request of the Engineer may require true copies of any document so kept and such other information as the Engineer may require for verification.
- (vii) Calculation of Price Variation and Price Adjustment amount at the time of preparation of interim and final bill will be based on confirm indices and the prices of the POL products and bitumen products declared by IOC/BPCL/HPCL.

- (viii) Save and except for what is provided in the foregoing clause, nothing herein shall be construed to entitle the contractor to reimbursement of any increase in the price of materials or in the wages of labour occurring at any time and for any reason whatsoever, including the imposition of any tax, duty or fee or an increase in the price of any petroleum product, coal, electricity or water effected by or under the order of the Central Government of a State Government.
  - (ix) The basic price (star rate) will be fixed as per the prevailing rate at the time of invitation of the tender before 28 days from date of submission of the tenders.
  - (x) The mobilization and de-mobilization shall not be considered for calculation of Price Variations and the price variation for the items quoted on Lump sum basis shall not be payable .
- 47.2 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 and prices included in the contract shall be deemed to include amount to cover the contingency of such other rise or fall in costs.
- 47.3 Subsequent Legislation
- If, after the date 28 (Twenty eight) days prior to the date for submission of tenders for the contract there occur changes to any National or Statute Stature, Ordinance or Decree or other Law or any regulation or bye law of any local or other duly constituted authority or introduction of any such state statute, Ordinance, Decree, Law, regulation or bye law which causes additional or reduced cost to the contractor in execution of the contract, such additional or reduced cost shall, after due consultation with the Employer and the contractor be determined by the Engineer or his nominee and shall be added to or deducted from the contract price and the Engineer or his nominee shall notify the contractor accordingly with a copy to the Employer.
- 48. Retention**
- 48.1 The Employer shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the

whole of the Works.

48.2 Retention Money shall be deducted at the rate of 10% from first Running Bill onwards subject to a max. of 5% of the contract price including GST. Retention money shall be refunded after completion of defect liability period along with performance security.

#### **49. Liquidated Damages**

49A In case of delay in completion of the contract, liquidated damages (L.D) may be levied at the rate of half per cent ( $\frac{1}{2}\%$ ) of the contract price per week of delay, or part thereof subject to a maximum of 10 per cent of the contract price.

49A(i)The Employer, if satisfied, that the works can be completed by the contractor within a reasonable time after the specified time for completion, may allow further extension of time at its discretion with or without the levy of L.D. In the event of extension granted being with L.D, the Employer will be entitled without prejudice to any other right or remedy available in that behalf, to recover from the contractor as agreed damages equivalent to half per cent ( $\frac{1}{2}\%$ ) of the contract value of the works for each week or part of the week subject to the ceiling defined in sub-Clause 49 A. In the event of forfeiting the LD/EMD/SD performance guaranty and while imposing penalty GST at applicable rate is applicable.

49A(ii)The Employer, if not satisfied that the works can be completed by the contractor, and in the event of failure on the part of the contractor to complete work within further extension of time allowed as aforesaid, shall be entitled, without prejudice to any other right, or remedy available in that behalf, to rescind the contract.

49A(iii)The Employer, if not satisfied with the progress of the contract and in the event of failure of the contractor to recoup the delays in the mutually agreed time frame, shall be entitled to terminate the contract.

49A(iv)In the event of such termination of the contract as described in clauses 49A(ii) or 49A(iii) or both the Employer shall be entitled to recover L.D. up to ten per cent (10%) of the contract value and forfeit the security deposit made by the contractor besides getting the work completed by other means at the risk and cost of the contractor.

49A(v) In case Part / portions of the work can be commissioned and the Port operates the portion for commercial purposes, the rate of LD will be restricted to the uncompleted value of work, the maximum LD being on the entire contract value.

#### **50. Nominated Subcontractors**

All specialists, merchants, tradesmen and others executing any work or supplying any good, materials, Plant or services for which provisional Sums are included in the Contract, who may have been or be nominated or selected or approved by the Employer or the Engineer, and all persons to whom by virtue of the provisions of the Contract, the Contractor is required to subcontract shall, in the execution of such work or the supply of such goods, materials, Plant or services, be deemed to be subcontractors to the Contractor and are referred to in this Contract as "Nominated Subcontractors".

#### **51. Advance payment (not applicable)**

The Employer shall make the following advance payments:

- 51.1 Mobilization Advance shall be paid up to 10% of Contract price, payable in two equal installments. The first installment shall be paid after mobilization has started and next installment shall be paid after satisfactory utilisation of earlier advance.
- 51.2 Construction / installation equipment Advance shall be paid up to 5% of Contract price, limited to 90% of assessed cost of machinery.
- 51.3 Mobilization Advance and Construction Equipment Advance shall be paid at SBI PLR + 2% p.a. (as on date of payment) interest rate at the discretion of the employer and against Bank Guarantee for Mobilization Advance and against hypothecation of Construction Equipment to the Employer.
- 51.4 Equipment advance will be paid in two or more installments. First installment shall be paid after Construction Equipment has arrived at the site and next installment shall be paid after satisfactory utilization of earlier advance (s).
- 51.5 Recovery of Mobilization and Construction Equipment advance will start when 15% of the work is executed and recovery of total advance should be completed by the time 80% of the original Contract work is

executed.

51.6 Secured Advance: The Engineer or his nominee shall make advance payment in respect of materials and plant brought to site but not yet incorporated and installed in the Works in accordance with conditions stipulated in the Contract Data.

75% of cost of materials and plant brought to site for incorporation into the works only shall be paid as Secured Advance. Materials which are of perishable nature should be adequately insured.

## **52. Securities**

52.1 Security deposit shall consist of two parts

- a) Performance security to be submitted at award of the work
- b) Retention Money to be recovered from Running Bills.

52.2 The Security Deposit at 8% of the Contract amount including GST of which 3% of contract price should be submitted as Bank Guarantee within 21 days of receipt of letter of acceptance and balance 5% recovered as retention money from running bills. Recovery of 5% of retention money shall commence from the first RA bill onwards @ 10% for each bill. The retention money shall be refunded after completion of defect liability period. The performance Bank Guarantee will be released after completion of defect liability period.

## **53. Removal of Craft or Plant which has sunk**

The Contractor shall forthwith and with dispatch at his own cost raise and remove any craft or plant (floating or otherwise) belonging to him or to any sub-contractor employed by him (including also any plant which is held by the Contractor or any sub-contractor under agreement for hire or hire-purchase) which may be sunk in the course of the construction completion or maintenance of the Works or otherwise deal with the same as the Engineer may direct or until the same shall be raised and removed, the contractor shall set al such buoys and display at night such lights and do all such things for the safety of navigation as may be required by the Engineer or by Employer. In the event of the Contractor not carrying out his obligation imposed upon him by this clause the Employer may provide buoy and light such sunken craft or plant and raise and remove the same (without prejudice to the right of the Employer to hold the Contractor liable under

General Conditions) and the Contractor shall refund to the Employer all costs incurred in connection therewith.

#### Contractor's Temporary Moorings

Should the Contractor need, in connection with implementing the Works, to provide temporary moorings for his craft he may be allowed to do so in location and manner approved by the Engineer subject to all necessary permissions being first obtained by the Contractor from the authorities concerned. The Contractor shall not lay his temporary moorings such as to interfere with the port traffic and such moorings shall be removed if and when required by the Employer.

### **54. Cost of Repairs**

53.1 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 period 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**

### **55. Completion**

After completion of the work, the contractor will serve a written notice to the Engineer or his nominee/Employer to this effect. The Engineer or his nominee/Employer upon receipt of this notice shall conduct a complete joint survey of the work within 7 days and prepare a defects list jointly. The defects pointed out by the Engineer or his nominee/Employer would be rectified by the contractor within 14 days and thereafter acceptance report be signed jointly by the contractor and the Employer. This joint acceptance report shall be treated as 'Completion Certificate'.

### **56. Taking Over**

The Employer shall take over the Site and the Works within seven days of the Engineer or his nominee issuing a certificate of Completion.

### **57. Final Account**

The Contractor shall supply to the Engineer or his nominee a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Engineer or his nominee shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within 60 days of receiving the Contractor's account if it is correct and complete. If it is not, the Engineer or his nominee shall issue within 15 days a schedule that states the scope of the corrections or additions that are necessary for the correction and certify payment of 50% of the undisputed amount to the contractor. If the Final Account is still unsatisfactory after it has been resubmitted the Engineer or his nominee shall decide on the amount payable to the Contractor and issue a payment certificate, within 60 days of receiving the Contractor's revised account.

### **58. Submission of 'As built Drawings'**

"As built" Drawings are required to be submitted by the Contractor and shall be supplied by them by the dates stated in the Contract Data. If the Contractor does not supply the Drawings and/or manuals by the dates



stated in the Contract Data, or they do not receive the Engineer or his nominee's approval, the Engineer or his nominee shall withhold the amount stated in the Contract Data from payments due to the Contractor.

## 59. Termination

59.1 The Employer or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract.

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

- (a) **The Delay in signing of contract agreement beyond prescribed time limit.**
- (b) The Contractor stops work for 28 days when no stoppage of work is shown on the current Program and the stoppage has not been authorized by the Engineer or his nominee.
- (c) The Engineer or his nominee instructs the Contractor to delay the progress of the Works and the instruction is not withdrawn within 28 days.
- (d) The Employer or the Contractor becomes bankrupt or goes into liquidation other than for a reconstruction restructure or amalgamation.
- (e) a payment certified by the Engineer or his nominee is not paid by the Employer to the Contractor within 50 days of the date of the Engineer or his nominee's certificate:
- (f) The Engineer or his nominee 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 Engineer or his nominee.
- (g) The Contractor does not maintain a security which is required.
- (h) the Contractor has delayed the completion of works by the number days for which the maximum amount of liquidated damages can be paid as defined in the Contract data and
- (i) 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 Employer, and includes collusive practice. Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Employer of the benefits of free and open competition."

- 59.3 When either party to the Contract gives notice of a breach of contract to the Engineer or his nominee for a cause other than those listed under Sub Clause 59.2 above, the Engineer or his nominee shall decide whether the breach is fundamental or not.
- 59.4 Notwithstanding the above, the Employer may terminate the Contract for convenience subject to payment of compensation to the contractor including loss of profit on uncompleted works. Loss of profit shall be calculated on the same basis as adopted for calculation of extra/additional items.
- 59.5 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.

## **60. Payment upon Termination**

- 60.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Engineer or his nominee shall issue a certificate for the value of the work done less advance payments received up to the date of the issue of the certificate, 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.
- 60.2 If the Contract is terminated at the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Engineer or his nominee shall issue a certificate 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 loss of profit on uncompleted works 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.

### **61. Property**

All materials on the Site, Plant, Equipment, Temporary Works and Works for which payment has been made to the contractor by the Employer, are deemed to be the property of the Employer, if the Contract is terminated because of a Contractor's default.

### **62. Release from Performance**

If the Contract is frustrated by the outbreak of war or by other event entirely outside the control of either the Employer or the Contractor, the Engineer or his nominee shall certify that the Contract has been frustrated. The Contractor shall leave the Site 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**

The conditions of contract shall be the general conditions of contract in Section-III (v) as modified or added by the following condition of special conditions as provided in Section - III(vi) herein, which shall be read and construed with the general condition in Section - 3 A to E as if they were incorporated therein. In so far as any of the condition of the special conditions may conflict or be in consisting with any of general conditions of in Section -3F- Special condition of the contract shall prevail.

### **63. 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 Engineer or his nominee, deliver to the Engineer or his nominee a return in detail, in such form and at such

intervals as the Engineer or his nominee 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 Engineer or his nominee may require.

#### **64. Compliance with labour regulations**

During continuance of the contract, the Contractor and his sub-contractors shall abide at all times by all existing labour enactment 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 Central Government or the local authority. Salient features of some of the major labour laws that are applicable to construction industry are given below. 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 the Engineer or his nominee/Employer shall have the right to deduct any money due to the Contractor including his amount of performance security. The Employer / Engineer or his nominee 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.

#### **65. Safety, Security and Protection of the Environment.**

Subject and without prejudice to any other provision of the Contract, the Contractor shall take all reasonable precautions:

- (a) In connection with underground water resources (including percolating water) to prevent
  - (j) Any interference with the supply to or abstraction from such sources

- (ii) Pollution of the water so as to affect adversely the quality thereof.
- (b) All works shall be carried out without unreasonable noise and disturbance. The Contractor shall indemnify the Employer from and against any liability for damages on account of noise or other disturbance created while or in carrying out the work and from and against all claims, demands, proceedings, damages, costs, charges and expenses whatsoever in regard or in relation to such liability.
- (c) The Contractor at his own cost shall make such provisions for lighting of Works, Temporary Works, Materials and Plant and shall provide all such marks and lights as may be required by the Employer or the Engineer or any other authority having jurisdiction over the Site together with all labour stores and services required for their efficient working and use at any time, day or night.

The Contractor shall also provide at his own cost every description of watching and maintenance required in connection with the foregoing, and all other services for protecting and securing all places dangerous whether to Contractor's workmen or to other persons until the Works are handed over to the Employer, or till such time when the Engineer decides that such services are no longer required.

All lights provided by the Contractor shall be placed or screened such as not to interfere with any navigation lights or with any traffic or signal lights of any local or other authority.

#### **66. Insurance of Works and Contractor's Equipment**

The Insurance shall be issued by Nationalized Insurance Company from its Mangalore Branch which has been determined by the Contractor to be acceptable to the Employer.

The contractor shall at his own costs and expenses obtain and shall cause any subcontractor to obtain such insurance as may be necessary to cover the liability of the contractor or as the case may be of such subcontractor in respect of personal injuries and death arising out of or in the course of or caused during the execution of the works for a minimum amount of Rs. 25 lakhs and shall produce or cause any such subcontractor to produce for inspection the relevant policy or policies together with receipt for the premium paid under such policy/policies as and when required by the

Employer.

- i. The Employer (NMPA) shall not be liable for any accident, damage or compensation payable to any workman or other person in the employment of the Contractor or any Subcontractor.
- ii. Employer Liability Insurance: The Contractor shall indemnify and keep indemnified the Employer i.e. NMPA against all damages or compensation payable at Law in respect of or in consequence of any accident or injury to any workman or other person in the employment of the Contractor or Sub-Contractor against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto and the Employer shall be at liberty to deduct or adjust from the Contractor's bills an amount that Employer may be called upon to pay towards claims, demands, proceedings, costs, charges and expenses Whatsoever in respect of or in relation to any accident or injury referred to above without any reference to the Contractor.
- iii. The Contractor shall comply with all the Central State and Municipal Laws and Rules and shall be solely responsible for complying with the provisions of the Contract Labour (Regulations & Abolition) Act, 1970 & the contract labour (Regulation & Abolition) Karnataka Rules 1974 and rules there under and the enactments that may be applicable including ESI Act, the payment of wages act, Provident Fund Act, the Minimum Wages Act, the Factory's Act. The Workmen Compensation Act or any other applicable legislation and the Municipal by-laws or other statutory Rules and Regulations whatsoever in force if these are applicable. Any obligations finding or otherwise missed under any statutory enactments, rules & regulations there under shall be the responsibility of the Contractor and the NMPA will take no responsibility for the same. The Contractor should take Workmen's Compensation Policy for his Workers, who are not covered under ESI and submit the same to the EIC immediately after commencement of the work.
- iv. The Contractor is liable to pay all Statutory Compensation to the Labourers/persons engaged by him for the satisfactory execution of the works. If any claim is made against New Mangalore Port Authority on this work, the Port Authority shall have the right to deduct the same from the

bill amount payable to the contractor after verification of the validity and if admissible as per rules.

- v. PERSONAL PROTECTIVE EQUIPMENTS The Contractor shall ensure the use of PPE such as helmets, safety shoes, nose masks, hand gloves, Safety Harness or any other equipment as required depending on nature of work by his staff at site.

#### **67. War Risks Insurance**

If the Contractor receives instructions from the Employer to insure against war risks, such insurance if normally available shall be effected, at the cost of the Employer, with the Insurance Company acceptable to the Employer and shall be in the joint names of the Employer and the Contractor.

#### **68. Royalty**

Except where otherwise stated, the contractor shall pay to the authority all tonnage and other royalties, rent and other payments or compensation if any, for getting stone, sand, gravel, clay or other materials by him and his subordinates and his subcontractors and required for the works, at the rates and such conditions as notified by the State Government. The applicable rates for royalty is enclosed as Schedule-A in Volume -III. The contractor should submit the Mineral Dispatch Permit (MDP) in original for the quantity executed by the contractor for the requisite quantity of material incorporated in works for which MDP is issued by the authorized supplier. If contractor fails to submit the MDP in original the amount equal to 5 times the royalty charges shall be deducted from the contractor's bills as per prevailing orders issued by the Authority.

#### **69. Transport of Contractor's Equipment or Temporary Works**

If it is found necessary for the Contractor to move one or more loads of heavy constructional plant or equipment materials or pre-constructed units or parts of units of work over roads, highways or bridges on which such oversized and over weight items are not normally allowed to be moved, the Contractor shall obtain prior permission from the concerned authorities. Payments for complying with the requirements, if any, for protection of or strengthening of the roads, highways or bridges shall be deemed to be included in his contract price.

**70. Transport of Materials or Plant**

The contractor shall save harmless and indemnify the Employer in respect of all claims, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to any claim made by the concerned authorities in respect of damage or injury to roads, highways or bridges. In case of failure of the Contractor to settle such claims and in case the Employer is held responsible for payment to the authorities, then the Employer shall settle the claim and the Employer's expenses in this regard, as certified by the Engineer, may be deducted by the Employer from any money due or to become due to the Contractor and the Engineer shall notify the Contractor accordingly with a copy to the Employer.

**71. Labor Laws & Regulations**

The Contractor shall at all times during the continuance of the Contract comply fully with all existing Acts, regulations and bye-laws including all statutory amendments and re-enactment of State or Central Govt. and other local authorities and any other enactments and act that may be passed in future either by the State or the Central Govt. or local authority, including Indian Workmen's Compensation Act, Contract Labour (Regulation And Abolition) Act 1970 and Equal Remuneration Act 1976, Employees' State Insurance Act, 1948, Factories Act, Minimum Wages Act, Provident Fund Regulations. Employees' Provident Fund Act and schemes made under the same Act, Health and Sanitary Arrangements for Workmen, Insurance and other benefits and shall keep the Employer indemnified in case any action is commenced for contravention by the Contractor. If the Employer is caused to pay or reimburse any amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated here-forth on the part of the Contractor, the Engineer shall have the right to recover from the Contractor any sum required estimated to be required for making good the loss or damage suffered by the Employer. The Tenderers must have valid ESI and PF registration and shall maintain the records prescribed under ESI Regulations and PF Act & make the contribution towards ESI and PF in respect of persons employed by the Contractor. These contributions on the part of Employer paid by the contractor shall be reimbursed by the Engineer -in -charge to the contractor on actual basis. The contractor shall make



available such records for inspection by ESI and PF authorities during inspection and furnish the copies of such records to the employer regularly. The EPF and ESI contribution on the part of the employer in respect of this contract shall be paid by the contractor. These contributions on the part of Employer paid by the contractor shall be reimbursed by the Engineer -in - charge to the contractor on actual basis. The minimum wages applicable for Mangalore City is enclosed as Schedule - B in Volume - III.

71.1. Accident Prevention/Safety Officer

The Contractor shall have on his staff on site an officer dealing with all matters regarding safety and protection against, accidents of all staff and labour. This officer shall be qualified for this work and shall have the authority to issue instructions and shall take protective measures to prevent accidents.

71.2 Disorderly Conduct

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

71.3 Health and Safety

Due precautions shall be taken by the Contractor, and at his own cost, to ensure the safety of his staff and labour and, in collaboration with and to the requirements of the local health authorities, to ensure that medical staff, first aid equipment and stores, sick bay and suitable ambulance services are available at the camps, housing and on the site at all times throughout the period of the Contract and that suitable arrangements are made for the prevention of epidemics and for all necessary welfare and hygiene requirements.

71.4 Supply of Water

The Contractor shall, so far as is reasonably practicable, having regard to local conditions provide on the Site, to the satisfaction of the Engineer's Representative, an adequate supply of drinking and other water for the use of the Contractor's staff and work people.

71.5 Alcoholic Liquor or Drugs

The Contractor shall not, otherwise than in accordance with the

Statutes, Ordinances and Government Regulations or Orders for the time being in force, import, sell, give, barter or otherwise dispose of any alcoholic liquor, or drugs or permit or suffer any such importation, sale, and gift, barter disposal by his sub-contractions agents or employees.

71.6 Arms and Ammunition

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

71.7 Festivals and Religious Customs

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

71.8 Epidemics

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

71.9 Employment of Person in the Service of Others

The Contractor shall not recruit or attempt to recruit his staff and labour from amongst persons in the service of the Employer or other agencies engaged for any works of the Employer.

71.10 Housing for Labour

Save in so far as the Contract otherwise provides, the Contractor shall provide and maintain such accommodation and amenities as he may consider necessary for all his staff and labour employed for the purposes of or in connection with the Contract, including all fencing water supply (both for drinking and other purposes), electricity supply, sanitation, cook houses fire prevention and fire-fighting equipment, **crèche for children** of his staff and labour employed for the purposes, furniture other requirements in connection with such accommodation or amenities. On completion of the Contract, unless otherwise agreed with the Employer, the temporary camps/housing provided by the Contractor shall be removed and the site reinstated to

its original condition, all to the approval of the Engineer. The land for construction of labour camps shall be allotted outside the security area to the extent available and such area allotted for labour camps will be charged a ground rent at TAMP approved rates depending upon the location. The ground rent is liable for change as per the prevailing TAMP rates from time to time during the currency of the contract.

71.11 Fair Wages, Records, Inspection

The Contractor shall pay the labourers engaged by him on the work not less than a fair wage which expression shall mean whether for time or piecework the respective rates of wages as fixed by the Public Works Department as fair wages for Dakshina Kannada District payable to the different categories of labourers of those notified under the Minimum Wages Act.

The Contractor shall maintain records of Wages and other remuneration paid to his employee in such form as may be convenient and to the requirements of the Employer/Engineer and the Labour Enforcement Officer (Central), Ministry of Labour, Govt. of India, or such other authorized person appointed by the Central Govt. The Contractor shall allow inspection of the aforesaid Wage Records and Wage Slips to the Engineer and to any of his workers or to his agent at a convenient time and place after due notice is received, or to any other person authorized by him on his behalf.

71.12 Reporting of Accidents

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

71.13 Observance by Sub-Contractors

The Contractor shall be responsible for observance by his sub-contractors of the foregoing provisions.

71.14 Port Entry Permission

The Contractor shall submit prior application for Port entry passes to the concerned Port authority for his Materials, labours and the staffs engaged in the works. The Contractor has to get the vehicle and

labour RFID based passes for the entry inside the wharf area based on prevailing rates.

#### 71.15 Site - Protected Area

The Site of Work is a protected area. Entry to the Port premises is regulated by entry passes. These passes will be issued by the Central Industrial Security Force or any other authority authorized by the Employer. The Contractor should furnish a list of person for whom the passes are to be issued to the Engineer and arrange to obtain the passes from the appropriate authority, based on the recommendation of the Engineer and abide by the Rules of the New Mangalore Port Authority with regard to entry etc. For the entry of trucks and other vehicles also, the Contractor should obtain necessary permits.

The Contractor shall retain the original passes obtained by them in respect of their labour and staffs engaged in the Works and produce the same to the Engineer as and when called for. It should not be either destroyed or allowed to be taken by the labour/staff after its use.

The entry and exit of construction equipment, Plants, construction materials etc., into the Port premises is also regulated by Gate passes. These gate passes will be issued by the Engineer and the Contractor shall produce the same at the security Gate during the entry and exit of the materials. The duplicate copy of the inward pass shall be retained by the Contractor and shall be produced at the Gate during the exit of the materials along with the outward gate pass.

#### **72. Life Saving Appliances and First Aid**

The Contractor shall provide and maintain upon the Works sufficient proper and efficient lifesaving appliances and first aid equipment to the approval of the Engineer. The appliances and equipment shall be available for use at all times.

#### **73. Diving Operations (Not Applicable)**

- a) Any diving work shall be carried out in accordance with the Diving Operations Regulations of the Government of India.
- b) Before any diving work is undertaken the Contractor shall supply the Engineer or his representative with two copies of the Code of signals

to be employed and is to have a copy of such Code Prominently displayed on the craft or structure from which the operations take place

#### **74. Bribes**

If the Contractor, or any of his Subcontractors, agents or servants gives or offers to give to any person any bribe, gift, gratuity or commission as an inducement or reward for doing or forbearing to do any action in relation to the Contract or any other contract with the Employer, or for showing or forbearing to show favour or disfavor to any person in relation to the Contract or to any other contract with the Employer, then the Employer may enter upon the Site and the works and terminate the employment of the Contractor and the provisions of Clause 63 hereof shall apply as if such entry and termination had been made pursuant to that Clause.

The bidders shall give an undertaking that they have not made any payment or illegal gratification to any person/authority connected with the bid process so as to influence the bid process and have not committed any offence under the PC Act in connection with the bid.

The bidders shall disclose any payments made or proposed to be made to any intermediaries (agents etc) in connection with the bid.

The bidder shall execute Integrity Pact Agreement with NMPA as per the Integrity Pact Agreement Appendix II. The following Independent External Monitor (IEM) is nominated.

Shri Prem Chand Pankaj, Ex CMD, NEEPCO,  
M 402, Pioneer Park, Sector 61, Golf Course,  
Extn., Road, Gurgaon  
Mob No. 9717433886  
E-mail ID : prempankaj@gmail.com

Details to be Confidential

The Contractor shall treat the details of the contract as private and confidential, save insofar as may be necessary for the purposes thereof, and shall not publish or disclose the same or any particulars thereof in any trade or technical paper or elsewhere without the previous consent in writing of the employer. If any dispute arises as to the necessity of any publication or disclosure for the purpose of the Contract the same shall be referred to the

decision of the Employer whose award shall be final.

#### **75. Contractor's Temporary works, office, etc.**

76.1 The Contractor shall submit to the Engineer for his approval not less than 15 days before commencement of erection of any part of Temporary Works, drawings and detailed proposals for the method of construction of Temporary works such as office, store, false work and temporary platforms etc. which he intends to construct for the execution of the contract and no such work shall be constructed before obtaining the written approval of Chief Engineer. These temporary works, office, store etc. shall be erected at or near the work area subject to approval of the Employer and the land space for the same will be allotted free of ground rent to the extent available. The Contractor shall obtain permission for any Temporary Works and would ensure that during execution of works the statutory requirements of the concerned authorities such as New Mangalore Port Authority, Police, Customs, etc. would be complied with.

76.2 Submission of Reports, Returns, etc.

All reports, statements, returns, drawings, diagrams etc. which the Contractor is required to submit to the Engineer during the progress of the Works, shall be furnished in triplicate without any additional cost.

#### **76. Water Supply**

Water to the extent available will be supplied to the Contractor at a fixed point on the main water supply line within the Port area. The plumbing connection and extension of necessary supply pipeline to the working area shall be arranged by the Contractor at his own cost. The Contractor shall also provide a water meter at his cost for metering the quantity of water used. Charges for the consumption of the water will be paid by the Contractor to the Employer at the prevailing rate notified time to time during the currency of the Contract. For non-supply of water at any stage port will not be responsible and the Contractor shall not have any claim whatever for loss or damage.

#### **77. Power Supply**

The Electricity connection for lighting, welding and other mechanical works

to the extent available will be made available by the Employer within the Port area. Drawing of power lines etc. from the available point of supply of power to the actual work site either by overhead lines or underground cables shall be arranged by the contractor at his cost. The temporary lines and connections by the Contractor shall be approved by the Engineer's representative before availing power. The Contractor shall provide Trivector Meter to read consumption in units, power demand and power factor.

The Contractor shall indicate his requirement of power to the Engineer within 15 days from the date of the letter of acceptance of the tender. If the power requirement is more than 50 KW, the Contractor has to avail the power supply at 11 KV and install his own transformer of suitable capacity and work carried out as per IE Rules & Regulations as approved by the CEA. The Contractor shall pay to the Employer, the power charges as per the prevailing Tariff schedule of MESCOM in force during the work of the Contractor with applicable demand charges and security deposit along with departmental charges @ 23.75% of the bill amount. The Contractor shall also pay the connection and disconnection charges as applicable.

The Contractor shall ensure that the power factor of the system does not fall below 0.90 at any time and shall provide at his cost required capacity capacitors bank to maintain the Power Factor of all power loads. If the capacity of the capacitor found less than stipulated as per regulation during inspection, surcharge at Rs. 0.03 per unit will be levied. The contractor shall pay refundable Security Deposit before availing the power supply.

The Contractor shall submit a complete drawing of the power points, wiring, diagram indicating all electrical loads, earthing etc. in complete shape along with the completion report. The Trivector Meter provided is calibrated either by M/s. MESCOM or NITK, Surathkal, and such a Certificate to be produced. For non supply of power at any stage port will not be responsible and the Contractor shall not have any claim whatever for loss or damage.

## **78. Taxes and Duties**

- 79.1 The Contractor shall pay tax if any, and other levies as applicable from time to time. GST at applicable rate shall be shown separate line items in the tax invoice.
- 79.2 Sales / Turnover Tax on Works Contract(**DELETED**)
- 79.3 Income Tax

The Contractor and his staff shall be responsible for payment of all personal income taxes to the concerned authorities as per the law in force from time to time. Deduction of Income Tax shall be made by the Employer from each certificate of payment to the contractor at the rate of 2% plus surcharge or such other rates as may be specified by the Central Government from time to time, on the gross amount of the Contractor's bill for payment.

#### 79.4 Goods and Service Tax

The contractor shall not include GST component in rate. The GST shall be paid to the contractor separately as applicable. The contractor shall submit running account bills indicating GST separately as applicable. The Contractor shall be responsible for the payment of GST applicable, to the GST authority.

### **79. Price Adjustment (not applicable to this contract)**

The following clause shall be read in continuation to clause no. 47 of GCC. The sanction towards the compensation for escalation or deduction on account of de-escalation and the amount thus sanctioned will be included in the next running account bill or final bill as the case may be. The cost of work for which escalation/de-escalation is applicable / deductible shall be worked out as per cl. 32.8.6.1., CPWD works manual, 2003.

The cost of work for which escalation/de-escalation is applicable / deductible shall be worked out as below:

- (a) Gross value of work done up to this quarter (A)
- (b) Gross value of work done up to the last quarter (B)
- (c) Gross value of work done since previous quarter (a) – (b) (C)
- (d) Full assessed value of SA fresh paid in this quarter (D)
- (e) Full assessed value of SA recovered in this quarter (E)
- (f) Full assessed value of SA for which escalation is payable in this quarter (d) – (e) (F)
- (g) Advance payment made during the quarter (G)
- (h) Advance payment recovered during the quarter (H)
- (i) Advance payment for which escalation is payable in this quarter (g)– (h) (I)
- (j) EI paid based on prevailing M/R during the quarter (J)

$$X = C \pm F \pm I - J$$

$$Y = 0.85 X$$



(k) Less cost of materials supplied by the department & recovered during the quarter (K)

(l) Less cost of services tendered at fixed charges & recovered during the quarter (L)

(m) Cost of work for which escalation/de-escalation is applicable  $W=Y - (K + L)$

#### **80. Noise and Disturbance**

All works shall be carried out without unreasonable noise and disturbance. The Contractor shall indemnify the Employer from and against any liability for damages on account of noise or other disturbance created while or in carrying out the work and from and against all claims demands proceedings damages costs charges and expenses whatsoever in regard or in relation to such liability.

#### **81. Safety Code**

Necessary Indian Safety regulations for the safety purpose shall be adhered to by the contractor and he will be held responsible for any violations of the same. The set of such conditions (regulation) is available with NMPA and the contractor is required to go through it before tendering.

Besides the above, the Contractor shall also scrupulously adhere to and observe the following safety codes:

The Contractor has to provide sufficient barricades to site of work so that traffic plying nearby should not damage the recently concreted work. In case of any damage on account of above, the entire responsibility will remain with contractor and nothing extra will be paid on this account.

Suitable and strong scaffolds should be provided for the workmen for all work that cannot be safely done from ground. No portable single ladder shall be over 8 meters in length.

Hoisting machines and tackles used in the works including their attachments, and supports shall be in perfect condition as per stipulations of the relevant Rules. The ropes used for hoisting or lowering materials or as means or suspension shall be of durable quality and adequate strength and free from defects.

The excavated material shall no be placed within 1.5 meters of the edge of the trench or half of the depth of the trench, whichever is more. All trenches

and excavation shall be provided with necessary fencing to lighting. Every opening in the floor of a building or in a working platform shall be provided with suitable fence to prevent the fall of persons or materials. No floor, roof or other parts of the structure shall be so overloaded with debris or materials as to render it unsafe.

Workers employed on mixing and handling materials such cement, cement mortar, concrete, lime mortar and asphalt shall be provided with protective footwear and rubber hand gloves and thin cloth for covering face and head.

Those engaged in welding work shall be provided with welder protective eye shield and glove.

All safety rules shall be strictly followed while working on live electrical systems or installations as stipulated in the relevant Rules.

## **82. Port Authority Rules**

The Contractor shall observe the Conservancy Rules relating to the harbour and shall always take such necessary additional steps to keep the harbour waters free of noxious or unhygienic matters coming from his works as are required by the Employer. Under no circumstances shall inflammable materials be allowed to spill into the harbour waters.

The Contractor shall always observe and comply with the working rules and regulations of the Port Authority in force or as issued from time to time.

## **83. Execution of work**

The contractor shall be required to execute the work in such a way so as not to cause any damage, hindrance or interference with port activities going on in the area or nearby. He should not also deposit the materials at such places which may cause inconvenience to the public and the work going on in the nearby area. The Contractor shall have to make good all damages done by him to the structures nearby while executing the work and no extra payment shall be made to him on that account.

All the materials required to be used in the work shall have to be got approved from the Engineer-in-Charge before stacking at the site of work.

Barricading, including proper lighting arrangement in the night at the required places shall have to be provided by the contractor at his own cost, including necessary arrangements for proper movement of traffic by carefully maintained approaches and road diversions with suitable sign boards for

indications of road signs etc. as directed by the Engineer-in-Charge.

#### **84. Customs Duty**

Being Port Development Project, Customs Duty shall be applicable as per project import chapter 9801.00 read with Notification 17-2001, serial No. 38 (vi) and Notification 42-96 amended by 21-2000 of customs tariff, Government of India.

Customs Duty leviable shall be paid directly by the Contractor to the Customs Authorities, Government of India. The Employer shall reimburse this amount upon submission of documentary evidence in original for the proof of payment of such Customs Duty. The reimbursement of such amount towards Customs Duty shall be limited to the Ceiling amount quoted by the Contractor in the Bill of Quantities as above. If the Contractor incurs Customs Duty Levy less than the said Ceiling Amount, the reimbursement by the Employer shall be limited to the documented cost of Customs Duty levies actually paid to the Customs Authorities, Government of India. If the Actual Customs Duty levies paid by the Contractor exceeds the said Ceiling Amount, then the reimbursement by the Employer shall be limited to the Ceiling Amount. The reimbursement of the Customs Duty will be limited only to the Imported Materials listed in "Preamble and Bill of Quantities", BOQ No.\_\_. During the execution of the Works, if it necessitates for expeditious completion of the Works, Contractor may resort to import of any of the materials not listed aforesaid, with the approval of the Employer. However, the aggregate amount of Customs Duty to be reimbursed shall not exceed the lump sum amount offered in the Priced Bill of Quantities.

It shall be the responsibility of the Contractor to provide the requisite particulars and documents to the customs and other Government authorities and get the Imported Materials cleared and transported in time. The Contractor shall be fully responsible for port and Customs clearance including stevedoring, handling, unloading, loading, storage, inland transportation, if any of materials, equipment's and plant to storage godowns, yards, sites etc. The contractor shall be fully responsible for any delays, penalties charges and losses if any in this regard.

The Employer shall upon request from the Contractor along with necessary details, provide recommendatory letter(s) for Imported Materials at

concession rate or Customs Duty as applicable. However, the responsibility for obtaining such concession rate of customs duty shall be that of the Contractor.

It shall be the responsibility of the Contractor to check the latest position on Customs duty levies applicable and the Employer does not accept any liability on the account. For bill of Lading, the "Consignee" for permanent materials to be incorporated into the Works will be the New Mangalore Port Authority. The Contractor will be "Notify Party". Notwithstanding the above, obtaining "Essentiality Certificate" (if any), payment of deposit (if any) towards Customs Duty, etc. shall be the responsibility of the Contractor.

The Contractor shall give an undertaking follows:

- a) Being the ultimate Employer of the materials to be imported and incorporated into the works covered under the Tender \_\_\_\_\_ we request New Mangalore Port Authority to be consignee in the matter of permanent materials to be imported by us at our cost (covering payments of materials by letter of credit) including freight, insurances, taxes and any other charges whatsoever payable in connection with the import and its incorporation into the work.
- b) We hereby confirm, in the event of New Mangalore Port Authority becoming consignee, it will not absolve us from any of the obligations, and will not alter the payment terms under the Contract No. SCB II/ 2009 dated ..... between ..... (*the Contractor*) and New Mangalore Port Authority.
- c) New Mangalore Port Authority becoming a consignee is a matter of convenience and we undertake to abide by all the obligations, responsibilities etc. as if we are our self a consignee.
- d) In respect of nay consequences arising out of New Mangalore Port Authority becoming the consignee we hereby unequivocally and irrevocably agree to indemnify New Mangalore Port Authority for such consequences.
- e) We also undertake and confirm to obtained all permits and licenses etc. at our own cost. New Mangalore Port Authority's responsibilities in this regard will be the same as under the said contract and limited to issuing required recommendatory letters for obtaining such permits and licenses.

- f) *This undertaking does not in anyway vitiate our contractual liabilities and obligations cast upon us by Contract No. SCB II/ 2009 dated ..... between .....(the Contractor) and New Mangalore Port Authority.*

#### **85. Drawings & Designs**

- (a) General details of the works are shown on the drawings accompanying this tender document. The Engineer will supply to the Contractor from time to time during the progress of the works such further working drawings as will be necessary in his opinion for the proper and adequate execution and maintenance of the Works in accordance with the Engineer's designs and/or any modification thereof as decided by the Engineer and the Contractor shall carry out the work in accordance with the said working drawings. Two sets of such working drawings will be issued. If the Contractor requires more sets he will have to make his own arrangement at his cost. Residual Design, Detailing & Engineering: - The Engineer to the project has done the detailed design and engineering for the subject tender. During execution of the work the residual design, detailing and engineering, if needed, is to be carried out by the contractor at no extra cost to the Employer. For equipment/ Installations detailed drawings need to be produced by the contractor at no extra cost to the Employer. The contractor shall also get approved such design, detailing & engineering from the Engineer.
- (b) In the event of the Contractor proposing any alteration/modification to the Engineer's design, detail, method of construction, he shall at his own expenses prepare and submit for approval of the Engineer copies in duplicate (in the first instance) of detailed working drawings which may be required for such alteration/modification and at the same time call the attention of the Engineer to any alternative detail or modification of the contract drawings which the Contractor may wish to make at least 30 days prior to the commencement of the work or part of the work to which such drawings relate. The contractor shall at the same time, if so required by the Engineer, furnish calculation sheets in duplicate relating to the strength and anticipated deflections in respect of such altered/modified works. The

Engineer will, after any such alteration which he may approve, record on the copies as amended his approval and will return one copy of the drawings and calculation sheets to the contractor, who shall carry out the work in accordance therewith. The contractor shall forward to the Engineer three additional copies of the working drawings and calculation sheets as approved in addition to these working drawings and calculation sheets as approved. In addition to these working drawings are also to be submitted (the same procedure as in the case of the contractor) in respect of any work proposed to be executed by sub-contractors. The approval of the Engineer of all or any of the calculation sheets, drawings shall not relieve the contractor of responsibility in connection with the execution of the altered/modified or subcontractor's work.

- (c) **Submission of 'As built Drawings'**  
 "As built" Drawings are required to be submitted by the Contractor and shall be supplied by them by the dates stated in the Contract Data. If the Contractor does not supply the Drawings and/or manuals by the dates stated in the Contract Data, or they do not receive the Engineer or his nominee's approval, the Engineer or his nominee shall withhold the amount stated in the Contract Data from payments due to the Contractor.

#### **86. Monsoon Period**

Monsoon period will be reckoned from 1st June to 30th September.

#### **87. Progress Report**

The following reports shall be submitted for review; as an input to the Management meeting to be held as per Clause No 31 of Conditions of Contract.

##### **88.1 Daily reports**

The contractor shall submit daily report indicating daily activities, weather condition, actual manpower, equipment and the prominent materials available and arriving to site. The contractor shall submit the daily report format to the Department for prior approval.

##### **88.2 Monthly Reports**

Monthly progress reports shall be prepared by the Contractor and

submitted to the Engineer in triplicate. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates. Reporting shall continue until the Contractor has completed all work, which is known to be outstanding at the completion date, stated in the Taking-Over Certificate for the Works.

Each report shall include:

Charts and detailed descriptions of progress, including each stage of design (if any), Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection and testing; and including these stages for work by each Sub-Contractor,

Photographs in hardcopy & digital copy and videography in two sets showing the various stages of progress on the Site monthly;

For the supply of manufactured items, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:

Commencement of manufacture,

Contractor's/Engineer's inspections,

Tests,

Shipment and arrival at the Site;

Copies of quality assurance documents, test results and certificates of Materials;

Safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations; and

Comparisons of actual and planned progress, with details of any events or circumstances which may jeopardize the completion. In accordance with the Contract, and the measures being (or to be) adopted to overcome delays.

## **88. Completion Documents**

To treat that the work has been completed and issue a final payment certificate, the following documents will be deemed to form the completion documents:

The Technical documents according to which the work was carried out.  
Certificates of final levels and dimensions as set out for various works.  
Certificates of tests performed for various works.

**89. Facilities / Services to be provided at the site (Not Applicable)**

After the issue of Engineer's notice to commence, the Contractor shall as soon as possible, make available of the following facilities for the staff of the Engineer at the Site of Work, all to the approval of the Engineer or his Representative and the Contract Price shall be deemed to be inclusive of the provision for these facilities:

Provide and maintain, throughout the period of Contract, one no of Office accommodation at site office / Porta cabin measuring not less than 4m x 5m. each, with electricity and water supply and adequate ventilation for the sole use of Engineer's Representative, his staff.

Provide and maintain suitable furniture for the office, including: Tables with two lockable drawers and chairs, Almira with shelves and necessary electrical fittings.

Provide and maintain, throughout the period of Contract, a Toilet along with washroom facilities with electricity and water supply and adequate ventilation for the sole use of Engineer's Representative, his staff.

Desk top Computers of latest configuration with printers and all other necessary accessories, internet and loaded with the latest version of software like M.S. Office, AutoCAD etc. with windows operating system.

One photocopying machine capable of Black & White copying / Scanning A4 & A3 size of paper, with auto feed of papers (Source to be copied) along with sorting facilities.

The contractor shall make available during the currency of contract all the Survey instruments and various measuring devices necessary for the execution of the project.

A lock and four (4) keys for the office room. There shall be no spare keys in the possession of any person other than Engineer's Representative.

**90. Payments**

The Clause No. 43 payments shall be replaced as follows

- i. The Contractor has to submit the bill within 7 days of joint measurement taken along with the concerned Engineer. The Engineer has to ensure that joint measurement to be completed within 7 days of completing of part work / running work. The concerned Engineer



i/c shall check and make entries into bill/M.B within 10 days of submission of the interim bill and submit to Executive Engineer/ Superintending Engineer (Civil). The Executive Engineer/ Superintending Engineer (Civil) shall check the bills and after certification of the quantities as per manual shall forward to the Finance Department within 3 working days. The Contractor and Assistant Engineer both jointly complete the measurements, if Contractor due to any reason does not attend/avoid joint survey/measurements the Executive Engineer shall give notice to the contractor to be present at the site for joint measurement within 7 days' notice. If the contractor fails to attend the joint measurement second notice shall be issued to the contractor to attend the joint measurement within 3 days failure to attend the site for joint measurement the Assistant Engineer and AEE or EE would record the reason and complete the measurements in a transparent manner departmentally and submit the bill. Bills shall be prepared and submitted by the Contractor. Joint measurements shall be taken continuously and need not be connected with billing stage. System of 4 copies of measurements, one each for Contractor, Employer and Engineer or his nominee, and signed by both Contractor and Employer shall be followed.

- ii. Interim of bill amount will be paid within 14 days of submission of the bill.
- iii. Contractor shall submit final Bill within 60 days from the date of completion of work and the same will be paid by the Port within 30 days from the date of submission
- iv. The payment will be made to the contractor after deducting any dues payable to the Port statutory authorities etc
- v. If an amount certified is increased in a later certificate as a result of an award by the DRB or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.
- vi. Items of the 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.

**91. Retention**

The Clause No. 48 Retention shall be replaced as follows

The Employer shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole of the Works.

Retention Money shall be deducted at 10% from Running Bills subject to a max. of 5% of the contract price plus Goods Service tax applicable. Retention money shall be refunded after issue of No defects certificate.

**92. Submission of statutory documents**

The successful bidder, with in 7days from the date of work order, shall submit self-attested copy of statutory documents such PAN card, GST registration certificate, ESI registration certificate, EPF registration certificate, Labour Identification Number (LIN) and any other documents required for successful completion of work.

- G. SALIENT FEATURES OF SOME MAJOR LAWS APPLICABLE TO ESTABLISHMENTS ENGAGED IN CONSTRUCTION WORK**
- (a) Workmen Compensation Act 1923:- The Act provides for compensation in case of injury by accident arising out of and during the course of employment.
  - b) Payment of Gratuity Act 1972: Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years service or more on death at the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.
  - (c) Employees P.F and Miscellaneous Provision Act 1952: The Act Provides for monthly contributions by the employer and workers @ 13.61% and 12% respectively. The benefits payable under the Act are:
    - (i) Pension to family pension on retirement or death, as the case may be.
    - (ii) Deposit linked insurance on the death in harness of the worker.
    - (iii) Payment of P.F accumulation on retirement/death etc.
  - d) Maternity Benefit Act 1951:-The Act provides for leave and some other benefits to workmen/ employees in case of confinement or miscarriage etc.
  - e) Contract Labour (Regulation & Abolition) Act 1970:-The Act provides for certain welfare measures to be provided by the Contractor to contract labour and in case the Contractor fails to provide, the same are required to be provided, by the Principal Employer by Law. The Principal Employer is required to- take Certificate of Registration and the Contractor is required to take license from the designated Officer. The Act is applicable to the establishments or Contractor of Principal Employer if they employ 20 or more contract labor.
  - f) Minimum Wages Act 1948: The Employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act if the employment is a scheduled employment Construction of Buildings, Roads, Runways are scheduled employment.
  - (g) Payment of Wages Act 1936:-It lays down as to by what date the wages are to be paid when it will be paid and what deductions can be made from the wages of the workers.

- (h) Equal Remuneration Act 1979:-The Act provides for payment of equal wages for work of equal nature to Male and Female workers and for not making discrimination against Female employees in the matters of transfers, training and promotions etc.
- i) Payment of Bonus Act 1965: The Act is applicable to all establishments employing 20 or more employees. The Act provides for payments of annual bonus subject to a minimum of 8.33% of wages and maximum of 20% of wages to employees drawing Rs. 3,500/- per month or less. The bonus to be paid to employees getting Rs. 2,500/- per month or above up to Rs. 3,500/- per month shall be worked out by taking wages as Rs. 2,500/- per month only. The Act does not apply to certain establishments. The newly set-up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of this Act.
- j) Inter-State Migrant workmen's (Regulation of Employment & Conditions of Service) Act 1979:The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The Inter-State migrant workmen, in establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, travelling expenses from home upon the establishment and back,
- k) The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and the Cess Act of 1996:-All the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the Government. The Employer of the establishment is required to provide safety measures at the Building or Construction work and other welfare measures, such as Canteens, First-Aid facilities. Ambulance, Housing accommodations for workers near the work place etc. The Employer to whom the Act applies has to obtain a

registration certificate from the Registering Officer appointed by the Government.

## v) CONTRACT DATA

Items marked "N/A" do not apply in this Contract.

Sl. No.	Description	Reference Cl. No.
1	The following documents are also part of the Contract	
	The Schedule of other contractors	(8)
	The Schedule of Key personnel	(9)
2	The above insertions should correspond to the information provided in the Invitation of Bids.	
3	The Employer is	(1)
	New Mangalore Port Authority, Panambur, Mangalore – 575010	
	Name of Authorized Representative:	
	Name : Chairman, New Mangalore Port Authority, Panambur, Mangalore – 575010	
4	The Engineer is	
	Name : Chief Engineer (C), New Mangalore Port Authority, Panambur, Mangalore- 57501010	
	Name of Nominee is	
	Name : Superintending Engineer SE(C-II) Civil Engineering Department, NMPA, Panambur, Mangalore- 575010	
5	The name and identification number of the Contract is	
	Name of Contract:- "Construction of Cruise Terminal Gate at New Mangalore Port" Tender no: CIVIL/CE(C)/EE(C)/89/2022-23	(1)
6	The works consist of Construction of Cruise Terminal Gate	(1)

Sl. No.	Description	Reference Cl. No.		
	at New Mangalore Port.			
7	<p>Schedule date of commencement 15 days from the date of Issue of Letter of Acceptance.</p> <p>However No work shall be commenced before signing of contract Agreement.</p>	<p>Conditions of contract A-General 1.Definitions 59.2(a)</p>		
8	The Contract price is the price stated in the letter of acceptance. However payment will be made as per actual work done accordance with the contract provisions.	1.Definitions		
9	The Intended completion Date for the whole of the Work is 12 (Twelve Months excluding monsoon) with the following milestones:	(17,28)		
10	<p>Milestone dates:</p> <table border="1"> <tr> <td>Physical works to be completed</td> <td>Period from the date of commencement of work</td> </tr> </table> <p>Milestones dates shall be provided to the Contractor by the Executive Engineer executing the work for completion of the work as per the scheduled date.</p>	Physical works to be completed	Period from the date of commencement of work	
Physical works to be completed	Period from the date of commencement of work			
11	<p>The following shall form part of the Contract Document:</p> <ol style="list-style-type: none"> <li>(1) Form of Agreement</li> <li>(2) Letter of Acceptance</li> <li>(3) Contractor's Bid</li> <li>(4) Contract Data</li> <li>(5) Conditions of Contract including Special Conditions of Contract</li> <li>(6) Specifications</li> <li>(7) Drawings</li> <li>(8) Bill of quantities and</li> <li>(9) Any other documents listed in the Contract Data as forming part of the Contract.</li> <li>(10) Correspondence exchanged after the opening of the Bid and before the issue of Letter of Acceptance by which the Condition of Contract are amended, varied or modified</li> </ol>	(2.3)		

Sl. No.	Description	Reference Cl. No.
	in any way by mutual consent (to be enumerated).	
12	The Contractor shall submit a Program for the Works within 14 days of delivery of the letter of Acceptance.	(27)
13	The site possession date The site will be handed over immediately after issue of Letter of acceptance and the site is free from encumbrances.	(21)
14	The site is located at Panambur in NMP area and is defined in drawing No. 20/59/MTC-II/2020-Ts	
15	The Defects Liability Period is 1 (One ) year)777.	(35)
16	The minimum insurance cover for physical property, injury and death is Rs.5,00,000/- (Rupees five Lakhs) per occurrence with the number of occurrences limited to four. After each occurrence, contractor will pay additional premium necessary to make insurance valid for four occurrences always.	(13)
17	The following events shall also be Compensation Events: The Employer terminates the contract for his convenience.	(44)
18	The period between Programme updates shall be 30 days.	(27)
19	The amount to be withheld for late submission of an updated Programme shall be Rs.25,000/-.	(27)
20	The Penalty for the delay in submission of the Performance guarantee shall be at the rate of 0.25% of the amount of performance guarantee for each week or part of the week for the number of weeks delayed beyond the stipulated date of submission.	(52.2) 34.1
21	The language of the Contract documents is English.	(3)
22	The law, which applies to the Contract, is the law of Union of India.	(3)
23	The currency of the Contract is Indian Rupees.	(46)
24	Fees and types of reimbursable expenses to be paid to the Dispute Review Board as per actual and equally shared by	(25)



Sl. No.	Description	Reference Cl. No.
	both the parties.	
25	The Dispute Review Board shall be constituted after signing of the agreement on mutually agreed terms.(Appendix 1). (Not applicable to this contract)	(25)
26	Price Adjustment (deleted)	(47) (80)
27	The proportion of payments retained (retention money) shall be 10% of total tax invoice value from each running bill subject to a maximum of 5% of the contract price including GST as applicable.	(48)
28	The maximum amount of liquidated damages for the whole of the works is 10 % of the contract price plus taxes and duties. The half per cent (½%) per week L.D is applicable for delay period of $\frac{1}{3}$ of contract period and thereafter 10% L.D is applicable.	[49]
29	Clause No. 49A (v) deleted.	
30	Advance payment is not applicable to this contract	[51]
31	Repayment of secured advance: deleted	(51.6)
32	The Securities shall be for the following minimum amounts equivalent as a percentage of the Contract Price.	(52)
33	Performance Security in the form of Bank guarantee for 5% of contract price including GST.	(52.2)
34	The standard form of Performance Security acceptable to the Employer shall be an unconditional Bank Guarantee of the type as presented in Section III (iv) of the Bidding Documents.	Annexure-A

## vi) FORM OF SECURITIES

Acceptable forms of securities are annexed. Bidders should not complete the Performance Security form at this time. Only the successful Bidder will be required to provide Performance and Advance Payment Securities in accordance with one of the forms, or in a similar form acceptable to the Employer.

Annexure A: Performance Bank Guarantee

Annexure B: Bank Guarantee for Advance Payment

**Annexure A****PERFORMANCE BANK GUARANTEE**

To: \_\_\_\_\_ [name of Employer]  
 \_\_\_\_\_ [address of Employer]

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 \_\_\_\_\_ [amount of guarantee]1  
 \_\_\_\_\_ [In words], such sum being payable in the types and proportions of currencies in which the Contract Price is payable, 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]1 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 28 days from the date of expiry of the Defects Liability Period.

Notwithstanding anything mentioned above,

Our liability against this guarantee is restricted to Rs..... (Rupees ..... only) and unless a claim in writing is lodged with us within 3 months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharges.

IN WITNESS WHEREOF this guarantee has been duly executed on this ..... day of .....

Signature and seal of the guarantor \_\_\_\_\_

Name of Bank \_\_\_\_\_

Address \_\_\_\_\_ Date \_\_\_\_\_

- 1 An amount shall be inserted by the Guarantor, representing the percentage of the Contract Price specified in the Contract and denominated in Indian Rupees.

**BANK GUARANTEE FOR ADVANCE PAYMENT**

To: \_\_\_\_\_ [name of Employer]  
 \_\_\_\_\_ [address of Employer]  
 \_\_\_\_\_ [name of Contract]

Gentlemen:

In accordance with the provisions of the Conditions of Contract, Sub-clause 51.1 ("Advance Payment") of the above mentioned Contract, \_\_\_\_\_ [name and address of Contractor] (hereinafter called "the Contractor") shall deposit with \_\_\_\_\_ [name of Employer] a bank guarantee to guarantee his proper and faithful performance under the said Clause of the Contract in an amount of

1

\_\_\_\_\_ [amount of guarantee] \_\_\_\_\_ [in words].

We, the \_\_\_\_\_ [bank or financial institution], as instructed by the Contractor, agree unconditionally and irrevocably to guarantee as primary obligator and not as Surety merely, the payment to \_\_\_\_\_ [name of Employer] on his first demand without whatsoever right of objection on our part and without his first claim to the Contractor, in the amount not exceeding \_\_\_\_\_ [amount of guarantee]1 \_\_\_\_\_ [in words].

We further agree that no change or addition to or other modification of the terms of the Contract or of Works to be performed there under or of any of the Contract documents which may be made between \_\_\_\_\_ [name of Employer] 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.

The guarantee shall remain valid and in full effect from the date of the advance payment under the Contract until \_\_\_\_\_ [name of Employer] receives full repayment of the same amount from the Contractor.

Notwithstanding anything mentioned above,

Our liability against this guarantee is restricted to Rs.....(Rupees .....only) and unless a claim in writing is lodged with us within 3 months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharges.

IN WITNESS WHEREOF this guarantee has been duly executed on this .....day of .....

Yours truly,

Signature and seal:\_\_\_\_\_

Name of Bank/Financial Institution:\_\_\_\_\_

Address:\_\_\_\_\_

Date:\_\_\_\_\_ 1. An amount shall be inserted by the bank or financial institution representing the amount of the Advance Payment, and denominated in Indian Rupees.

**APPENDIX - I**  
**(Not applicable to this contract)**

TO GENERAL CONDITIONS OF CONTRACT

DISPUTES REVIEW BOARD AGREEMENT

THIS AGREEMENT, made and entered into this ..... Day of  
..... 20..... Between ..... ("the Employer")  
and.....  
..... ("the Contractor"),and the  
Disputes Review Board ("the Board") consisting of One / three Board  
Members, (1)  
..... (2)  
..... (3)  
.....

[Note: Delete whatever is not applicable]

WITNESSETH, that

WHEREAS, the Employer and the Contractor have contracted for the  
construction of the .....  
.....  
..... (Project name)  
..... (the "Contract") and

WHEREAS, the contract provides for the establishment and operation of the  
Board NOW THEREFORE, the parties hereto agree as follows:

The parties agree to the establishment and operation of the Board in  
accordance with this Board Agreement.

Except for providing the services required hereunder, the Board Members  
should not give any advice to either party or to the Engineer or his nominee  
concerning conduct of the Works.

The Board Members:

- (a) shall have no financial interest in any party to the contract or the Engineer or his nominee, or a financial interest in the contract, except for payment for services on the Board.
- (b) shall have had no previous employment by, or financial ties to, any party to the contract, or the Engineer or his nominee, except for fee based consulting services on other projects, all of which must be disclosed prior to appointment to the Board.
- (c) shall have disclosed in writing to the parties prior to signature of this Agreement any and all recent or close professional or personal or personal relationships with any director, officer, or employee of any party to the contract, or the Engineer or his nominee, and any and all prior involvement in the project to which the contract relates;
- (d) shall not, while a Board Member, be employed whether as a consultant or otherwise by either party to the contract, or the Engineer or his nominee, except as a Board Member.
- (e) shall not, while a Board Member, engage in discussion or make any agreement with any party to the contract, or with the Engineer or his nominee, regarding employment whether as a consultant or otherwise either after the contract is completed or after services as a Board Member is completed;
- (f) shall be and remain impartial and independent of the parties and shall disclose in writing to the Employer, the Contractor, the Engineer or his nominee, and one another any fact or circumstances which might be such to cause either the Employer or the Contractor to question the continued existence of the impartiality and independence required of Board Members.

Except for its participation in the Board's activities as provided in the contract and in this Agreement none of the Employer, the Contractor, the Engineer or his nominee, and one another any fact or circumstances which might be such to cause either the Employer or the Contractor to question the continued existence of the impartiality and independence required of Board Members.



The Contractor shall :

- a) furnish to each Board Members one copy of all documents which the Board may request including contract documents, progress reports, variation orders, and other documents, pertinent to the performance of the Contract.
- b) in co-operation with the Employer, co-ordinate the Site visits of the Board, including conference facilities, and secretarial and copying services. The Board shall serve throughout the operation of the contract. It shall begin operation following execution of this Agreement, and shall terminate its activities after issuance of the taking over Certificate and the Board's issuance of its Recommendations on all disputes referred to it.

Board Member shall not assign or subcontract any of their work under this Agreement.

The Board Members are independent and not employees or agents of either the Employer or the Contractor.

The Board Members are absolved of any personal or professional liability arising from the activities and the Recommendations of the Board.

Fees and expenses of the Board Member[s] shall be agreed to and shared equally by the Employer and the Contractor. If the Board requires special services, such as accounting, data research, and the like, both parties must agree and the costs shall be shared by them as mutually agreed.

Board Site visits :

- a) The Board shall visit the Site and meet with representatives of the Employer and the Contractor and the Engineer or his nominee at regular intervals, at times of critical construction events, and at the written request of either party. The timing of Site falling agreement shall be fixed by the Board.
- b) Site meetings shall consist of an informal discussion of the status of the construction of the works followed by an inspection of the works, both attended by personnel from the Employer, the Contractor and the Engineer or his nominee.
- c) If requested by either party or the Board, the Employer will prepare minutes of the meetings and circulate them for comments of the parties and the Engineer or his nominee.

11. Procedure for disputes referred to the Board:
  - a) If either party objects to any action or inaction of the other party or the Engineer or his nominee, the objecting party may file a written Notice of Dispute to the other party with a copy to the Engineer or his nominee stating that it is given pursuant to Clause 65 and stating clearly and in detail the basis of the dispute.
  - b) The party receiving the Notice of Dispute will consider it and respond in writing within 7 days after receipt.
  - c) This response shall be final and conclusive on the subject, unless a written appeal to the response is filed with the responding party within 7 days of receiving the response. Both parties are encouraged to pursue the matter further to attempt to settle the dispute. When it appears that the dispute cannot be resolved without the assistance of the Board either party may refer the dispute to the Board by written Request for Recommendation to the Board, the other party and the Engineer or his nominee stating that it is made pursuant to Clause 65.
  - d) The Request for recommendation shall state clearly and in full detail the specific issues of the dispute to be considered by the Board.
  - e) When a dispute is referred to the Board, and the Board is satisfied that the dispute requires the Board's assistance, the Board shall decide when to conduct a hearing on the dispute. The Board may request that written documentation and arguments from both parties be submitted to each Board Member before the hearing begins. The parties shall submit insofar as possible agreed statements of the relevant facts.
  - f) During the hearing, the Contractor, the Employer, and the Engineer or his nominee shall each have ample opportunity to be heard and to offer evidence. The Board's Recommendations for resolution of the dispute will be given in writing, to the Employer, the Contractor and the Engineer or his nominee as soon as possible, and in any event not more than 28 days after the Board's final hearing on the dispute.
12. Conduct of Hearings:
  - a) Normally hearing will be conducted at the Site, but any location that

would be more convenient and still provide all required facilities and access to necessary documentation may be utilised by the Board. Private Sessions of the Board may be held at any location convenient to the Board.

- b) The Employer, the Engineer or his nominee and the Contractor shall have representatives at all hearings.
- c) During the hearings, no Board Member shall express any opinion concerning the merit of any facet of the case. After the hearings are concluded, the Board shall meet privately to formulate its Recommendations. All Board deliberations shall be conducted in private, with all individual views kept strictly confidential. The Board's Recommendations, together with an explanation of its reasoning shall be submitted in writing to both parties and to the Engineer or his nominee. The Recommendations shall be based on the pertinent contract provisions, applicable laws and regulations, and the facts and circumstances involved in the dispute.

The Board shall make every effort to reach a unanimous Recommendation. If this proves impossible, the majority shall decide, and the dissenting member any prepare a written minority report for submission to both parties.

[Note: Delete if it is one member Board]

- 13. If during the contract period, the Employer and the Contractor are of the opinion that the Dispute Review Board is not performing its functions properly; the Employer and the Contractor may together disband the Disputes Review Board. In such an event, the disputes shall be referred to Arbitration straightaway.

The Employer and the Contractor shall jointly sign a notice specifying that the Board shall stand disbanded with effect from the date specified in the notice. The notice shall be posted by a registered letter with AD or delivery of the letter, even if he refuses to do so.

**TO SPECIAL CONDITIONS OF CONTRACT  
PRE CONTRACT INTEGRITY PACT AGREEMENT**

**General**

This pre-bid pre-contract Agreement (hereinafter called the Integrity Pact) is made on \_\_\_\_\_ day of the month of \_\_\_\_\_ 20\_\_, between, on one hand, the Board of Members of New Mangalore Port Authority acting through \_\_\_\_\_, Chief Engineer (Civil), (Name & Designation of the Officer) New Mangalore Port Authority (hereinafter called the 'BUYER/EMPLOYER', which expression shall mean and include, unless the context otherwise requires, his successors in office and assigns) of the First Part and M/s \_\_\_\_\_ represented by Shri \_\_\_\_\_, Chief Executive Officer (hereinafter called the 'BIDDER' which expression shall mean and include, unless the context otherwise requires, his successors and permitted assigns) of the Second Part.

WHEREAS the 'BUYER/EMPLOYER' has invited bids for Construction of Cruise Terminal Gate at New Mangalore Port and the BIDDER is submitting his bid for the same and

WHEREAS the BIDDER is a Private company / Public company / Government undertaking / registered partnership firm, constituted in accordance with the relevant law in the matter and the 'BUYER/EMPLOYER' is New Mangalore Port Authority.

NOW, THEREFORE,

To avoid all forms of corruption by following a system that is fair, transparent and free from any influence/prejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to:-

Enabling the 'BUYER/EMPLOYER' to obtain the desired said stores/equipment/services/works at a competitive price in conformity with the defined specifications by avoiding the high cost and the distortionary impact of corruption on public procurement, and

Enabling BIDDERS to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that

their competitors will also abstain from bribing and other corrupt practices and the 'BUYER/EMPLOYER' will commit to prevent corruption, in any form, by its officials by following transparent procedures.

The parties hereto hereby agree to enter into this Integrity Pact and agree as follows:

**Commitments of the 'BUYER/ EMPLOYER'**

- 1.1 The 'BUYER/EMPLOYER' undertakes that no official of the 'BUYER/EMPLOYER', connected directly or indirectly with the contract, will demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward, favour or any material or immaterial benefit or any other advantage from the BIDDER, either for themselves or for any person, organization or third party related to the contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the contract.
  - 1.2 The 'BUYER/EMPLOYER' will, during the pre-contract stage, treat all BIDDERS alike and will provide to all BIDDERS the same information and will not provide any such information to any particular BIDDER which could afford an advantage to that particular BIDDER in comparison to other BIDDERS.
  - 1.3 All the officials of the 'BUYER/EMPLOYER' will report to the appropriate Government office any attempted or completed breaches of the above commitments as well as any substantial suspicion of such a breach.
2. In case any such preceding misconduct on the part of such official(s) is reported by the BIDDER to the 'BUYER/ EMPLOYER' with full and verifiable facts and the same is prima facie found to be correct by the 'BUYER/EMPLOYER' necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by the 'BUYER/ EMPLOYER' and such a person shall be debarred from further dealings related-to the contract process. In such a case while an enquiry is being conducted by the 'BUYER/ EMPLOYER' the proceedings under the contract would not be stalled.

**Commitments of BIDDERS**

3. The BIDDER commits itself to take all measures necessary to prevent

corrupt practices, unfair means and illegal activities during any stage of its bid or during any pre-contract or post-contract stage in order to secure the contract or in furtherance to secure it and in particular commit itself to the following.:-

- 3.1. The BIDDER will not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the 'BUYER/EMPLOYER' connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the contract.
- 3.2. The BIDDER further undertakes that it has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the 'BUYER/EMPLOYER' or otherwise in procuring the Contract or forbearing to do or having done any act in relation to the obtaining or execution of the contract or any other contract with the Government for showing or forbearing to show favour or disfavour to any person in relation to the contract or any other contract with the Government.
- 3.3. BIDDERS shall disclose the name and address of agents and representatives and Indian BIDDERS shall disclose their foreign principals or associates.
- 3.4. BIDDERS shall disclose the payments to be made by them to agents/brokers or any other intermediary, in connection with this bid/contract.
- 3.5. The BIDDER further confirms and declares to the 'BUYER/EMPLOYER' that the BIDDER has not engaged any individual or firm or company whether Indian or foreign to intercede, facilitate or in any way to recommend to the 'BUYER/EMPLOYER' or any of its functionaries, whether officially or unofficially to the award of the contract to the BIDDER, nor has any amount been paid, promised or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation or

recommendation.

- 3.6. The BIDDER, either while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to or intends to make to officials of the 'BUYER/ EMPLOYER' or their family members, agents, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.
- 3.7. The BIDDER will not collude with other parties interested in the contract to impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract.
- 3.8. The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.
- 3.9. The BIDDER shall not use improperly, for purposes of competition or personal gain, or pass on to others, any information provided by the 'BUYER/ EMPLOYER' as part of the business relationship, regarding plans, technical proposals and business details, including information contained in any electronic data carrier. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.
- 3.10. The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.
- 3.11. The BIDDER shall not instigate or cause to instigate any third person to commit any of the actions mentioned above.
- 3.12. If the BIDDER or any employee of the BIDDER or any person acting on behalf of the BIDDER, either directly or indirectly, is a relative of any of the officers of the 'BUYER/EMPLOYER' or alternatively, if any relative of an officer of the 'BUYER/EMPLOYER' has financial interest/stake in the BIDDER's firm, the same shall be disclosed by the BIDDER at the time of filing of tender.  
The term 'relative' for this purpose would be as defined in Section 6 of the Companies Act 1956.
- 3.13. The BIDDER shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any

employee of the 'BUYER/EMPLOYER'.

- 3.14. The bidder signing IP shall not approach courts while representing the matters to IEMs and he / she / they will wait their decision in the matter.

#### **4. Previous Transgression**

- 4.1 The BIDDER declares that no previous transgression occurred in the last three years immediately before signing of this Integrity Pact, with any other company in any country in respect of any corrupt practices envisaged hereunder or with any Public Sector Enterprise in India or any Government Department in India that could justify bidder's exclusion from the tender process.
- 4.2 The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

#### **5. Earnest Money (Security Deposit)**

- 5.1 While submitting commercial bid, the BIDDER shall deposit an amount 448500/- (Rupees Four Lakh FourtyEight Thousand Five Hundred Only) as Earnest Money/Security Deposit, with the 'BUYER/ EMPLOYER' through any of the following instruments:

##### **i) Paid by RTGS in favour of FA and CAO, NMPA**

The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udyam Registration Certificate or any other body specified by Ministry of MSME.

- 5.2 The Earnest Money/Security Deposit shall be valid up to a period of 148days or the complete conclusion of the contractual obligations to the complete satisfaction of both the BIDDER and the 'BUYER/EMPLOYER', including warranty period, whichever is later.
- 5.3 In case of the successful BIDDER, a clause would also be incorporated in the Article pertaining to Performance Security in the Project Contract that the provisions of Sanctions for Violation shall be



applicable for forfeiture of Performance Security in case of a decision by the 'BUYER/EMPLOYER' to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.

- 5.4 No interest shall be payable by the 'BUYER/EMPLOYER' to the BIDDER on Earnest Money/Security Deposit for the period of its currency.

## **6. Sanctions for Violations**

- 6.1 Any breach of the aforesaid provisions by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle the 'BUYER/EMPLOYER' to take all or any one of the following actions, wherever required:-
- i) To immediately call off the pre contract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.
  - ii) The Earnest Money Deposit (in pre-contract stage) and/or Security Deposit/Performance Bond (after the contract is signed) shall stand forfeited either fully or partially, as decided by the 'BUYER/EMPLOYER' and the 'BUYER/ EMPLOYER' shall not be required to assign any reason therefore.
  - iii) To immediately cancel the contract, if already signed, without giving any compensation to the BIDDER.
  - iv) To recover all sums already paid by the 'BUYER/EMPLOYER', and in case of an Indian BIDDER with interest thereon at 2% higher than the prevailing Prime Lending Rate of State Bank of India, while in case of a BIDDER from a country other than India with interest thereon at 2% higher than the LIBOR. If any outstanding payment is due to the BIDDER from the 'BUYER/EMPLOYER' in connection with any other contract, such outstanding payment could also be utilized to recover the aforesaid sum and interest.
  - v) To encash the advance bank guarantee and performance bond/warranty bond, if furnished by the BIDDER, in order to recover the payments, already made by the 'BUYER/EMPLOYER', alongwith interest.

- vi) To cancel all or any other Contracts with the BIDDER. The BIDDER shall, be liable to pay compensation for any loss or damage to the 'BUYER/EMPLOYER' resulting from such cancellation/rescission and the 'BUYER/EMPLOYER' shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.
  - vii) To debar the BIDDER from participating in future bidding processes for a minimum period of five years, which may be further extended at the discretion of the 'BUYER/EMPLOYER'.
  - viii) To recover all sums paid in violation of this Pact by BIDDER(s) to any middleman or agent or broker with a view to securing the contract.
  - ix) In cases where irrevocable Letters of Credit have been received in respect of any contract signed by the 'BUYER/EMPLOYER' with the BIDDER, the same shall not be opened.
  - x) Forfeiture of Performance Guarantee in case of a decision by the 'BUYER/ EMPLOYER' to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.
- 6.2 The 'BUYER/EMPLOYER' will be entitled to take all or any of the actions mentioned at para 6.1(i) to (x) of this Pact also on the Commission by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER), of an offence as defined in Chapter IX of the Indian Penal code, 1860 or Prevention of Corruption Act, 1988 or any other statute enacted for prevention of corruption.
- 6.3 The bidder the decision of the 'BUYER/EMPLOYER' to the effect that a breach of the provisions of this Pact has been committed by the BIDDER shall be final and conclusive on the BIDDER. However, the BIDDER can approach the Independent Monitor(s) appointed for the purposes of this Pact.

## **7. Fall Clause**

- 7.1 Undertakes that it has not performed/is not performing similar project at a price lower than that offered in the present bid in respect of any other Ministry/Department of the Government of India or PSU and if it is found

at any stage that similar project was performed by the BIDDER in any other Ministry/Department of the Government of India or a PSU at a lower price, then that very price, with due allowance for elapsed time, will be applicable to the present case and the difference in the cost would be refunded by the BIDDER to the 'BUYER/EMPLOYER', if the contract has already been concluded.

#### **8. Independent Monitors**

- 8.1 The 'BUYER/EMPLOYER' has appointed the following Independent Monitor (hereinafter referred to as Monitor) for this Pact in consultation with the Central Vigilance Commission Name and Address of the Monitor: Shri Prem Chand Pankaj, Ex CMD, NEEPCO, M 402, Pioneer Park, Sector 61, Golf Course, Extn., Road, Gurgaon  
Mob No. 9717433886  
E-mail ID: prempankaj@gmail.com
- 8.2 The task of the Monitor shall be to review independently and objectively, whether and to what extent the parties comply with the obligations under this Pact.
- 8.3 The Monitor shall not be subject to instructions by the representatives of the parties and perform his functions neutrally and independently.
- 8.4 Both the parties accept that the Monitor has the right to access all the documents relating to the project/bidding, including minutes of meetings.
- 8.5 As soon as the Monitor notices, or has reason to believe, a violation of this Pact, he will so inform the Authority designated by the 'BUYER/EMPLOYER'.
- 8.6 The BIDDER(s) accepts that the Monitor has the right to access without restriction to all Project documentation of the 'BUYER/EMPLOYER', including that provided by the BIDDER. The BIDDER will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to Subcontractors. The Monitor shall be under contractual obligation to treat the information and documents of the BIDDER/Subcontractor(s) with confidentiality.
- 8.7 The 'BUYER/EMPLOYER', will provide to the Monitor sufficient

information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the parties. The parties will offer to the Monitor the option to participate in such meetings.

- 8.8 The Monitor will submit a written report to the designated Authority of 'BUYER/EMPLOYER' within 8 to 10 weeks from the date of reference or intimation to him by the BUYER / EMPLOYER / BIDDER and, should the occasion arise, submit proposals for correcting problematic situations.

#### **9. Facilitation of Investigation**

In case of any allegation of violation of any provisions of this pact or payment of commission, the 'BUYER/EMPLOYER' or its agencies shall be entitled to examine all the documents including the Books of Accounts of the BIDDER and the BIDDER shall provide necessary information and documents in English and shall extend all possible help for the purpose of such examination.

#### **10. Law and Place of Jurisdiction**

This Pact is subject to Indian Law.' The place of performance and jurisdiction is the seat of the 'BUYER/EMPLOYER'.

#### **11. Other Legal Actions**

The actions stipulated in this Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.

#### **12. Validity**

- 12.1 The validity of this Integrity Pact shall be from date of its signing and extend up to 5 years or the complete execution of the contract to the satisfaction of both the 'BUYER/EMPLOYER' and the BIDDER, including warranty period, whichever is later. In case BIDDER is unsuccessful, this Integrity Pact shall expire after six months from the date of the signing of the contract.
- 12.2 Should one or several provisions of this Pact turn out to be invalid, the remainder of this Pact shall remain valid. In this case, the parties will strive to come to an agreement to their original intentions.
- 12.3 If the BIDDER is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

13. The parties hereby sign this Integrity Pact at \_\_\_\_\_ on \_\_\_\_\_

BUYER/EMPLOYER

BIDDER

Name of the Officer  
and Designation

CHIEF EXECUTIVE OFFICER

Witness

Witness

1. \_\_\_\_\_
2. \_\_\_\_\_

1. \_\_\_\_\_
2. \_\_\_\_\_,

\* Provisions of these clauses would need to be amended/ deleted in line with the policy of the BUYER/ EMPLOYER in regard to involvement of Indian agents of



**NEW MANGALORE PORT AUTHORITY**  
**Panambur, Mangalore**

**"CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
PORT"**

**TENDER DOCUMENT**  
**Volume - II**

**TECHNICAL SPECIFICATION**

**NEW MANGALORE PORT AUTHORITY**  
CIVIL ENGINEERING DEPARTMENT

Tender no: CIVIL/CE(C)/EE(C)/88/2020-21

Tender for

**“CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE  
PORT”**

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	Section II	i) Form of Agreement
	Section III	i) Conditions of Contract: Part A - E: General Conditions ii) Conditions of Contract : Part F: Special Conditions iii) Contract Data iv) Form of Securities (A & B) v) Appendix - I and Appendix - II
<u>Volume II</u>	Section IV	i) Technical Specifications
	Section V	ii) Drawings
<u>Volume</u>	Section VI	i) Preamble
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**SECTION IV****TECHNICAL SPECIFICATIONS****A. GENERAL****1. INTRODUCTION**

The intent of this technical specification covers construction of all civil works as covered in the scope of contract as per drawings supplied by Owner.

All civil works shall be carried out as per design / drawings standardized by the Consultant / Owner and the specification provided by the Consultant / Owner. All standard drawings are enclosed with the tender documents. In case any item is not covered under specification then the same shall be carried out as per CPWD specification and applicable Standards and Codes. Any item for which specification is not provided herein and is not covered under CPWD specification shall be executed as per manufacturer guidelines. All materials shall be of best quality conforming to relevant Standards and Codes. In case of any conflict between Standards / Code and Technical Specification, the provisions of Technical Specification shall prevail, and the Engineer's decision on interpretation shall be final.

The Contractor shall furnish all labor, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with drawings, specifications and direction of Owner.

Excavated earth is to be disposed from site as instructed, only into approved landfill areas and dump yard. The cost of excavation to include for necessary lead and lift as specified.

All materials including cement, reinforcement steel and structural steel etc. shall be arranged by the Contractor. All testing required shall be arranged by the Contractor at his own cost. The contractor shall execute the work as per the standard Field Quality Plan (FQP) of NMPT.

The bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon patterns, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

Level and date of concreting shall be marked on the building from outside at every floor level with proper paint, etc.

All levels and survey work shall be measured by total station and electronic level machine at all floors and places.

Brief Description of Works

The scope of work is defined in the Notice Inviting Tender. The Contractor shall provide all necessary materials, equipment and labour etc. for the execution and maintenance of the work till completion.

The work shall be executed in accordance with the specification stipulated in the Bill of Quantity and other bidding documents read along with CPWD (Central Public Works Department) specifications for civil works and IS codes with up-to-date revisions. For non-schedule items specification as given along with tender document and similar items of CPWD shall be applicable.

The list of references for civil works are CPWD specifications, relevant IS codes and best practices.

For deep excavations, necessary shoring is to be done, the design of which will be provided by the contractor, after assessing site and soil conditions, and work only to be commenced on site after the same is duly approved by NMPT. Any approval if required from the Mineral department or any other statutory body that has jurisdiction on such excavations has to be obtained by the contractor.

All earth used for back filling should be of approved quality.

Portland Cement of IS 8112 shall be used for all cement & concrete works. This will supersede other specifications of cement to be used for the works.

For ready mixed cement concrete, in addition to the CPWD specification, the following also to be noted:

The cost towards cement quantity reduced from the specified quantity in the item due to mixing of fly ash shall be deducted as per relevant BOQ item. The design mix shall be submitted to Engineer in Charge for approval.

All hard ware fittings shall be of best quality and shall be selected as per the Instructions of Engineer in Charge.

Site location, Boundaries and Possession

The location and boundaries of the Site are shown on DRAWING No. DP1033DRG CL 01010

The Contractor shall confine his activities strictly to the allotted site area(s) and shall not allow his personnel to trespass upon any other areas occupied by the Employer.

#### 1.4 Site Datum and Base Lines

A base line shall be established within the working area by the Contractor. The base line shall be referenced to the site co-ordinate system (based on the Local Coordinates of New Mangalore Port). This bench mark and base line will be the basis for the setting-out for all the Works. The main levels and lines for each portion of the Works shall be established from the bench mark and base line by the Contractor.

## 1.5 Site Conditions

### 1.5.1 Location of Work

The location and boundaries of the Site are shown on the Drawing No. DP1033DRG CL 01010

### **LOCATION PLAN**

### 1.5.2 Climate

The climate at Mangalore is tropical with high humidity and a maximum shade temperature of 36°C. The average annual rainfall is approximately 3330 mm and concentrated in the south-west monsoon months of June, July, August and September during which period the average rainfall is as much as 82% of the total annual rainfall.

### 1.5.3 Wind

The wind in the monsoon months of June, July and August are predominantly from south-west and west with a maximum intensity of 5 on the Beaufort Scale. The winds in the remaining months of the year are predominantly from the north-west and the maximum intensity during this period is also of 5 on the Beaufort Scale.

### 1.5.4 Cyclones

Even though Mangalore is within the cyclonic area of storms originating in the Arabian Sea and those that enter across the Indian Peninsula from Bay of Bengal, cyclones are not as severe or frequent as in the Bay of Bengal. The maximum wind speed so far recorded in cyclonic storm, generally does not exceed 62 kmph (16.9 m/sec.) except one during 1965 when the maximum speed recorded was 97 kmph (26.9 m/sec.)

### 1.5.5 Visibility

Thirty year period observations conducted by the Indian Meteorological Department reveal that poor visibility (visibility less than 4 Kms) is encountered for about 10 days in the south-west monsoon period. The maximum number of foggy days in a year is only 3.

### 1.5.6 Site Preparation

The Contractor shall furnish all necessary supervision, labour, materials, equipment and tools for Site Preparation, clearing and all other works. Clearing shall mean to completely demolish, remove and dispose with all leads, lifts and descents from the area marked, trees, bushes, deadfalls, embedded logs, dislodged roots, stumps, snogs, boulders, mounds, existing structures and other objectionable materials. The areas required to be cleared shall consist of the work Site, ditches, borrow pits,

diversions and all other areas necessary for the construction work as directed by the Engineer-in-Charge.

Before any Temporary Works are commenced, the Contractor shall submit his proposal along with complete drawings of all Temporary Work, he may require for the execution of the Works in advance to the Engineer for approval. The Contractor shall also submit his calculations relating to the design of temporary works, strength, etc. if required by the Engineer and shall carry out the modifications that the Engineer may require of such temporary works at Contractor's own cost. The Contractor shall be solely responsible for the stability and safety of all Temporary Work.

It will be the responsibility of the Contractor to make timely procurement of all materials and mobilize all essential equipment for both Temporary and Permanent Works.

#### 1.6 Site Information

The reference is invited to detailed drawing of the construction site for adaptation of methodology for the construction of foundation. However, on account of this change in the geographical profile of site, no extra cost for additional arrangement required to be made will be paid for.

#### 1.7 The Nature of Soil Profile & Pile Depth

The details furnished herein are only for the information/guidelines of the tenderers and the successful contractor shall not claim for any deviation in the actual subsoil profile encountered at site.

#### 1.8 Records

Complete records of all operations connected with the work shall be kept by the Contractor. The Contractor shall submit to the Engineer-in-charge for approval his proposal of the manner of presentation of these records. Three copies of all such records shall be furnished to the Engineer-in-charge on completion of each test or operation.

**B. WORKS**

1. The following technical specification, code of practice etc. referred herein is form a part of the Item Specification and work shall be executed accordingly. Items which are not covered under Technical Specification shall be carried out as per relevant IS Specification or as per manufactures specification or as directed by Engineer-in-charge.
2. In case of discrepancy between technical specification and item specification provided along with Bill of Quantities, the Item Specification shall prevail.
3. All the measurements shall be as per latest edition of B.I.S.

**ALUMINIUM WORK****Sl. No. IS Code Subject**

1. IS 733 :Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineering Purposes) –Specification.
2. IS 737:Wrought Aluminium and Aluminium alloy sheet and strip for general engineering purposes –Specification.
3. IS 1285:Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) - Specification
4. IS 1868:Anodic coating on Aluminium and its Alloys-Specification
5. IS 1948:Specification for Aluminium Doors, Windows and Ventilators
6. IS 3908:Specification for Aluminium equal leg angles
7. IS 3909:Specification for Aluminium unequal leg angles
8. IS 3965:Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.
9. IS 5523:Method of testing anodic coating on aluminium and its alloys.
- 10.IS 6012:Measurement of coating thickness by Eddy Current Method
- 11.IS 6315:Floor springs (Hydraulically regulated) for heavy doors-Specifications
- 12.IS 6477:Dimensions of extruded hollow section and tolerances
- 13.IS12823:Wood products- Pre-laminated particle board –Specifications.
14. IS 14900: Transparent Float glass- Specifications

**Aluminium Sections**

Aluminium sections used for fixed/openable windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in-Charge for technical, structural, functional and visual considerations. The aluminium extruded sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304.

The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and

appearance of door and windows.

Aluminium glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings. The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminium work, with the approval of Engineer-in-Charge. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Engineer-in-Charge. If the sections are varied, the contractor shall obtain prior approval of Engineer-in-Charge and nothing extra shall be paid on this account.

### **Powder Coating**

**Material:** The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer-in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer-in-Charge or his authorized representative.

**Pre-treatment:** Each aluminium alloy extrusion or performed section shall be thoroughly cleaned by alkaline or acidic solutions under the conditions specified by chemical conversion coating supplier and then rinsed. A chemical conversion coating shall be applied by treatment with a solution containing essentially chromate ions or chromate and phosphate ions as the active components as applicable. The amount of the conversion coating deposited depends on the type used by the conversion coating chemical supplier. The conversion coating shall be thoroughly rinsed either with the solution specified by the conversion coating chemical supplier or with de-mineralized water and then dried at the temperature for the time specified by the conversion coating chemical supplier. The contractor shall submit the detail specifications and application procedure for application of conversion coating for approval of Engineer-in-Charge. The metal surface after the conversion coating pretreatment and prior to the application of the coating shall be free from dust or powdery deposits

**Process:** The polyester powder shall be applied by electrostatic powder spray method. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The powder coating shall be applied as per the specification approved by Engineer-in-Charge.

**Thickness:** The thickness of the finished polyester powder coating measured by micron meter shall not be less than 50 micron nor more than 120 micron at any point.

### **Performance Requirements for the Finish**

**Surface appearance:** The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours

of different surfaces of same section.

*Adhesion:* When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

**Protection of Powder Coated / Anodizing Finish:** It is mandatory that all aluminium members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

**Measurement:** All the aluminium sections including snap beading fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment. (Weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

**Rate:** The rate shall include the cost of all the materials, labours involved in all the operations as described in nomenclature of item and particular specification.

## **DOOR, WINDOW, VENTILATOR AND PARTITION FRAMES**

### **Frame Work**

First of all the shop drawings for each type of doors/windows/ventilators etc. shall be prepared by using suitable sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of glazed doors, windows, ventilators etc. The shop drawings shall also show the details of fittings and joints. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-Charge. Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual door/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site. The frames shall be truly rectangular and flat with regular shape corners fabricated to true right angles. The frames shall be fabricated out of section which have been cut to length, mitered and jointed mechanically using appropriate machines. Mitered joints shall be corner crimped or fixed with self tapping stainless steel screws using extruded aluminium cleats of required length and profile. All aluminium work shall provide for replacing damaged/broken glass panes without having to remove or damage any member of exterior finishing material.

### **Fixing of Frames**

The holes in concrete/masonry/wood/any other members for fixing anchor bolts/ fasteners/ screws shall be drilled with an appropriate electric drill. Windows/ doors/ ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed, counter sunk and matching size groove. of required size at spacing not more than 250 mm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. Engineer-in-Charge in his sole discretion may allow the units to be assembled in their final location if the situation so warrants. Snap beadings and EPDM gasket shall be fixed as per the detail shown in the shop drawings.

Where aluminium comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electrochemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The contractor shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

#### **Measurements**

All the aluminium sections including snap beadings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

#### **Rate**

The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification.

#### **FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES**

Door Frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up or resin transfer moulding process. The process shall consist of laying gel coat at 1000 gms./m<sup>2</sup> and laid over with layer of FRP Mat (CSM mat) gel coat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isobathic resin and fillers & additives) by weight. The edge shall be sealed with gel coat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat. FRP door shall be



manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

**Tolerance**

Tolerance of size of frame to be + 2 mm and on size of rebate to be + 1 mm.

**Finish**

The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

**Fixing of Frames**

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untilled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the centre. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

**Measurement**

The outer length of the vertical and horizontal members of door frame shall be measure in running metres including embedded length in floor corrected up to a cm.

**Rate**

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

The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately.

**FIBRE GLASS REINFORCED PLASTIC (F.R.P.) SHUTTERS**

F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge.

Blocks of any seasoned hardwood of bulk density not less than 450 kg./m<sup>3</sup> at 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three

locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

#### **Location of Fittings and Accessories**

The lock rail of door shutters shall be so placed that its centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminum.

#### **Sampling & Criteria for Conformity**

The test specimens shall not have been exposed to a temperature below 40°C for 24 hours immediately preceding the test and shall be free from all visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded. If any test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

#### **Sampling**

Sampling criteria for conformity shall be in accordance with IS 4020 (Part -I) Lot in any consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to form a lot. The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Table.

**TABLE**  
**No. of Sample and Criteria for Conformity**

<i>Sl. No.</i>	<i>Sample size</i>	<i>Permissible No. of Defects</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>
26 to 50	8	1
51 to 100	13	1
101 to 150	20	1
151 to 300	32	1
301 to 500	50	2
501 and above	80	2

**Note :** For lot size 25 or less, number of samples to be taken for testing shall be as agreed to between the manufacturer & Engineer-in-Charge. *Number of Tests :* The samples selected as in column 2 of Table shall be as agreed to between the manufacturer & Engineer-in-Charge. *Criteria for Conformity* The lot shall be considered conforming to the requirements if the

number of samples failing to satisfy the requirements of characteristics does not exceed the permissible number mentioned in col. 3.

### **Finish**

The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

### **Tests**

The door shutters shall be subjected to the following tests in accordance with IS 4020 (Part 1 to 16)

**Fixing of Shutter** Door shutter shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel

### **Tolerance**

The tolerance on the width and the height of the door shall be + 5 mm and the tolerance on the nominal thickness of the door shall be + 2 mm.

### **Measurement**

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

### **Rate**

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

## **FITTINGS AND FIXTURES**

### **Scope of Work**

The work covered under these specifications consist of supplying different types of fittings and fixtures required for doors, windows, ventilators etc. The supply shall be in accordance with the specification, drawings / approved samples. Samples of various fittings and fixtures proposed to be incorporated in the work shall be submitted by the contractor for approval of the Engineer-in-charge before order for bulk supply is placed.

### **General**

All fittings and fixtures shall conform to relevant IS code and made with approved materials as specified. These shall be well made reasonably smooth and free from sharp

edges, corners, flaws and other defects. Screw holes shall be counter sunk to suit the heads of the specified screws. All riveted heads pertaining to hinge pins shall be well formed. Screws supplied for fittings shall be of the same metal and finish as the fittings. Samples of each fixture/ fitting shall be furnished by the contractor for approval of the Engineer-in-Charge. Order for procurement of fittings and fixtures in bulk shall be placed only after approval by the Engineer-in-Charge.

The fittings and fixtures to be incorporated in the work shall be strictly according to the approved sample. Fittings shall be fixed in proper position as shown in the drawing and as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with a screwdriver and not hammered in. Recess shall be cut to the exact size and depth for the counter sinking of hinges. The fittings and fixtures shall be fixed in a workman like manner and any damages done either to fittings and fixtures or to the shutter frames etc. should be rectified by the contractor at his own cost.

Fittings shall be of Stainless steel or as specified. The fittings shall be well made, smooth, and free from sharp edges and corners, flaws and other defects.

Stainless steel fittings shall be non-magnetic, rust & moisture proof, strong & sturdy. Pin of hinges shall also be of stainless steel.

#### **Measurement**

All the fittings with all the necessary accessories shall be measured in numbers and the rate shall include the cost of all materials, loading, unloading, transporting, cost of screws, bolts and other accessories complete, fixing charges etc complete .

#### **Rate**

The rate shall include the cost & conveyance of all materials as above, and labour involved in all the operations including, installation, lead, lift etc complete as directed by Engineer in Charge.

### **DISMANTLING AND DEMOLITION**

#### **General**

The term dismantling implies carefully taking up or down and removing without damage.

This shall consist of dismantling one or more parts of the building as specified or shown on the drawings.

The term Demolition implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on drawings.

#### **Precautions**

Necessary propping, shoring and /or underpinning shall be provided for the safety of the adjoining work or property, which is to be left in tact, before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property.

Wherever required, temporary enclosures or partitions/barricades shall also be provided.

Necessary precautions shall be taken to keep the dust- nuisance down as and when necessary.

Dismantling shall be commenced in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roofs, masonry etc., shall be carefully dismantled first. The dismantled articles shall be passed by hand where necessary and lowered to the ground and not thrown. The materials then be properly stacked as directed by the Engineer-in-charge. Methodology of dismantling shall be got approved in toto by Engineer-in-charge prior to take up work at site.

All materials obtained from dismantling or demolition shall be the property of Client unless otherwise specified and shall be kept in safe custody until handed over to the Engineer-in-charge.

Any serviceable material, obtained during dismantling or demolition shall be separated out and stacked properly as indicated by the Engineer-in-charge within a lead of 150m, or as specified in the item. All under serviceable materials, rubbish etc., shall be disposed off as directed by the Engineer-in-charge.

#### **Treatment**

All the dismantled area shall be rendered clean off all debris, dust etc. The sides of jambs, sills, soffits etc., of the openings if any, after taking out doors and window chowkhats, unless and otherwise to be treated, shall be plastered in C.M 1:3 with neeru finish to render true sides, corners, edges etc. Reinforcement shall be cut either by hacksaw or gas cutting as approved by Engineer-in-charge. All services shall be disconnected prior to taking up job.

#### **Rates**

The rate shall include cost of all such operations mentioned above including necessary labour, materials, transport, scaffolding, stacking the serviceable materials, disposing the unserviceable materials within the lead specified, all as directed by the Engineer-in-charge.

### **STEEL WORK**

#### **TUBULAR / HOLLOW SECTION FOR TRUSSES &FRAMES**

##### **Structural Steel Tube**

These shall be of:

1. Hot finished welded (HFW) type, or
2. Hot finished seamless (HFS) type, or
3. Electric resistance or induction butt welded (ERW), YST 310

Conforming to the requirement of IS 4923. Tubes shall be designed by their nominal bore. These shall be light, medium or heavy as specified depending upon the wall thickness. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut clean and square with axis of tube, unless otherwise specified.

##### **Minimum Thickness of Metals**

Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm and for construction not exposed to weather it shall be not less than 3.2 mm where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

**Fabrication**

The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are, maintained. The tubular steel work shall be painted with one coat of approved steel primer after fabrication. All fabrication and welding is to be done in an approved workshop. The joint details shall be generally as per S.P-38 of B.I.S publication.

**Straightening**

All material before being assembled shall be straightened, if necessary, unless required to be of curvilinear form and shall be free from twist.

**Bolting**

Washers shall be specially shaped where necessary, or other means, used to give the nuts and the heads of bolts a satisfactory bearing.

In all cases, where the full area of the bolts is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together and washers of appropriate thickness shall be provided to allow the nuts to be completely tightened.

**Welding**

Where welding is adopted, it shall be as per IS 816.

**Caps and Bases for Columns**

The ends of all the tubes, for columns transmitting loads through the ends, should be true and square to the axis of the tubes and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

**Sealing of Tubes**

When the end of a tube is not automatically sealed by virtue of its connection by welding to another member the end shall be properly and completely sealed. Before sealing, the inside of the tubes should be dry and free from loose scale.

**Flattened Ends**

In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded. Riveted or bolted connections provide that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

**Hoisting and Erection**

Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workman. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-charge. The contractor shall however be fully responsible, for the work being carried out in a safe and

proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

**Measurements**

The work as fixed in place shall be measured in running metres correct to a centimeter on their weights calculated on the basis of standard tables correct to the nearest kilogram unless otherwise specified. Weight of cleats, brackets, packing pieces bolts nuts, washers distance pieces separators diaphragms gussets (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

**Rate**

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

**Providing and fixing inserts in concrete works**

Inserts are required to be fixed/embedded as indicated in construction drawings and/or as directed by Engineer-in-charge in foundations, columns and other miscellaneous concrete works. These inserts comprise plates, angles, pipe sleeves, anchor bolt assemblies, etc.

The rate quoted by the Tenderer shall hold good for accurately fixing the inserts at the correct levels/alignment and shall include for the cost of any temporary or permanent supports/anchors such as bars including cutting, bending, welding, etc. as required.

Steel templates shall be used by Contractor to locate and very accurately position bolts, group of bolts, inserts, embedded parts, etc. at his cost. Such templates shall be previously approved by the Engineer. Templates shall invariably be supported such that the same is not disturbed due to vibration, movement of labourers, materials, shuttering work, reinforcement, etc. while concreting. The Contractor will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at the locations of inserts as directed by the Engineer at no extra cost to OWNER. If the Engineer so directs, the inserts will have to be welded to reinforcement to keep them in place. Contractor shall be responsible for the accuracy of dimensions, levels, alignments and centre lines of the inserts in accordance with the drawings and for maintenance of the same until the erection of equipment/structure or final acceptance by Owner.

Contractor shall ensure proper protection of all bolts, inserts, etc. from weather and other damages by greasing or other approved means such as applying white lead putty and wrapping them with gunny bags or canvas or by other means as directed by Engineer to avoid damage due to movement of his labourers, material, equipment, etc. No extra claim from the Contractor on this account shall be entertained. Contractor shall be solely responsible for all the damages caused to bolts, inserts, etc. due to his negligence and in case damages do occur, they shall be rectified to the satisfaction of Engineer at the Contractor's cost.

### **Steel Work In Built Up Sections (Riveted and Bolted)**

The steel work in built up section (Riveted and bolted) such as trusses, framed work etc. is specified in this clause.

#### **Laying Out**

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the Engineer-in-Charge. Steel tape shall be used for measurements.

#### **Fabrication**

Fabrication shall generally be done as specified in IS 800. In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details or rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-charge. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints. Wooden or metal sheet templates shall be made to correspond to each member, and position of rivet holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions. The base of steel columns and the positions of anchor bolts shall be carefully set out at the required location. The steel section shall be straight or to be straightened or flattened by pressure unless required to be of curvilinear form and shall free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No tow pieces shall be welded or joined to make up for the required length of member.

**Making Holes:** Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

#### **Rivet Holes**

The diameter for rivets and black bolts holes shall be taken as the nominal diameter of a rivet/ black bolts plus 1.5 mm for rivets/ bolts of nominal diameter less than or equal to 25mm" and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts. Holes shall have their axis perpendicular to the surface



bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process.

Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

**Assembly** : Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall be fixed (or placed) tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover flange plates, shall have their ends flush with the tops of angles unless otherwise required. The web plate when spliced, shall have clearance of not more than 5mm. The erection clearance of cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, seating designed suitably shall be provided.

Column splices and butt joints of struts and compression members *requiring* contact for stress transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining. The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

**Riveting** : Rivets shall be used, where slip under load has to be avoided. Preliminaries before Rivetings:- Members to be riveted shall have all parts firmly placed and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

#### Process of Riveting

The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the Engineer-in-charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than 10mm may be driven cold. Rivets shall be finished neat with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly. All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (Specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar where so specified, other tests shall be carried out to ensure the soundness of rivets. All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

**Bolting** : The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly. Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nut, spring washers as directed by the Engineer-in-charge.

### **Erection**

Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-charge in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

The work of erection may be done in suitable units as may be directed by the Engineer-in-Charge. Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over-turning or collapse by suitable means. During execution, the steel members shall be securely bolted or otherwise fastened when necessary temporarily braced to provide for all loads including those due to erection equipments and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.

Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible. The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For larger spans the truss shall be provided with proper bearing as per design.

Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3(1 cement: 3 coarse sand) or as specified.

**Bedding of Column, Stanchions etc.:-** Bedding shall not be carried out until the steel work has been finally levelled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoried buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made upto 25 mm which shall be pressure grouted with cement grouts. With small columns, if permitted by the Engineer-in-charge, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

### **Painting**

Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified

### **Measurements**

The work as fixed in position shall be measured in running metres correct to a millimeter and their weight calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Steel sections shall be acceptable within tolerance limits. Payment for steel

sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower than permissible variation shall not be acceptable.

Unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivet heads. Unless otherwise specified and addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m<sup>2</sup>. The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m<sup>2</sup> for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### **Rate**

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

#### **STEEL WORK IN BUILT UP SECTION (WELDED)**

The steel work in built up sections (welded) such as in trusses, form work etc. is specified in this clause.

#### **Laying out**

It shall be as specified.

#### **Fabrication**

Straightening, shaping to form, cutting and assembling, shall be as per 10.3.2 as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

**Welding** : Welding shall generally be done by electric arc process as per IS 816 and IS 823.

The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only be resorted to using oxyacetylene flame with specific approval of the Engineer-in-charge. Gas welding shall not be permitted for structural steel work Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses. The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813. As far as possible every efforts shall be made to limit

the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

**Precautions:** All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

Operation, Workmanship and process of Welding is described in Appendix B, Inspection and testing of welds shall be as per IS 822.

**Assembly:** Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

**Erection:** The specification shall be as described except that while erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended.

Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed. 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

**Painting :** Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified.

**Measurements:** The mode of measurements shall be the same as specified except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

#### **Rate**

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

#### **Providing and fixing in position grill, railing, steel ladder, etc.**

This work shall be carried out as per the detailed drawings. The MS sections shall be of approved quality. The welding shall be perfect and the junctions shall be ground properly.

The frames shall be provided with hold fasts and the same shall be grouted with CC blocks in brick work. It shall be painted with two coats of zinc chromate primer and two coats of synthetic enamel paint of approved make and colour.

#### **Providing & Fixing MS holding down bolts**

The MS holding down bolts of specified dia, length and shape shall be provided as per the drawings in line & level. These shall be fixed to RCC work or brick work by grouting it with concrete. The bolt shall be provided with nuts and washers. The grease shall be applied to the threaded portion with the help of templates. If the bolts need some adjustment it shall be provided with a wooden piece 75x75 mm or 50 mm dia GI pipe around bolt shall be provided at the time of concreting and shall be removed after initial set.

#### **STAINLESS STEEL WORK**

The Stainless steel railing pipes, hardware's & accessories of specified grade to be supplied and installed at site as per the above mentioned specifications as per BOQ , drawings and approved by the Engineer-in-Charge.

Material Properties:

The material properties of stainless steel pipes and accessories should be conforming to SS 316 grade.

Stainless Steel Works

The stainless steel pipes shall be procured from approved manufacture and of approved grade. The quality of stainless steel sheet and pipe shall be approved by Client/Consultant before proceeding with execution any item of work.

Hand Rail

The pipe used for handrail shall be of 14 gauge thick. The welded links are to be ground and organ buffed to get the original finish of the surface of the material welded. The joints or junctions where two pieces are joined/welded to be precisely cut and then welded.

Surface Finish

Surface finish of all the stainless steel materials will be satin finish free from all marks and blemishes.

Execution

The execution shall be carried out at site respectively as per the BOQ and drawings.

Accessories

Fixing will be done by stainless steel bolts and joining shall be with SS connectors of approved type, size and make as per direction of Engineer-in-charge and welding to be done by using organ welding rods and the surface being duly finished and cleaned by K<sub>2</sub> passivation, which is nitric acid plus fluoric acid solution treatment by which the chances of corrosion will be eliminated and any burn out makes on the metal will also be eliminated.

Final Cleaning:-

Protective coating and warning markings shall remain undisturbed until final acceptance. Immediately prior to final inspection, temporary protective covering or coating shall be removed

and surfaces shall be washed with a suitable thinner and left in a finished condition having approved uniform appearance and free from all marks and blemishes.

#### Fabrication & Tolerances

Unless otherwise shown on the drawing, the fabricating tolerances shall generally be as follows:

**Straightness:** Compression members shall not deviate from straightness by more than 1/1000 of the axial length between points, which are to be laterally supported.

Completed members shall be free from twist bends and open joints. Sharp links or bends shall be cause for rejection of material.

**Length:** of 1mm is permissible in the overall length of members with parts of the structure, shall have a variation for the detailed length not greater than 2mm for members 10 meters or less in length and not greater than 3mm for members over 10 meters in length.

**Inspection:-**

The Agency should arrange for factory inspection of all stainless steel material and glass to ascertain the quality of material i.e. stainless steel fixtures / accessories and glass as per manufacturer's standard / BIS / ASTM standard as per specification to the satisfaction of Engineer in charge.

#### **Measurement**

The work as fixed in place shall be measured in running metres correct to a centimeter on their weights calculated on the basis of standard tables correct to the nearest kilogram unless otherwise specified & Rates shall be inclusive of all stainless steel pipes and fittings required vertically or horizontally per running meter of composite section of railing including all stainless steel components complete as per the BOQ as required. Glass railing shall be measured in running meter.

#### **Rate**

The rate shall include the cost of all materials like, Stainless Steel pipes, Stainless steel fitting & accessories, other fixing material ,T & P, scaffolding and labour involved in all the operations described above including fixing/installation, lead & lift etc. as applicable.

#### **CERAMIC TILES IN FLOORING, SKIRTING AND DADO**

The ceramic tiles in flooring and dado shall be of first class quality as specified in the item specification and shall be approved by the Engineer. The tiles shall be of standard size without warp and with straight edges, true and even in shape and size and of uniform colour. The tiles surface shall be of fine grained texture, dense and homogeneous. The thickness of the tile shall be as per the item specification. The tiles shall be submerged in water till the bubbles cease.

They should be laid on a base of 12 mm thick mortar bed (cement or lime 1:3 sand) and cement (3 kg/sq.m) paste. They shall be laid truly vertical on walls and truly horizontal on floors or to slopes as directed. The joint shall be very thin, uniform and perfectly straight. The tiles in dado shall be finished in such a way that, only the tile thickness projects over the finished plaster or as specified otherwise. Where full tiles are not possible, the same

should be cut or sawn to the required size and their edge rubbed to ensure straight and true joints. After the tiles are laid extra cement grout shall be removed. The joints shall be cleaned with wire brush and then the joint shall be floated with white or gray cement as approved by the Engineer. The tiles shall be cleaned after the work is complete.

#### **Measurement**

Measurements shall be taken correct to a cm in length and breadth and correct to 0.5 cm in thickness.

#### **Rate**

The rate shall include the cost and conveyance of all materials and labour involved in all the operations described above including the cost of material with wastage if any, cost of adhesive, cost of jointing with epoxy grout, rubbing, lead, lift etc. as applicable.

### **MANHOLE COVERS & FRAMES**

#### Manhole Covers

The covers and frames shall conform to IS 1726 for cast Iron and IS 12592 for pre-cast concrete covers and shall be of the following grades and types. Grades Grade Type/shape of cover Designation Light Duty LD - 2.5 Rectangular, Square, Circular Medium Duty MD - 10 Rectangular, Circular and Square (for pre-cast concrete manhole covers) Heavy Duty HD - 20 Circular-Square, Rectangular, (Scraper Manhole) Extra Heavy Duty EHD - 35 Circular, Square, Rectangular, (Scraper Manhole)

#### **Cast Iron Manhole Covers and Frames**

- (i) Manhole covers and frame shall be manufactured from appropriate grade of grey cast iron not inferior than FG150 grade of IS 210.
- (ii) They shall be cleanly cast and shall be free from air and sand holes, cold shuts and warping. (iii) Covers shall have on its operative top a raised chequered design to provide for an adequate no-slip grip. The rise of chequers shall be not less than 4mm.
- (iv) Key holes, keys and lifting devices shall be provided in the manhole covered to facilitate their placement in the frames and their operative maintenance.
- (v) Manhole covers and frames shall be coated with materials having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.
- (vi) Size and shape and performance requirement of manhole covers and frames shall conform to IS 1726.
- (vii) Each manhole covers and frame shall have cast on them the following information:
  - (a) Manufacturer's name or trade-mark
  - (b) Grade designation
  - (c) Date of manufacturer
  - (d) The words SWD or 'Sewer' to denote 'storm water drain' or 'sewer' respectively



- (e) Identification marks as required by Engineer-in-Charge.
- (viii) The cover shall be gas tight and water tight.
- (ix) The sizes of covers specified shall be taken as the clear internal dimensions of the frame.
- (x) The approximate weight of the various type of manhole covers and frames shall be as per IS 1726.
- (xi) The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

**Measurements:**

The manhole covers shall be enumerated under relevant items.

**Rates:**

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

**MOISTURE RESISTANT/FIRE RESISTANT 6 MM THICK FIBER CEMENT BOARD**

**Nominal Length and Width**

Flat fibre cement sheets shall be available in nominal lengths up to 3 000 mm and nominal widths up to 1240 mm.

**Min. Modulus of Rupture:** For 6mm & 9mm :13MPA

**Thickness:** Flat fibre cement sheets shall be 6, 8, 9mm.

**Tolerances on Dimensions:** Tolerances on nominal dimensions shall be as follows:

(a) On length and width (indicated by d)

$d < 1000 \text{ mm} : \pm 5\text{mm}$

$1000 \text{ mm} < d < 1600 \text{ mm} : \pm 0.5 \text{ percent}$

$d > 1600 \text{ mm} : \pm 8\text{mm}$

These tolerances do not apply to oversize sheets.

(b) On thickness, e :

$e < 6\text{mm} : \pm 0.6\text{mm}$

$e > 6\text{mm} : \pm 10\text{percent}$

For sheets without texture on the exposed face, the maximum difference between extreme values of the thickness measurements within one sheet shall not exceed 15 percent of the maximum measured value

**Tolerances on Shape**

**Straightness of edges:** The tolerance on the straightness of edges shall be 3 mm/m for the relevant dimension (length or width) when measured in accordance with the method given

**Squareness of edges:** The tolerance on the squareness of sheets shall be 4 mm/m when measured in accordance with the method given.

**Acceptance Tests**

The objective of an acceptance test is to establish whether a batch of products conforms to a specification. The tests shall be performed on samples drawn either from continuous

production or from a consignment (see also 8). The acceptance test shall be carried out at the manufacturer's works on sheets and test specimens cut from sheets as delivered. The following acceptance tests shall be carried out:

- (a) Dimensional and geometrical characteristics (compulsory) ,
- (b) Bending strength (compulsory) , and
- (c) Apparent density (compulsory).

**Method for testing:** As per IS 14862 2000

#### **Fixing**

Fixing the moisture resistant/ fire resistant 6mm thick fibre cement board (High Pressure Steam

cured) with necessary accessories & GI self drilling/ tapping screws etc., of required size (Screws

shall be of counter sunk rib head of 1.60mm to 4 mm thick of 8 to 10 gauge of length varying from 25

to 45 mm), and filling the groove (i.e. 2-3mm gap between boards), taping and jointing of the first

layer 6mm and 9mm thick fiber cement boards with epoxy based sealing compound or with silicon

sealant. Second layer is fixed over it in a staggered pattern, with suitable arrangement as per approval of Engineer-in-charge.

#### **Measurement:**

The length and breadth of fibre cement board shall be measured correct to the nearest cm and

area worked out in square metres correct to two places of decimal.

#### **Rate:**

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

above. Nothing extra shall be paid for fixing arrangement i.e. drilling, nut & bolts, filling groove etc.

#### **REPAIRS TO PLASTER**

The work includes cutting the patch and preparing the wall surface. Patches of 2.50 square metres and less in area shall be measured under item of 'Repairs to Plaster' under this sub-head. Plastering in patches over 2.5 square metres in area shall be paid for at the rate as applicable to new work under sub head 'Finishing' in CPWD specifications 2019.

#### **Scaffolding**

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder or jhoola these will be permitted in place of scaffolding.

#### **Cutting**

The mortar of the patch, where the existing plaster has cracked, crumbled or sounds hollow

when gently tapped on the surface, shall be removed. The patch shall be cut out to a square or rectangular shape at position marked on the wall as directed by the Engineer-in-Charge or his authorized representative. The edges shall be slightly under cut to provide a neat joint.

**Preparation of Surface**

The masonry joints which become exposed after removal of old plaster shall be raked out to a minimum depth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking shall be carried out uniformly with a raking tool and not with a basuli, and loose mortar dusted off.

The surface shall then be thoroughly washed with water, and kept wet till plastering is commenced. In case of concrete surfaces, the same shall be thoroughly scrubbed with wire brushes after the plaster had been cut out and pock marked as described in 13.1.2 of CPWD specifications 2019. The surface shall be washed and cleaned and kept wet till plastering is commenced.

**Application of Plaster**

Mortar of specified mix with the specified sand shall be used. The method of application shall be as described for single coat plaster work of the specified mix and under Chapter 13 of CPWD specifications 2019. The surface shall be finished even and flush and matching with the old surrounding plaster. All roundings necessary at junctions of walls, ceilings etc. shall be carried out in a tidy manner as specified in sub-head 13.0 of CPWD specifications 2019. All dismantled mortar & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.

**Protective Measure**

Doors, windows, floors, articles of furniture etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages, if any, to furniture or fittings and fixtures shall be recoverable from the contractor.

**Curing**

Curing shall be done as per plaster work with special reference to the particular type of plaster mix as described under sub-head 'finishing'.

**Finishing**

After the plaster is thoroughly cured and dried the surface shall be white washed or colour washed to suit the existing finishing as required unless specified.

**Measurements**

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Patches below 0.05 square metre in area shall not be measured for payment. Pre- measurements of the patches to be plastered shall be recorded after the old plaster has been cut and wall surface prepared.

**Rate**

The rate includes the cost of all the materials and labour involved in all the operations described above including lead as described in the item for disposal of old dismantled plaster /material.

### **TECHNICAL SPECIFICATIONS – CIVIL WORKS**

#### **SPECIFICATIONS FOR CLEARING AND GRUBBING**

200.1.1. **Scope** - This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., which in the opinion of the engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications.

200.1.2. **Preservation of property/amenities** - Roadside trees, shrubs, any other plants, pole, lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The contractor shall provide and install at his own expense, suitable safeguards approved by the engineer for this purpose.

During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide clause 300.6. Before start of operations, the contractor shall submit to the engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc., and the schedules for carrying out temporary and permanent erosion control works as stipulated in clause 300.6.3.

200.1.3. **Methods, tools and equipment** - Only such methods, tools and equipment as are approved by the engineer and which will not affect the property to be preserved shall be adopted for the Work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation to the satisfaction of the engineer. On areas beyond these limits, trees and stumps required to be removed as directed by the engineer shall be cut down to 1m below ground level so that these do not present an unsightly appearance. All branches of trees extending above the roadway shall be trimmed as directed by the engineer. All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Anti-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres, shall be suitably treated.

200.1.4. **Disposal of materials** - All materials arising from clearing and grubbing operations shall be the property of government and shall be disposed of by the contractor as hereinafter provided or directed by the engineer.

Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in road construction shall be neatly stacked as directed by the engineer. Stacking of stumps, boulders, stones, etc., shall be done at specified spots with all lifts and upto a lead of 1000m.

All products of clearing and grubbing which, in the opinion of the engineer, cannot be used or auctioned shall be cleared away from the roadside in a manner as directed by the engineer. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixed up with the materials meant for embankment, subgrade and road construction.

200.1.5. **Measurements for payment** - Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same. Cutting of trees upto 300 mm in girth including removal of stumps and roots after obtaining prior clearance from the forest department/authorities and trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps left over after trees have been cut by any other agency shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots if trees of girth above 300 mm and backfilling to required compaction shall be measured in terms of number according to the sizes given below :-

- (i) Above 300 mm to 600 mm
- (ii) Above 600 mm to 900 mm
- (iii) Above 900 mm to 1800 mm
- (iv) Above 1800 mm

For this purpose, the girth shall be measured at a height of 1 metre above ground or at the top of the stump if the height of the stump is less than one metre from the ground.

#### 200.1.6. **Rates**

200.1.6.1. The contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm in girth as well as stumps left

over after cutting of trees carried out by another agency, excavation and back-filling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m.

200.1.6.2. The contract unit rate for cutting (including removal of stumps and roots) of trees of girth above 300 mm shall include excavation and backfilling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m.

200.1.6.3. Where a contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the contract unit prices for the same shall be considered as including clearing and grubbing operations.

## **1.EARTH WORKS**

### 1.1 General

Before beginning excavation or filling, the Engineer-in-Charge and Contractor shall jointly survey and record all ground levels on the site. The area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, tree and saplings of girth up to 30 cm measured at a height of one metre above ground level and rubbish removed up to a distance of 50 meters outside the periphery of the area under clearance. The roots of trees and saplings shall be removed for the stilt floor construction level, whichever is lower, and the holes or hollows filled up with the earth, rammed and leveled.

### 1.2 Excavation

Excavation for roads, pavements, concrete drains, outfalls, various foundations, etc. shall be considered under this category.

The whole of the excavation for the works shall be carried out to the required widths, lengths and depths and within the approved lines and levels or as directed by the Engineer-in-Charge. Any excavation beyond such limits or instructions shall be made good by filling with M-10 concrete or other approved materials to the required compaction, by the Contractor, at his own expense to the satisfaction of the Engineer-in-Charge.

The Contractor shall provide all shoring, timbering or other approved support to the sides of the excavations as may be necessary to prevent any ground movement. The Contractor shall bear all responsibility connected with such shoring including dewatering notwithstanding the Engineer-in-Charge's Approval. Cost of all such shoring, etc. shall be deemed to be included in the prices.

All excavation except where otherwise noted shall be required to be kept completely free from water, from whatever source it may come at all times to the entire satisfaction of the Engineer-in-Charge. Cost of dewatering shall be deemed to have been included in the rates quoted.

The bottom of all excavations shall be trimmed and leveled and compacted properly to the satisfaction of the Engineer-in-Charge. A bottom layer of 150 mm thick shall be left undisturbed and removed only when concrete is about to be placed in order to prevent softening or deterioration of the surface of the bottom of the excavation due to exposure.

A masonry pillar to serve as a bench mark will be erected at a suitable point in the area, which is visible from the largest area. This bench mark shall be constructed and connected with the standard bench mark as approved by the Engineer-in-Charge. Necessary profiles with strings stretched on pegs, bamboos or "Burjis" shall be made to indicate the correct formation levels before the work is started. The contractor shall supply labour and material for constructing bench mark, setting out and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or "Burjis" and the bench mark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

The ground levels shall be taken at 5 to 15 metres intervals (as directed by the Engineer-in-Charge) in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. The plans shall be drawn to a scale of 5 metres to one cm or any other suitable scale decided by the Engineer-in-Charge. North direction line and position of bench mark shall invariably be shown on the plans. These plans shall be signed by the contractor and the Engineer-in-Charge or their authorized representatives before the earth work is started. The labour required for taking levels shall be supplied by the contractor at his own cost.

During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

In firm soils, the sides of the trenches shall be kept vertical up to a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal: 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping, sloping or shoring to be done for excavation deeper than 2 metres.

The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge shall be measured and recorded for payment.

While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly

dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils. In all other cases where the excavation is taken deeper or made wider by the contractor, it shall be brought to the required level/width by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed.

The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge considering feasibility, urgency of work, availability of labour/mechanical equipments and other factors involved. Contractor shall ensure every safety measure for the workers. Neither any deduction nor extra payment will be made on this account.

#### 1.2.1 Safety and Emergency Procedures

The Contractor shall take all necessary precautions to ensure stability of his excavations and shall take all necessary precautions and be responsible for the safety of personnel in the area of operation. He shall maintain, available for immediate use, a sufficient quantity of slurry to allow for any sudden loss. Should the loss continue despite the addition of the slurry and the stability of the trench be placed at risk, the Contractor shall backfill with lean mix concrete to preserve the stability of the trench and ensure the safety of neighbouring structures and utility services.

#### 1.2.2 Obstructions

An obstruction is defined as material, the excavation of which hinders normal progress and the existence of which could not have been foreseen. Upon encountering an obstruction, the Contractor shall determine the method to be employed in removing the obstruction.

#### 1.3 Disposal

Excavated materials deemed suitable by the Engineer-in-Charge for filling in other areas within a lead of five kilometers, shall be filled as directed by the Engineer-in-Charge.

Unsuitable or excess excavation material and debris shall be transported to spoil areas within a lead of five kilometers as defined and approved by the Engineer-in-Charge. Material shall be end dumped, graded and leveled at these areas to the grades and levels specified by the Engineer-in-Charge. Cost of such disposal shall be deemed to have been included in the price.

#### Backfill



Backfill shall contain no ashes, rubbish combustible or decomposable material, nor any other material, which the Engineer-in-Charge deems unsuitable for this purpose.

All material used as backfill / fill under structures or concrete slab or around structures or trenches and pits shall be placed in layers not exceeding 300 mm and compacted to a minimum of 95% of the maximum laboratory dry density as per IS: 2720 (Part 8) and as directed by the Engineer-in-Charge. Backfilling of trenches shall not commence till the respective piping and electrical cables/conduits have been approved by the Engineer-in-Charge.

#### Compaction Control of Fill Material

The Contractor shall provide all the testing equipment, facilities and personnel required for the work. The number and periodicity of tests required to be conducted at the Site of fill shall be determined by the Engineer. The Contractor shall submit to the Engineer-in-Charge prior to commencement of work a detailed execution plan indicating the method of compaction and the compaction tests he proposes to conduct. All compacting and testing equipment and method of compaction proposed by the Contractor shall be subject to the prior approval of the Engineer.

Control shall be exercised on each layer by taking at least one measurement of density for each 1000 square meters of compacted area or closer as required to yield the minimum number of test results for evaluating a day's work on statistical basis. The determination of density shall be in accordance with IS: 2720 (Part 28). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 6 as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurements shall be increased to 10. The acceptance criteria shall be subject to the condition that the mean density is not less than the specified density plus:  $[1.65 - 1.65 / (\text{No. of Samples})^{0.5}]$  times the standard deviation.

However, for earthwork in shoulders (earthen) and in the sub grade, at least one density measurements shall be taken for every 500 Sq.m for the compacted area provided further that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

Earthworks and all components thereof should satisfy the following tests and codes:

S.No	I.S. No.	Description
1	IS 632	Gamma - BHC (Lindane) emulsifiable concentrates

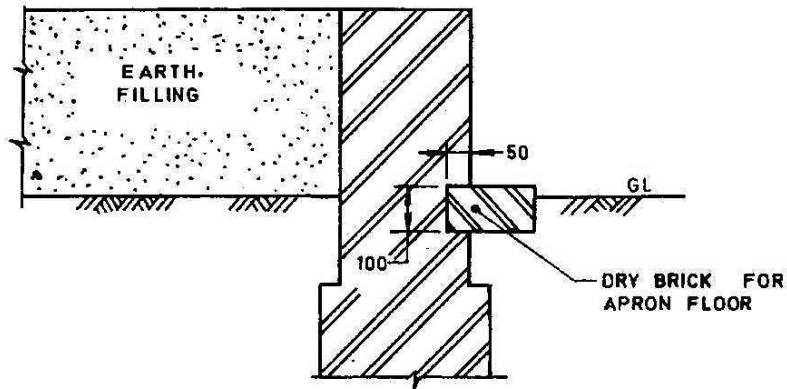
2	IS 1200 (Part 1)	Method of measurement of Earth work
3	IS 1200 (Part 27)	Method of measurement of Earth work (by Mechanical Appliances)
4	IS 4081	Safety code for Blasting and related drilling operation
5	IS 4988 (Part 4)	Excavators
6	IS 6313 (Part 2)	Anti Termite measures in buildings (pre-construction)
7	IS 6313 (Part 3)	Anti Termite measures in buildings (post-construction)
8	IS 6940	Methods of test for pesticides and their formulations
9	IS 8944	Chloropyrifos emulsifiable concentrates
10	IS 8963	Chloropyrifos – Technical specifications
11	IS 12138	Earth moving equipments

### ANTI-TERMITE WORK

#### 3.2.6 SPECIFICATIONS FOR INTERNAL AND EXTERNAL ANTI-TERMITE MEASURES

3.2.6.1 **Construction methods** - The construction methods as specified may be adopted for protection against subterranean termites originating both internally from within and externally from the area surrounding the building. Stagewise details are given.

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



All dimensions in millimetres.

around the periphery (see Fig. 4.)

Fig 4 Anti-Termite construction (Stage 1)

3.2.6.3 Brick on edge in cement mortar shall be laid on the plinth wall. Dry brick shall be placed on the inner side of the plinth wall for getting anticipated offset space for coarse sand

and on the other side for installing anti-termite masonry groove. In the case of intermediate walls, dry bricks are placed on either side of the brick on edge masonry for getting offset space for coarse sand layer (see Fig. 5).

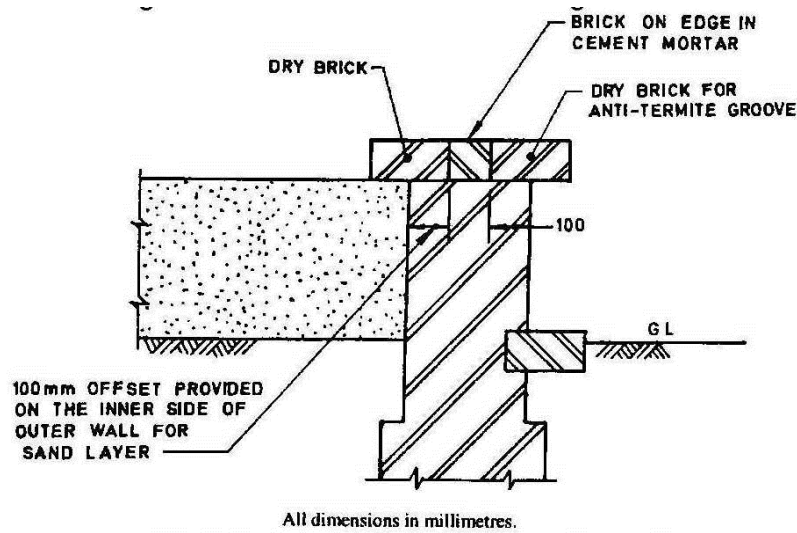


Fig 5 Anti-Termite construction (Stage 2)

3.2.6.4 The dry brick for the anti-termite groove shall be taken out and cement concrete (1:3:6) sub-floor shall be laid casting an anti-termite groove in position. In case of internal protection walls, the cement concrete sub-floor shall be laid on either side over dry bricks to sufficient extent for getting staggered vertical joints over the joint of plinth wall and earth filling (see Fig. 6.)

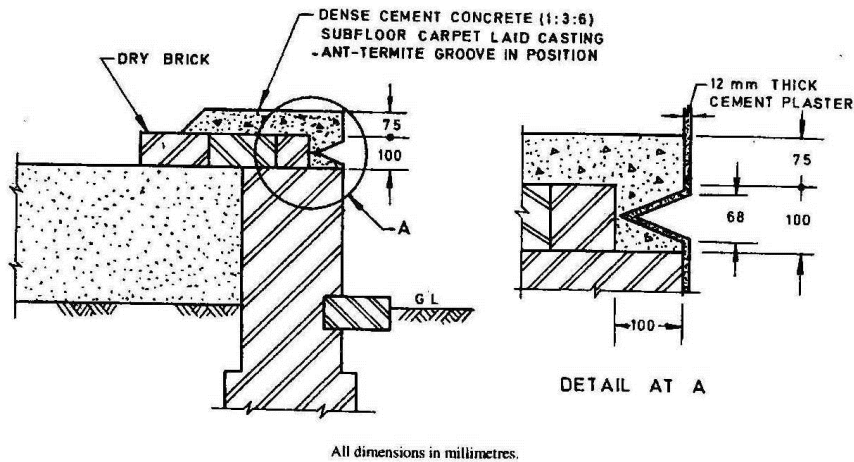


Fig 6 Anti-Termite construction (Stage 3)

3.2.6.5 Superstructure masonry shall be raised over the cement concrete sub-floor and overhead jobs completed (see Fig. 7).

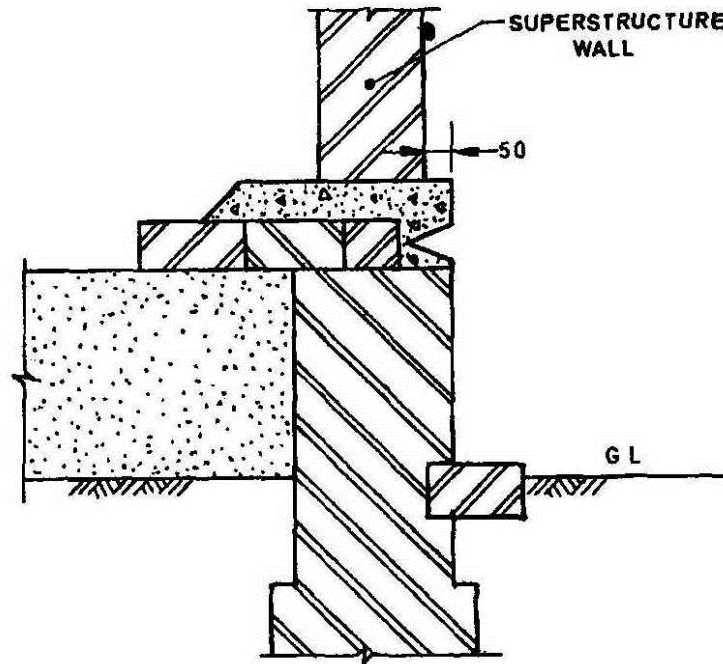


Fig 7 Anti-Termite construction (Stage 4)

3.2.6.6 The dry brick for coarse sand filling shall be removed and graded sand (of size 4 mm to 5 mm) layer at least 100 mm thick shall be compacted over the earth filling (see Fig. 8).

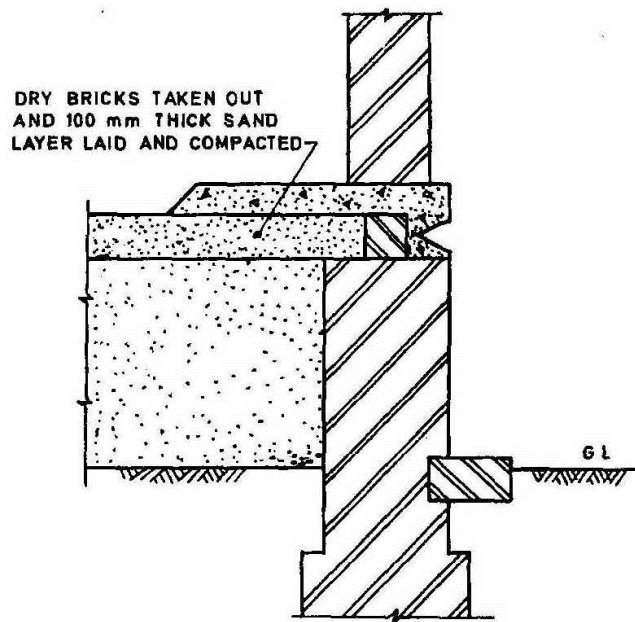


Fig 8 Anti-Termite construction (Stage 5)

3.2.6.7 Cement concrete (1:3:6 mix) sub-floor at least 75 mm thick shall be laid over the sand filling. Masonry finish may be provided to the cement concrete sub-floor (see Fig. 9).

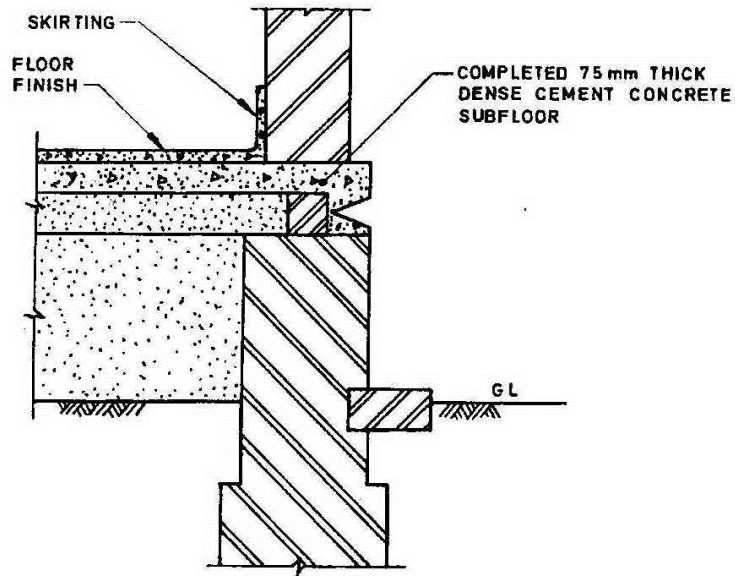


Fig 9 Anti-Termite construction (Stage 6)

3.2.6.8 Dry brick provided for apron floor (see Fig. 1) shall be taken out and 600 mm wide formation of earth of 1:30 slope shall be made. Over the formation 75 mm thick lime concrete (1:3:6 mix) shall be laid (see Fig. 10).

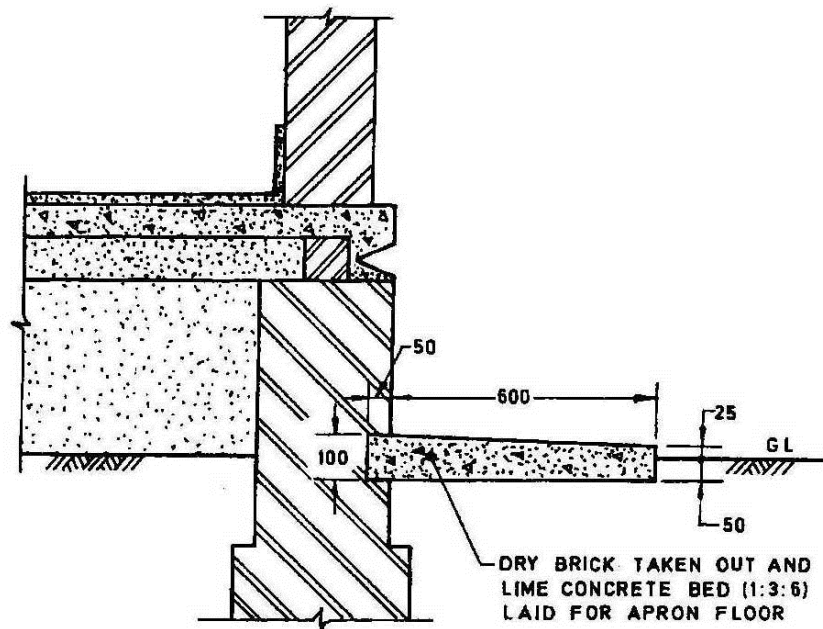


Fig 10 Anti-Termite construction (Stage 7)

3.2.6.9 Over the 75 mm thick lime concrete bed at least 25 mm thick cement concrete topping (1:2:4) shall be laid and 12 mm thick cement plaster shall be applied on the plinth (see Fig. 11).

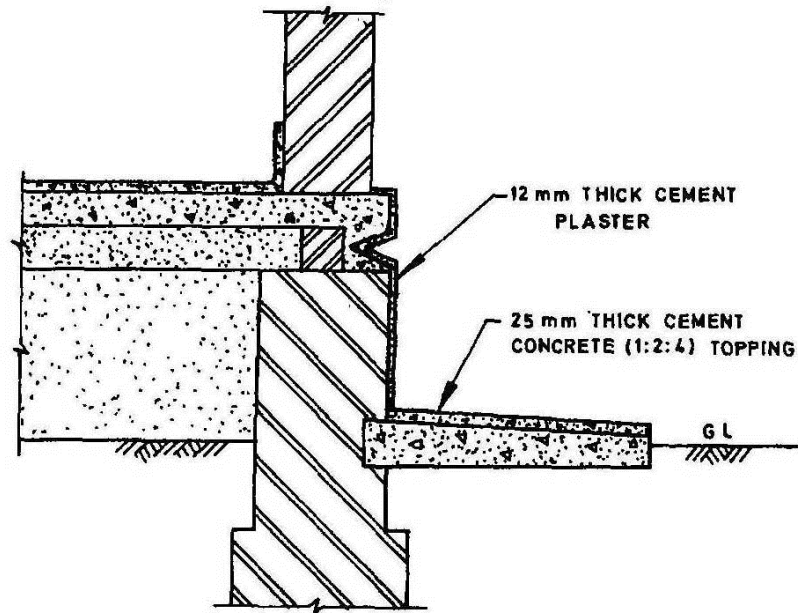


Fig 11 Anti-Termite construction (Stage 8)

3.2.6.10 The finished construction, incorporating the stages as mentioned appears as in Fig. 12

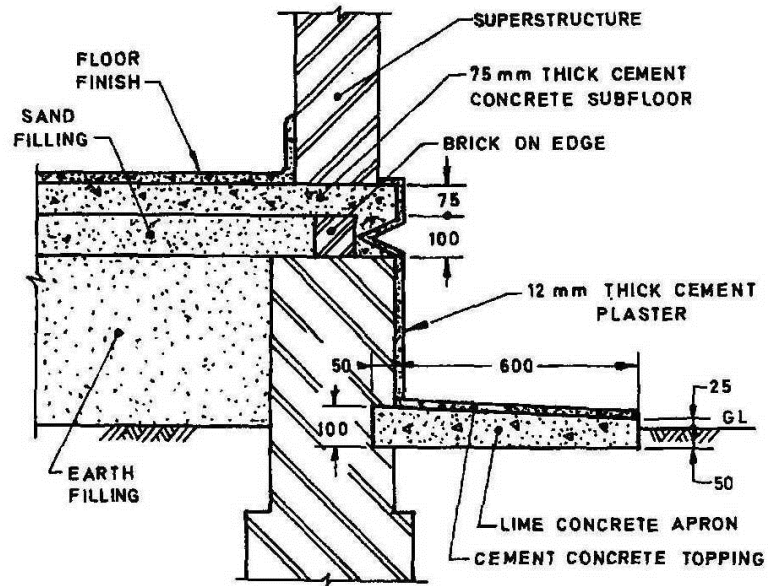


Fig 12 Anti-Termite construction – Final Recommendations

3.2.6.11 The finished construction for stone masonry incorporating the stages as mentioned would be as in Fig. 13 without plaster.

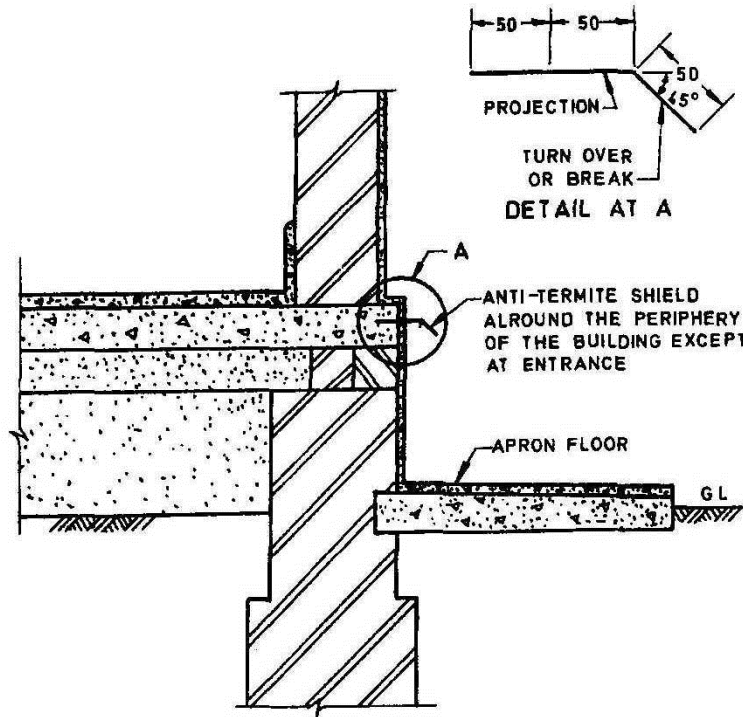


Fig 13 Anti-Termite shield at plinth level

## 2. CONCRETE WORK

4.0 The concrete can be designed in grades denoting by volumetric proportion of the constituents' characteristic compressive strength. The concrete by volumetric proportion or nominal mix concrete of the constituents as well as Design Mix denoting compressive strength as detailed in this section.

### 4.1. Materials.

Water, cement, lime, fine aggregate or sand, surkhi, cinder and fly ash shall be as specified in Section 0.

#### Coarse aggregate

4.1.2.1. General - Aggregate most of which is retained on 4.75 mm IS Sieve and contains only as much fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Coarse aggregate shall be specified as stone aggregate, gravel or brick aggregate and it shall be obtained from approved / authorised sources

a) Stone aggregate -It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean. It shall be free from veins, adherent coating, and injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided. It shall conform to IS: 383 unless otherwise specified.

b) Gravel - It shall consists of naturally occurring (uncrushed, crushed or broken ) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, and loam adherent coating, alkali vegetable, matter and other deleterious substances. Pit gravel shall be washed if it contains soil materials adhering to it. These shall soil materials soil materials adhering to it. These shall conform to IS: 383 unless otherwise specified.

c) Brick aggregate - Brick aggregate shall be obtained by breaking well burnt or over burnt dense bricks / brick bats. They shall be homogenous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil vegetable matter and other deleterious substances. Such aggregate should not contain more than one percent of sulphate and should not absorb more than 10% of their own mass of water, when used in cement concrete and 20% when used in lime concrete. It shall conform to IS: 383 unless otherwise specified.

d) Lightweight aggregates such as sintered fly ash aggregate may also be used provided the engineer is satisfied with the data on the proportion of concrete made with them.

4.1.2.2. Deleterious material - Course aggregate shall not contain any deleterious material, such as pyrites, coal, lignite, shale or similar laminates material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Coarse aggregate to be used for reinforced cement concrete shall not contain any material liable to

the steel reinforcement. Aggregates which are chemically reactive with alkali of cement shall not be used. The maximum quantity of deleterious material shall not more than five per cent of the weight of coarse aggregate when determined in accordance with IS: 2386 part II.

#### 4.1.2.3. Size and grading

(i) Stone aggregate and gravel - It shall be either graded or single sized as specified. Normal size and grading shall be as under --

(a) Nominal sizes of graded stone aggregate or gravel shall be 40, 20, 16, or 12.5 mm as specified. For any one of the nominal sizes, the proportion of other sizes shall be in accordance with Table 1.

Table 1 -Graded stone aggregate or gravel



IS Designation	Sieve	Percentage passing (by weight) for nominal size of			
		40 mm	20 mm	16 mm	12.5 mm
75 mm		100	-	-	-
37.5 mm		95 to 100	100	-	-
19 mm		-	95 to 100	100	100
16 mm		-	-	90 to 100	-
11.2 mm		-	-	-	90 to 100
9.5 mm		10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm		0 to 5	0 to 10	0 to 10	0 to 10
2.36 mm		-	-	-	-

Concrete work

(b). Normal sizes of single sized stone aggregate or gravel shall be 63, 40, 20, 16, 12.5 or 10 mm as specified. For any one of the nominal sizes the proportion of other sizes shall be in accordance with Table 2.

Table 2 -Single sized (ungraded) stone aggregate or gravel

IS Sieve Designation	Percentage passing (by weight) for nominal size of					
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
75 mm	100	-	-	-	-	-
63 mm	85-100	100	-	-	-	-
37.5 mm	0-30	85-100	100	-	-	-
19 mm	0-5	-20	85-100	100	-	-
16 mm	-	-	-	-85-100	100	-
11.2 mm	-	-	-	-	85-100	100
9.5	-	0-5	0-20	0-30	0-45	85-
100						
4.75 mm	-	-	0-5	0-5	0-10	0-20
2.36 mm	-	-	-	-	-	0-5

c). When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sizes aggregate of different sizes in the proportion to be determined by field tests to obtain graded aggregate of specified nominal size. For the required nominal

size, the proportion of other sizes in mixed aggregate shall be in accordance with Table 1. Recommended proportions by volume for mixing of different sizes of single size (ungraded) aggregate to obtain the required nominal size of graded aggregate are given in Table 3.

Table 3 -Single sized (ungraded) stone aggregate or gravel

Cement Concrete	Nominal size of graded aggregate required	Parts of single size aggregate of size				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
1: 6:12	63	9	-	3	-	-
1: 6: 12	40	-	9	3	-	-
1: 5: 10	63	7 ½	-	2 ½	-	-
1: 5: 10	40	-	7 ½	2 ½	-	-
1: 4: 8	63	6	-	2	-	-
1: 4: 8	40	-	6	2	-	-
1: 3: 6	63	4 ½	-	1 ½	-	-
1: 3: 6	40	-	4 ½	1 ½	-	-
1: 3:6	20	-	-	4 ½	-	-
1: 2: 4	40	-	2 ½	1	-	½
1: 2: 4	20	-	-	3	-	1
1: 2: 4	12.5	-	-	-	3	-
1: 1 ½ : 3	20	-	-	2	-	1

Note-(i) The proportions indicated in Table 3 above are by volume when considered necessary, these proportions may be varied marginally by engineer after making sieve analysis of aggregate brought to site for obtaining required graded aggregate. No adjustments in rate shall be made for any variation in the proportions so ordered by the engineer. If single size coarse aggregates are not premixed at site to obtain the graded coarse aggregate required for mix, the volume of single size aggregates required for the mix shall be suitably increased to account for reduction in total volume at the site of mixing.

(ii) Brick aggregate - Nominal size of brick aggregate shall be 40 mm and its grading shall be as specified in the Table 4 when tested for sieve.

Table 4 -Brick aggregate

IS Sieve Designation(by weight)	Percentage passing
---------------------------------	--------------------

75 mm	100
37.5 mm	95-100
19.0 mm	45-100
4.75	0-5

Note -Coarse aggregate for cement concrete shall generally conform to para 4.2.1 of IS: 456 and fine aggregate shall conform to IS: 383.

4.1.2.4. Stacking - Aggregate shall be stacked on a hard, dry and level patch of ground. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

4.1.2.5. Testing - Coarse aggregate shall be tested for the following (as per IS: 2386 )

Determination of particle size and shape

Estimation of organic impurities (as per IS: 2386-Part II )

Surface moisture

Determination of 10% fine value

Measurements - The aggregates shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks in respect of aggregates of nominal size 40 mm and above. No deduction from the gross measurements of the stacks is to be made in respect of aggregates nominal size below 40 mm.

Admixtures - When required, admixtures of approved quality shall be mixed with concrete, as specified. The admixtures shall conform to IS: 9103.

## 4.2. SPECIFICATIONS FOR CEMENT CONCRETE

4.2.0. This shall be prepared by mixing graded stone or brick aggregate of nominal size as specified with fine aggregate and cement in specified proportions with required quantity of water. The grading and quality of aggregates shall be such as to give minimum compressive strength of 140 kg/cm<sup>2</sup> and 210 kg / cm<sup>2</sup> at 7 days and 28 days respectively in case of mix 1:2:4, (One cement - two Coarse sand - four stone aggregate).

One sample consisting of 6 cubes 15x15x15 cm shall be taken for every 15 cubic meter or part thereof cement concrete 1:2:4. The cube tests shall not be carried out in case the quantity of cement concrete placed on any day is less than 15 cubic meter unless otherwise specific. For other details, refer section on R.C.C. work.

4.2.1. Proportioning - It shall be done by volume. Boxes of suitable size shall be used for measuring sand and aggregate. The internal dimensions of the boxes shall be generally 35 X 25 X40 cm deep or as otherwise approved by the engineer. The unit of measurement of cement shall be a bag of 50 kg. and this shall be taken as 0.035 cubic meter. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning

of sand shall be on the basis of its dry volume and in case of damp sand, allowances for bulk age shall be made as given for mortar.

4.2.2. Preparation - This shall be prepared by mixing coarse aggregate, fine aggregate and cement in specified proportions with required quantity of water. Nominal size and quality of aggregate shall be as specified.

Except where brick aggregate is used in cement concrete, minimum compressive strength on works test for different concrete mixes shall be as specified for various grades prepared by volume basis, in Table 5 below. The work test shall be carried out for every 15 cum of a day's concreting unless otherwise specified.

Table 5

Concrete mix	Min compressive strength on 15 cm cube in Kg / cm <sup>2</sup>	
	7 days strength	28 days strength
1:1:2	210	315
1:1½ :3		265
1:2:4	140	175

4.2.2.1. Mixing - Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS: 1791 having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical break down of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the engineer in writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a watertight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove, dirt, dust and other foreign materials. For guidance, the mixing time may be 1½ to 2 minutes, for hydrophobic cement it may be taken as 2½ to 3 minutes.

4.2.2.2. Power loader - Mixer will be fitted with a power loader complying with the following requirements.

a). The hopper shall be of adequate capacity to receive and discharge the maximum nominal batch of unmixed materials without spillage under normal operating conditions on a level site.

Note - In such a case the volume of the maximum nominal batch of mixed material is 50% greater than the nominal mixed batch capacity.

b). The minimum inside width of the feeding edge of the hopper shall be as specified below in Table 6.

Table 6

Nominal size of mixer (T, NT or R), litre	Minimum inside width of hopper feeding edge in mm
140	1.0
200	1.1
280	1.2
375	1.4
500	1.5
1000	2.0

..... T = tilting; NT = non-tilting; R = Reverse

The design of the loader shall be such that it allows the loading hopper to be elevated to such a height that the center line of the chute plate of the hopper when in discharge position, is at an angle of not less than 50° to the horizontal. A mechanical device to aid discharge of the contents as quickly as possible from the hopper to the drum may also be provided. Even when a mechanical device is provided, it is recommended that the angle of center line of the chute plate of the hopper when in discharge position, should be as large as practicable, preferably not less than 40° to horizontal.

When the means of raising and lowering the loading hopper includes flexible wire ropes winding on to a drum or drums, the method of fastening the wire to rope to the drums shall be such as to avoid, as far as possible any tendency to cut the strands of the ropes and the fastening should preferably be positioned clear of the barrel of the drum for example, outside the drums flange. When the loading hopper is lowered to its normal loading position, there should be at least one and half drums of rope on the drum.

Clutch brake and hydraulic control lever shall be designed so as to prevent displacement by liberation or by accidental contact with any person.

The clutch and brake control arrangements shall also be so designed that the operator can control the falling speed of the loader.

Safety device shall be provided to secure the hopper in raised position when not in use

4.2.2.3. Mixing efficiency - The mixer shall be tested under normal working conditions in accordance with the method specified in IS - 4643 with a view to check its ability to mix the ingredients to obtain concrete having uniformity within the prescribed limits. The uniformity of mixed concrete shall be evaluated by finding the percentage variation in quantity (mass in water) of cement, fine aggregate and coarse aggregate in a freshly mixed batch of concrete.

The percentage variation between the quantities of cement, fine aggregate and coarse aggregates (as found by weighing in water) in the two halves of a batch and average of the two halves of the batch shall not be more than the following limits -

Cement	8%
Fine aggregate	6%
Coarse aggregate	5%

4.2.2.4. Machine mixing - The mixer drum shall be flushed clean with water. Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement. Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for at least four turns of the drum. While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the engineer. After adding water, the mixing shall be continued until concrete of uniform colour, uniformly distributed material and consistency is obtained. Mixing shall be done for at least two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed. The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed clean with water.

4.2.2.5 Hand mixing - When hand mixing has been specifically permitted in exceptional circumstances by the engineer in writing, subject to adding 10% extra cement, it shall be carried out on a smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by shoveling and turning till the coarse aggregate gets evenly distributed in the cement sand mixture. Three quarter of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be

continued until concrete of uniform colour and consistency is obtained. The mixing platform shall be washed and cleaned at the end of the day.

4.2.3. Workability - The quantity of water to be used for each mix shall be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means specified. Generally, the quantity of water to be used for each mix of 50 Kgs cement shall not be more than 34 litres for 1:3:6 mix, 30 litres for 1:2:4 mix, 30 litres for 1:1½:3 mix and 25 litres for 1:1:2 mix. In case of vibrated concrete, the quantity of water may be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests as described in Annexure 4.A.1. The slump and workability for different kind of works shall be as per Table 7 below

Table 7

Placing conditions.	Degree of workability	Value of workability
Concreting of shallow Sections with vibration	Very low	0.75-0.80 Compacting factor.
Concreting of lightly reinforced section with vibration.	Low	Slump up to 25 mm, 10-5 Seconds, vee bee time 0.8-0.85 compacting factor.
Concreting of lightly reinforced Section without vibration or heavily reinforced sections with vibration.	Medium	25-75 mm, slump for 20 mm aggregate.
Concreting of heavily reinforced sections without vibration.	High	75-125 mm slump for 20 mm aggregate.

Note - Where considered necessary, the workability of the concrete may also be ascertained by compacting factor test and vee-bee consistometer method as specified in IS: 1199. For suggested ranges of value of workability of concrete by the above methods, reference may be made to IS: 456-2000.

4.2.4. Transportation - Concrete shall be transported from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability.

4.2.5. Placing - The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) and shall be thoroughly vibrated and

compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains.

4.2.6. Compaction - Concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till a dense concrete is obtained. The mechanical vibrators shall conform to IS: 2505 specifications for concrete vibrators (immersion type). To prevent segregation, over vibration shall be avoided. The use of mechanical vibrator may be relaxed by the engineer at his discretion for certain items and permit hand compaction. Hand compaction shall be done with the help of tamping rods. Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the engineer in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

4.2.7. Construction joints - Connecting shall be carried out continuously up to construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the engineer. Number of such joints shall be kept minimum and shall be kept as straight as possible.

4.2.7.1. When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints, neat cement slurry, of workable consistency by using 2kgs of cement per sq m shall be applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete

4.2.7.2. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement per sqm. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against corners and close spots; work, thereafter, shall proceed in the normal way.

4.2.8. Concreting under special conditions

4.2.8.1 Work in extreme weather conditions - During hot and cold weather, the concreting shall be done as per the procedure set out in IS: 7861(Part-I) and IS: 7861(Part II) respectively. Concreting shall not be done when the temperature falls below 4.5° C. In cold



weather, the concrete placed shall be protected against frost. During hot weather, it shall be ensured that the temperature of wet concrete does not exceed 38°C.

Under water concreting - Concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. The concrete shall contain at least 10% more cement than that required for the same mix placed in dry conditions, the quantity of extra cement varying with conditions of placing with prior written permission of the engineer. Such extra cement will be paid extra. The volume of coarse aggregate shall not be less than 1½ times nor more than twice the fine aggregate and slump not less than 100 mm nor more than 180 mm. Where found necessary to deposit any concrete under water, the method, equipment, materials and mix shall first be got approved by the engineer. Concrete shall be deposited continuously until it is brought to required height. While depositing, the top surface shall be kept as nearly level as possible and the formation of heaps shall be avoided. The concrete shall be deposited under water by one of the approved methods such as Tremie method, drop bottom bucket, bags, grouting etc. as per details given in IS: 456-2000. If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any waves or commotion tending to wash away cement or to disturb the fresh concrete in any way

4.2.9. Curing - When the concrete begins to harden i.e. two to three hours after compaction, the exposed surfaces shall be kept damp with moist gunny bags, sand or any other material approved by the engineer 24 hours after compaction, the exposed surface shall be kept continuously in damp or wet conditions by ponding or by covering with a layer of sacking, canvass, Hessian or similar absorbent materials and kept constantly wet for at least 7 days where ordinary Portland cement is used and 10 days, where Portland pozzolana cement is used from the date of placing of concrete. For concrete work with other types of cement, curing period shall be as directed by the engineer.

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set

4.2.9.1 Freshly laid concrete shall be protected from rain by suitable covering.

4.2.9.2 Over the foundation concrete, the masonry work may be started after 48 hours of its compaction but the curing of exposed surfaces of cement concrete shall be continued along with the masonry work for at least 7 days. And where cement concrete is used as base concrete for flooring, the flooring may be commenced before the curing of period of base concrete is over but the curing of base concrete shall be continued along with top layer of flooring for a minimum period of 7 days.

4.2.10. Testing of concrete will be done as described in section on R.C.C

4.2.11. Form work - Form work shall be as specified in R.C.C section and shall be paid for separately unless otherwise specified.

4.2.12. Finishes - Plastering and special finishes other than those, obtained through form work shall be specified and paid for separately unless otherwise specified.

4.2.13. Measurements

4.2.13.1. Dimensions of length, breadth and thickness shall be measured correct to nearest cm. Except for the thickness of slab and partition which shall be measured to nearest 5 mm. Area shall be worked out to nearest 0.01 square meter and the cubic contents of consolidated concrete shall be worked out nearest 0.001 cubic meters. Any work done in excess over the specified dimension or as required by engineer is ignored.

4.2.13.2. Concrete work executed in the following conditions shall be measured separately

At or near the ground level

Work in liquid mud

c. Work in or under foul positions

4.2.13.3. Cast-in-situ concrete and or precast concrete work shall be measured in stages described in the item of work, such as -

At or near the ground level,

Up to specified floor level

Between two specified floor levels

Up to specified height above or depth below plinth level/ defined datum level  
Between two specified heights or depths with reference to plinth level / defined datum level

4.2.13.4. No deduction shall be made for the following -

a. Ends of dissimilar materials for example beams, girders, rafters, purlins trusses corbels and steps up to 500sq. cm in cross sections.

b. Opening up to 0.1sq meter (1000sq.cm).

c. Volume occupied by pipes, conduits, sheathing etc. not exceeding 100sq cm each in cross sectional areas.

d. Small voids such as shaded portions in Figure when these do not exceed 40sq cm each in cross section.

Note - In calculating area of opening, the thickness of any separate lintel or sill shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

4.2.13.5. Cast-in-situ concrete shall be classified and measured as follows -

Foundation, footings, bases for columns

Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.

Shelves

Slabs

Chajjas including portions bearing on the wall

Lintels, beams and Bressemmers

Columns, piers abutments, pillars, post and struts

Stair case including stringer beams but excluding landings.

Balustrades, newels and sailing

Spiral staircase (including landing)

Arches

Domes, vaults

Shell roof, arch ribs and folded plates

Chimneys and shaft.

Breast walls, retaining, walls, return walls

Concrete filling to precast components

Kerbs, steps and the like

String or lacing courses, parapets, copings, bed block, anchor blocks, plain window sills and the like

Cornices and moulded windows sills.

Louvers, fins, fascia.

4.2.13.6. Precast cement concrete solid articles shall be measured separately and shall include muse of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position in cement mortar 1:2 (1 cement -2 coarse sand). Plain and moulded work shall be measured separately and the work shall be classified and measured as under -

Classification	Method of measurement
a. Wall panels In square meters stating the thickness	In square meters stating the thickness

b. String or lacing courses, coping, bed plats, plain windows sills, shelves, louvers, steps etc.	In cubic meters
c. Kerbs, edgings etc. In cubic meters	In cubic meters
d. Solid block work	In square meters stating the thickness or in cubic meters.
e. Hollow block work	In square meters stating the thickness or in cubic meters.
f. Light weight Partitions	In square meters stating the thickness or in cubic meters.

4.2.14. Rate - The rate is inclusive of the cost of labour and materials involved in all the operations described above.

#### 4.5 SPECIFICATIONS FOR READY MIXED CONCRETE

4.5.1 Ready Mixed Concrete - Concrete delivered at site or into the purchaser's vehicle in a plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden.

4.5.1.1 Agitation-The process of continuing the mixing of concrete at a reduced speed during transportation to prevent segregation.

4.5.1.2 Agitator-Truck mounted equipment designed to agitate concrete during transportation to the site of delivery.

4.5.1.3 Truck Mixer-A mixer generally mounted on a self-propelled chassis, capable of mixing the ingredients of concrete and of agitating the mixed concrete during transportation.

#### 4.5.2 Types

For the purpose of this standard, the ready-mixed concrete shall be one of the two types, according to the method of production and delivery as specified in 4.5.3.1 and 4.5.3.2.

4.5.2.1 Centrally-mixed concrete - Concrete produced by completely mixing cement, aggregates, admixtures, if any and water at a stationary central mixing plant and delivered in containers fitted with agitating devices, except that when so agreed to between the purchaser and the manufacturer, the concrete may be transported without being agitated.

4.5.2.2 Truck-mixed concrete - Concrete produced by placing cement, aggregates and admixtures, if any, other than those to be added with mixing water, in a truck mixer at the

batching plant, the addition of water and admixtures to be added along with mixing water, and the mixing being carried out entirely in the truck mixer either during the journey or on arrival at the site of delivery. No water shall be added to the aggregate and cement until the mixing of concrete commences.

#### 4.5.3. Materials

4.5.3.1 Cement - The cement used shall be ordinary Portland cement or low heat Portland cement conforming to IS: 269-1989 or 8112-1989 or 1226:1987 or Portland slag cement conforming to IS: 455-1989 or 'Portland-pozzolana cement conforming to IS: 1489-1991 or rapid hardening Portland cement conforming to IS: 8041-1976 as may be specified by the purchaser at the time of placing the order. If the type is not specified, ordinary Portland cement shall be used.

Fly ash when used for partial replacement of cement, shall conform to the requirements of IS:3812 -1981

4.5.3.2. Aggregates - Unless otherwise agreed to between the purchaser and the manufacturer, the aggregates shall conform to IS: 383-1970. Fly ash when used as fine aggregate shall conform to the requirements of IS: 3812-1981.

4.5.3.3. Water used for concrete shall conform to the requirements of IS: 456-2000.

4.5.3.4, Admixtures – Admixtures shall only be used when so agreed to between the purchaser and the manufacturer. The admixtures shall conform to the requirements of IS: 456-2000, and their nature, quantities and methods of use shall also be specified. Fly ash when used as an admixture for concrete shall conform to IS: 3812-1981.

4.5.3.5, Measurement and storage of materials – Measurement and storage of materials shall be done in accordance with the requirements of IS: 456-2000.

#### 4.5.4 Basis of supply

4.5.4.1 Depending upon the agreement between the purchaser and the manufacturer, the ready-mixed concrete shall be manufactured and supplied on either of the following basis:

a) Specified strength based on 28-day compressive strength of 15-cm cubes tested in accordance with IS: 456-2000.

b) Specified mix proportion.

Note - Under special circumstances and subject to the agreement between the purchaser and the supplier, strength of concrete in (a) above may be based on 28-day or 7-day flexural strength of concrete instead of compressive strength of 15-cm cube tested in accordance with IS: 456-2000.

When the concrete is manufactured and supplied on the basis of specified strength, the responsibility for the design of mix shall be that of the manufacturer and the concrete shall conform to the requirements.

When the concrete is manufactured and supplied on the basis of specified mix proportion, the responsibility for the design of the mix shall be that of the purchaser and the concrete shall conform to the requirements.

#### 4.5.4.2 Measurement of Ready-mixed concrete

The basis of purchase shall be the cubic meter of plastic concrete as delivered to the purchaser.

The volume of plastic concrete in a given batch shall be determined from the total mass of the batch divided by the actual mass per m<sup>3</sup> of concrete. The total mass of the batch shall be calculated either as the sum of the masses of all materials, including water, entering the batch or as the net mass of concrete in the batch as delivered. If the purchaser wishes to verify the total mass, of the batch, this shall be obtained from the gross and tare masses of the vehicle on a stamped weigh bridge. The mass per m<sup>3</sup> shall be determined in accordance with the method given in IS:1199-1959.

#### 4.5.5 General requirements

4.5.5.1. In addition to the requirements specified in this standard and subject to such modifications as may be agreed to between the purchaser and the manufacturer at the time of placing order, the ready-mixed concrete shall generally comply with the requirements of IS:456-2000.

Unless otherwise agreed to between the purchaser and the supplier, the minimum quantity of cement and the details regarding proportioning and works control shall be in accordance with IS:456-2000.

When a truck mixer agitator is used for mixing or transportation of concrete, no water from the truck-water system or from elsewhere shall be added after the initial introduction of the mixing water for the batch, except when on arrival at the site of work, the slump of the concrete is less than that specified; such additional water to bring the slump within required limits shall be injected into the mixer under such pressure and direction of flow that the requirements for uniformity specified in Appendix. A are met.

Unless otherwise agreed to between the purchaser and the supplier, when a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of work and discharge shall be complete within 1½ hour (when the prevailing atmospheric temperature is above 20° C) and within 2 hours (when the prevailing atmospheric temperature is at or below 20° C) of adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the aggregate, whichever is earlier.

4.5.5.2 Temperature - The temperature of the concrete at the place and time of delivery shall be not less than 5° C. Unless otherwise required by the purchaser, no concrete shall be delivered, when the site temperature is less than 2.5° C and the thermometer reading is falling.

The temperature of the concrete shall not exceed 5° C above the prevailing shade temperature, when the shade temperature is over 20° C. The temperature of concrete mass on delivery shall not exceed 40° C.

4.5.5.3. Sampling and testing - Adequate facilities shall be provided by the manufacturer for the purchaser to inspect the materials used, the process of manufacture and the methods of delivery of concrete. He shall also adequate facilities for the purchaser to take samples of the materials used.

Unless otherwise agreed to between the purchaser and the supplier, the sampling and testing of concrete shall be done in accordance with the relevant requirements of IS: 456-2000, IS:1199-1959 and IS: 516-1959

Consistency or workability – The tests for consistency or workability shall be carried out in accordance with requirements of IS: 1199-1959 or by such other method as may be agreed to between the purchaser and the manufacturer.

4.5.5.4. Strength test – The compressive strength, and flexural strength tests shall be carried out in accordance with the requirements of IS: 516-1959 and the acceptance criteria for concrete whether supplied on the basis of specified strength or on the basis of mix proportion, shall conform to the requirements mentioned below.

Compressive strength - The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:

- a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of Table.
- b) Any individual test result complies with the appropriate limits in col.3 of Table.

Flexural strength - When both the following conditions are met, the concrete complies with the specified flexural strength.

- a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm<sup>2</sup>.
- b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm<sup>2</sup>.

4.5.5.5. Quantity of concrete represented by strength test results - The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in col.2 of Table 9 or in item (b) of 16.2 only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60m<sup>3</sup>.

If the concrete is deemed not to comply, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

Concrete of each grade shall be assessed separately.

Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the engineer-in-charge.

Table 9 Characteristic compressive strength compliance requirement

Specified Grade	Mean of Group of 4 Non-Overlapping Consecutive Test Results in N/mm <sup>2</sup> .	Individual Test Results in N/mm <sup>2</sup> .
(1)	(2)	(3)
M15	+0.825 x established standard deviation (rounded off to nearest 0.5 N/mm <sup>2</sup> ).	N/mm <sup>2</sup> .
M 20 or above	+ 3 N/mm <sup>2</sup> , whichever is greater + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm <sup>2</sup> ) or +4 N/mm <sup>2</sup> , whichever is greater	N/mm <sup>2</sup> .

Note:- In the absence of established value of standard deviation, the value given in Table 8 of IS:456-2000 may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

4.5.5.6 Cost of testing – Unless otherwise agreed to between the purchaser and the manufacturer, the cost of the tests carried out in accordance with the requirements of this specification shall be borne as follows:

- a) By the manufacturer if the results show that the concrete does not comply with the requirements of this standard.
- b) By the purchaser if the results show that the concrete complies with the requirements of this standard.

4.5.5.7 Manufacturer's records and certificates – The manufacturer shall keep batch records of the quantities by mass of all the solid materials, of the total amount of water used in



mixing and of the results of all tests. If required by the purchaser, the manufacturer shall furnish certificates, at agreed intervals, giving this information.

#### 4.5.6. Concrete manufactured and supplied on the basis of specified strength

4.5.6.1 The purchaser shall supply the following information for guidance of the manufacturer :

- a) The type of cement to be used;
- b) The maximum size and type of the aggregate;
- c) The type of admixtures to be used;
- d) The minimum acceptable compressive strength of flexural strength or both, determined from samples of plastic concrete taken at the place and time of delivery, in accordance with requirements of IS:456-2000.
- e) The slump or compacting factor or both, or other requirements for consistency or workability at the place and time of delivery of the concrete;
- f) The ages at which the test cubes or beams are to be tested, and the frequency and the number of tests to be made; and
- g) Any other requirements.

4.5.6.2 Tolerances – Unless otherwise agreed to between the purchaser and the manufacturer, the concrete shall be deemed to comply with the requirement of these standard, if the results of tests where applicable, lie within the tolerances specified.

4.5.6.3. Consistency of workability – The slump (average of two tests) shall not differ from the specified value by  $\pm 10$  mm for a specified slump of 75mm or less and  $\pm 25$ mm when the specified slump is greater than  $\pm 75$ mm. The compacting factor average of two tests shall be within 0.03 of the value specified. If any other method of determining consistency is to be used, a suitable tolerance shall be agreed to between the purchaser and the manufacturer. The test for consistency or workability shall be completed within 15 minutes of the time of receipt of the ready-mixed concrete at the site.

4.5.6.4. Aggregates – When tested in accordance with IS: 2386(Part I)-1963, the quantity of aggregate larger than the maximum size specified by the purchaser shall not exceed 5 percent of the quantity of coarse aggregate and all such excess shall pass through sieve (conforming to IS: 460 (Part 1-3)-1985 of the next higher size.

#### 4.5.7. Concrete manufactured and supplied on the basis of mix proportion

4.5.7.1 The purchaser shall supply the following information for guidance of the manufacturer:

- a) The type of the cement to be used;

- b) The sizes and types of the aggregate;
- c) The type of admixtures to be used;
- d) The proportions of the mix including the maximum water cement ration at the place and time of delivery of the concrete;
- e) The minimum mixing time after addition of the water; and
- f) Any other requirements.

Tolerances – Unless otherwise agreed to between the purchaser and the manufacturer, the concrete shall be deemed to comply with the requirements of this standard, if the result of tests where applicable, lie within the tolerance specified.

Cement content – The cement content, as shown by the samples taken, shall be not less than 95 percent of that specified.

Ratio of coarse to fine aggregates – The ratio of coarse to fine aggregates, as indicated by the sample taken, shall neither exceed nor fall below the ration specified by the purchaser by more than 10 percent.

Water/ cement ratio -  $\pm 5$  percent of the specified value.

Consistency or workability – The slump shall not differ from the amount specified by  $\pm 10$ mm for a specified slump of 75 mm or less and  $\pm 25$ mm when the specified a slump is greater than 75mm. The compacting factor shall be within  $\pm 0.03$  of the value specified. If any other method of determining consistency is used, a suitable tolerance shall be agreed to between the purchaser and the supplier.

## APPENDIX A

### Concrete uniformity requirement

#### A-1 Tests

A-1.1 The variation within a batch as provided in Table 10 shall determined for each property listed as the difference between the highest value and the lowest value obtained from the different portions of the same batch. For this specification the comparison shall be between two samples, representing the first and last portions of the batch being tested. Test results conforming to the limits of five of the six tests listed in Table I shall indicate uniform concrete within the limits of this specification. Analysis of concrete samples shall be made in accordance with the relevant requirements of IS: 1159-1959.

#### A.2. Coarse aggregate content

A-2.1 Coarse aggregate content shall be determined using the following equation:

$$p = \frac{c}{b} \times 100$$

Where

P= Percentage of coarse aggregate by mass in concrete;

c= saturated surface dry mass in kg of aggregate retained on 4.75 mm IS Sieve, resulting from washing all material finer than this sieve from the fresh concrete; and

b= mass of sample, in kg of fresh concrete in unit mass container.

Table 10 Requirements for uniformity of concrete

Sl. No.	Test	Requirement expressed as maximum permissible difference in results of tests or samples representing the first and last portions or concrete batch
1	2	3
i)	Mass per cubic meter calculated to an air-free basis	16 kg/m <sup>3</sup>
ii)	Air-content, percent by volume of concrete	1.0
iii)	Slump:	
	If average slump is 10cm or less	2.5 cm
	If average slump is 10 to 15 cm	3.8 cm
iv)	Coarse aggregate content, percent (portion by mass of each sample retained on 4.75-mm IS Sieve)	6.0
v)	Unit mass of air-free mortar, percent based on average for all comparative samples tested	1.6
VI)	Average compressive strength at 7 days for each comparative test specimens, percent	7.5

A-3. Unit mass of air free mortar

$$M = \frac{b - c}{V = \left\{ \frac{V \times A}{100} + \frac{c}{1000G} \right\}}$$

A-3.1 Unit mass of air free mortar shall be calculated as follows:

Where

M= Unit mass of air free mortar in Kg/m<sup>3</sup>

b= mass of concrete sample in unit mass container in kg,

c= saturated-surface-dry mass of aggregate in kg retained on 4.75mm IS Sieve,

V= Volume of unit mass container in m<sup>3</sup>

A= air content of concrete in percent measured in accordance with the relevant requirements of IS:1199-1959\*, and

G = specific gravity of coarse aggregate.

#### 4.6 SPECIFICATIONS FOR REINFORCED CEMENT CONCRETE WORK

General - Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by engineer according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.

Form work ( Centering and shuttering )

Reinforcement

Concreting - 1) Cast-in-situ 2) Precast

##### 4.6.1 Materials

4.6.1.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of mortars and section 04-concrete work as applicable.

##### 4.6.1.2 Steel for reinforcement

The steel used for reinforcement shall be any of the following types -

Mild steel sand medium tensile bars conforming to IS: 432 (part I)

Hard drawn steel wire conforming to IS: 432 (part II)

High strength deformed steel bars conforming to IS: 1786

Hard drawn steel wire fabric conforming to IS: 1566

Structural steel section conforming to IS: 2062-1999

Types and grades - Reinforcement supplied in accordance with this standard shall be classified into the following types -

Mild steel bars - It shall be supplied in the following two grades

i) Mild steel bars grade I designated as Fe 410-S

ii) Mild steel bars grade II designated as Fe 410-O.

b) Medium tensile steel bars, grade II designated as Fe-540-W-HT.

Mild steel and medium tensile steel - Physical requirement are given in Table 11.

Table 11

Sl No	Type and nominal size Of bars	Ultimate tensile stress N/mm <sup>2</sup> minimum	Yield stress N/mm <sup>2</sup> minimum	Elongation Percent
1	Mild steel grade I For bars up to and including 20 mm	410	250	23
	For bars over 20 mm up to and Including 50 mm	410	240	23
2	Mild steel grade I For bars up to and including 20 mm	370	225	23
	For bars over 20 mm up to and Including 50 mm	370	215	23
3	Medium tensile steel For bars up to & including 16 mm	540	350	20
	For bars over 16 mm, up to and including 32 mm	540	340	20
	For bars over 32 mm, up to and including 50 mm	510	330	20

Elongation percent on gauge length  $5.65 \sqrt{S_0}$  where  $S_0$  is the cross section area of the test piece.

Note-1. Grade (II) Mild steel bars are not recommended for the use in structures located in the earthquake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.

2. Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS: 2751.

Nominal mass / weight - The tolerance on mass/weight for round and square bars shall be the percentage given in Table.12 of the mass/weight calculated on the basis that the masses of the bar/wire of nominal diameter and of density 0.785 kg / cm<sup>3</sup> or 0.00785 kg / mm<sup>3</sup>.

Table 12 (Tolerance on nominal mass)

Nominal size In mm	Tolerance on the nominal mass percent		
	Batch	Individual Sample +	Individual sample for coil(-x-)
a) up to and including 10	± 7	± 8	± 8
over 10, up to and including 16	+5	-6	+6
c) over 16	± 3	-4	± 4

+ for individual sample plus tolerance in not specified

(x) for coil batch tolerance is not applicable

Tolerance shall be determined in accordance with method given in IS 1786-1985

Tests - Following type of lab test shall be carried out

Tensile test - This shall be done as per IS: 1608

Bend test - This shall be done as per IS: 1599

Re-test - This shall be done as per IS: 1786

Rebend test - This shall be done as per IS: 1786

Should any one of the test pieces first selected fail to pass any of the tests specified above, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the materials represented by the test samples shall be deemed to comply with the requirement of the particular test. Should the test piece from either of these additional samples fail, the material represented by the test samples shall be considered as not having complied with standard. High strength deformed bars & wires shall conform to IS: 1786. The physical properties for all sizes of steel bars are mentioned below in Table 13.

Table 13

Sl. No	Property	Grade		
		Fe 415	Fe 500	Fe 550
1	0.2% proof Stress/Yield stress, in. N/mm <sup>2</sup>	415	500	550

	Elongation, percent min. on gauge Length 5.65 A, Where A is the X-sectional Area of the test piece	14.5	12	8
3	Tensile strength	10 % more than actual 0.2 % proof stress but not less than 465 N/mm <sup>2</sup>	8 % more than actual 0.2 % proof stress but not less than 545 N/mm <sup>2</sup>	6 % more than actual 0.2 % proof stress but not less than 585 N/mm <sup>2</sup>

Tests - Selection and preparation of test sample. All the tests pieces shall be selected by the engineer or his authorised representative either-

From cutting of bars or

If he so desires, from any after it has been cut to the required or specified size and the test piece taken from any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the engineer or his authorised representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deductions in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile test - This shall be done as per IS: 1599.

Re-test -This shall be done as per IS: 1786.

4.6.1.3 Stacking and storage - Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause to minimum wastage in cutting from standard length.

#### 4.6.2 SPECIFICATIONS FOR FORMWORK (CENTRING & SHUTTERING)

4.6.2.1 - Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

4.6.2.2 - Design & tolerance in construction - Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerances given below.

a)	Deviation from specified dimensions of	+ 12 mm
----	--	---------

	cross section of columns and beams		
b)	Deviation from dimensions of footings		+ 12 mm
	i)	Dimension in plan	+ 50 mm
	ii)	Eccentrically in plan	0.02 times the width of the footings in the direction of deviation but not more than 50 mm
	iii)	Thickness	+ 0.05 times the specified thickness.

(Note – Tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels.)

4.6.2.3. General requirement - It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, Screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Care shall be taken to see that no piece is keyed into the concrete. See also Annexure 4-A.7

4.6.2.4. Material for form work

Propping and centering - All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

Centering / Staging - Staging should be as designed with required extension pieces as approved by engineer to ensure proper slopes, as per design for slabs /beams etc. and as per levels as shown in drawings. All the staging to be either tubular steel structure with adequate bracings as approved or made of built up structural sections made from rolled structural steel sections

a). In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.

b). Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.



Shuttering - Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the engineer shall be provided in the joints.

Steel shuttering used for concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

Runner joints RS, MS Channel or any other suitable section of the required size shall be used as runners.

Assembly of beam head over props, Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.

Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 meters, the prop may be provided in multi-stages. Typical arrangements of form work for Beams, columns and walls, and forms secured by wall ties are shown in Figure 1 to 8: and typical detail of multistage shuttering is given in Fig. 9.

Camber - Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per meter (1 to 250) or as directed by the engineer, so as to offset the subsequent deflection. For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the engineer.

Walls - The forms faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. A typical wall form with the components identified is given in Fig.1, 2, & 3. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs.

Removal of form work (stripping time) - In normal circumstance and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods -

a) Walls ,columns and faces of all structural members 24 to 48 hours as many be decided by the engineer

b) Slab

i) Spanning up to 4.50 M 7 days

ii) Spanning over 4.50 M 14 days

c) Beams and arches

- |                                   |         |
|-----------------------------------|---------|
| i) Spanning up to 6 M             | 14 days |
| ii) Spanning over 6 M & up to 9 m | 21 days |
| iii) Spanning over 9 M            | 28 days |

Note 1 -For the other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. If Portland pozzolana or low heat cement has been used for concrete, the stripping time will be 10/7 of the period stated above.

Note 2 - The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead of the slabs, beam or arch as the case may be together with any live load likely to occur during curing of further construction.

Note 3 - For rapid hardening cement, 3/7 of above periods will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

Note 4 - In case cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

Note 5 - Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

Note 6 - Work damaged through premature or careless removal of forms shall be reconstructed.

#### 4.6.2.5. Surface treatment

Oiling the surface - Shuttering gives much longer service life in the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections. Typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3-4 uses and also in case when shuttering has been stored for a long time, it should be recoated with mould oil before the next use. The design of form work shall conform to sound engineering practices and relevant IS codes.

4.6.2.6. Inspection of form work - The completed form work shall be inspected and approved by the engineer before reinforcement bars are placed in position. Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discolouration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by engineer.

Shuttering surface before concreting should be free from any defect / deposits and fully cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

4.6.2.7. Erection of form work (centering and shuttering) - Following points shall be borne in mind while checking during erection.

Any member which is to remain in position after the general dismantling is done, should be clearly marked.

Material used should be checked to ensure that, wrong items / rejects are not used.

If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.

i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.

Sole plates shall be properly seated on their bearing pads or sleepers.

The bearing plates of steel props shall not be distorted.

The steel parts on the bearing members shall have adequate bearing areas.

d) Safety measures to prevent impact of traffic; scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

e) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing device and bracing shall be tightened.

f) The stacked materials shall be placed as catered for, in the design.

g) When adjustable steel props are used, they should -

i). Be undamaged and not visibly bent.

ii). Have the steel pins provided by the manufacturers for use.

iii). Be restrained laterally near each end.

iv). Have means for centralizing beams placed in the fork heads.

h) Screw adjustment of adjustable props shall not be over extended.

i) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening of props occur. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened / clamped down after adjustment to prevent their shifting.

- j) No member shall be eccentric upon vertical member.
- k) The number of nuts and bolts shall be adequate.
- l) All provisions of the design and / or drawings shall be complied with.
- m) Cantilever supports shall be adequate.
- n) Props shall be directly under one another in multistage constructions as far as possible.
- o) Guy ropes or stays shall be tensioned properly.
- p) There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.
- q) Required camber shall be provided over long spans.
- r) Supports shall be adequate, and in plumb within the specified tolerances.

#### 4.6.2.8 Measurements

4.6.2.8.1. General - The form work shall include the following;

- a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.
- b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.
- c) Bolts, wire ties, clamps, spreaders, nails or any other items to hold the sheathing together.
- d) Working scaffolds ladders, gangways, and similar items.
- e) Filling to form stop chamfered edges of splayed external angles not exceeding 20 mm wide to beams, columns and the like.
- f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before concrete.
- g) Dressing with oil to prevent adhesion and
- h) Raking or circular cutting.

4.6.2.8.2. Classification of measurements - Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following -

- a). Foundations, footings, bases of columns etc. and for mass concrete and precast shelves,

b). Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc. c). Suspended floors, roofs, landings, shelves and their supports and balconies. d). Lintels, beams, girders, Bressummers and cantilevers. e). Columns, pillars, posts and struts. f). Stairs (excluding landing) except Spiral staircase. g). Spiral staircase (including landing). h). Arches. i). Domes, vaults, shells roofs, arch ribs and folded plates. j). Chimneys and shafts. k). Well steining. l). Vertical and horizontal fins individually nor forming box, louvers and bands. m). Waffle or ribbed slabs. n). Edges of slabs and breaks in floors and walls (to be measured in running meters where below 200 mm in width or thickness). o). Cornices and mouldings. p). Small surfaces, such as cantilevers ends, brackets and end of steps, caps and boxes to pilasters and columns and like. q). Chula hoods, weather shades, Chajjas, corbels etc. including edges and r). Elevated water reservoirs.

4.6.2.8.3 Centering, and shuttering where exceeding 3.5 meter height in one floor shall be measured and paid for separately.

4.6.2.8.4 Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

4.6.2.8.5. No deductions from the shuttering due to the openings / obstructions shall be made if the area of such openings / obstructions does not exceed 0.1 square meters. Nothing extra shall be paid for forming such openings.

4.6.2.8.7 Rate - The rate of the form work includes the cost of labour and materials required for all the operations described above.

#### 4.6.3. SPECIFICATIONS FOR REINFORCEMENTS IN CONCRETE

4.6.3.1. General requirements - Steel conforming to para 4.6.1.2. for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coatings which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall used for removing the rust.

(1). Assembly of reinforcement - Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by engineer. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Over lapping of bars, where necessary shall be done as directed by the engineer. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25 mm or  $1 \frac{1}{4}$  times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. Of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps / splices shall be staggered as per directions of the engineer. But in no case the over lapping shall be more than 50% of cross sectional area at one section.

(2). Bonds and hooks forming end anchorages - Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice for bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.

a) U-Type hook - In case of mild steel plain bars standard U-type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter of the bar

Note-In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawing.

b) Bends - Bend forming anchorage to a M.S. plain bar shall be bent with an internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

(3). Anchoring bars in tension - Deformed bars may be used without end anchorages provided, development length requirement is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per clause 25.2.1 of IS: 456-2000.

(4). Anchoring bars in compression - The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in of IS: 456-2000. The projected length of hooks, bends and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

(5). Binders, stirrups, links and the like - In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times the nominal size of bar.

(6). Welding of bars - Whenever facility for electric arc welding is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the engineer. Welding shall be as per IS: 2751 for mild steel bars and for cold worked bars.

4.6.3.2 Placing in position - Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the engineer. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Track welding in crossing bars shall also be permitted in lieu of bending with steel wire if approved by engineer.

The bars shall be kept in correct position by the following methods -

a) In case of beam and slab construction precast cover blocks of cement mortar 1:2 about 4x4 cm section and of thickness equal to the specified cover shall be placed between

the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.

b) In case of cantilevered and doubly reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 meter or at shorter spacing to avoid sagging.

c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with block of cement mortar 1:2 of required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.

d) In case of R.C.C. structure such arches, domes, shells, storage tanks etc. a combination of cover blocks, spaces and templates shall be used as directed by engineer.

Tolerance on placing of reinforcement - Unless otherwise specified by the engineer, reinforcement shall be placed within the following tolerances -

Tolerance in spacing

		Tolerance in spacing
a)	For effective depth 200 mm or less	$\pm 10$
b)	For effective depth More than 200 mm	$\pm 15$

The cover shall in no case be reduced by more than one third of specified cover or 5 mm which ever is less.

Bending at construction joints - Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bars diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bars in not damaged.

4.6.3.3. Measurements - Reinforcement including authorised spacer bars and laps shall be measured in length of different diameters, as actually (not more than as specified in the drawings.) used in the work nearest to a centimeter and their weight calculated on the basis of standard weight given in Table 14 below. Wastage and unauthorized overlaps shall be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate reinforcement.

Wherever tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the engineer and measured separately and paid for.

Table 14 Cross-sectional area and mass of steel bar

Nominal size mm	Cross sectional area sq.mm	Mass per meter run kg
6	28.3	0.222
7	38.5	0.302
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
18	254.6	2.00
20	314.3	2.47
22	380.3	2.98
25	491.1	3.85
28	616.0	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.85
45	1591.1	12.50
50	1964.3	15.42

Note - These are as per clause 5.2 of IS 1786.

4.6.3.4. Rate - The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, as required of directed including tack welding on crossing of bars in lieu of binding with wires.

#### 4.6.4 SPECIFICATIONS FOR CONCRETING

The concrete shall be done as specified. The proportion by volume of ingredients shall be as specified.



4.6.4.1 Consistency - The concrete which will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar shall be used. The consistency shall depend on whether the concrete is vibrated or hand tamped. It shall be determined by slump test as prescribed in chapter " concrete under para 4.2.3 workability"

Where considered necessary, the workability of the concrete may also be ascertained by compacting factor test and VEE BEE consistometer method specified in IS: 1199. For suggested ranges of values of workability of concrete by the above two methods, reference may be made to IS: 456.

#### 4.6.4.2 Placing of concrete

Concreting shall be commenced only after engineer has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shaving, saw dust, pieces of wood, or other foreign material and surfaces shall be treated as prescribed.

In case of concreting of slabs and beams, wooden plank or cat walks of chequered MS plates or bamboo chlies or any other suitable material supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

In case of columns and walls, it is desirable to place concrete without construction joints. The progress of concreting in the vertical direction shall be restricted to one meter per hour.

The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings concrete shall be placed through chutes or as directed by the engineer. In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 meters at a time.

During cold weather, concreting shall not be done when the temperature falls below 4.5° c. the concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

During hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38°C. no concrete shall be laid within half of the closing time of the day, unless permitted by the engineer.

It is necessary that the time taken between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with

4.6.4.3 Compaction - Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations. The engineer may however relax this conditions at his discretion for certain items, depending on the

thickness of the members and feasibility of vibrating the same and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the form. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation, such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being compacted at the time of placing.

Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibrators. In case both internal and external vibrators are being used, the internal vibrator shall be first withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. within 30 minutes of addition of water to the dry mixture.

4.6.4.4 Construction joints - Concreting shall be carried out continuously up to the construction joints, the position and details of which shall be as shown in structural drawing or as indicated in Fig. 26 or as directed by engineer. Number of such joints shall be kept to minimum. The joints shall be kept at places where the shear force is the minimum. These shall be straight and shall be at right angles to the direction of main reinforcement.

In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head. The portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.

When stopping the concrete on a vertical plane in slabs and beams, an approved stop-board (see Fig.26C) shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop-board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of stop-board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement

per square meter shall then be applied on the roughened surface before fresh concrete is laid.

4.6.4.5 Expansion joints - Expansion joints shall be provided as shown in the structural drawings or as indicated in Fig. 10 to 25 or as directed by engineer, for the purpose of general guidance. However it is recommended that structures exceeding 45 m in length shall be divided by one or more expansion joints. The filling of these joints with bitumen filler, bitumen felt or any such material and provision of copper plate, etc. shall be paid for separately in running meter. The measurement shall be taken up to two places of decimal stating the depth and width of joint.

4.6.4.6 Curing - After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying by covering with moist gunny bags, sand, canvass Hessian or any other material approved by the engineer. After 24 hours of laying of concrete, the surface shall be cured of ponding with water for a minimum period of 7 days from the date of placing of concrete.

4.6.4.7 Finishing - In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set.

Immediately on removal of forms, the R.C.C work shall be examined by the engineer, before any defects are made good.

The work that has sagged or contains honey combing to an extent detrimental to structural safety or architectural concept shall be rejected as given for visual inspection test.

Surface defects of a minor nature may be accepted. On acceptance of such a work by the engineer, the same shall be rectified as follows -

1) Surface defects which require repair when forms are removed, usually consist of bulges due to movement of forms, ridges at form joints, honey combed areas, damage resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey-combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferable slightly undercut to provide a key at the edge of the path.

2) Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of fine sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10 mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.

3) Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.

4) Holes left by bolts are filled with mortar carefully packed into places in small amounts. The mortar is mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.

5) Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motor cars.

6) Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.

7) The same amount of care to cure the material in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound in these cases will be most convenient.

c). The exposed surface of R.C.C work shall be plastered with cement mortar 1 -3 (1 cement - 3 fine sand) of thickness not exceeding 6 mm to give smooth and even surface true to line and form. Any RCC surface which remains permanently exposed to view in the completed structure shall be considered exposed surface for the purpose of this specification.

Where such exposed surface exceeding 0.5 sq.m in each location is not plastered with cement mortar 1:3 (1 cement to 3 fine sand) 6 mm thick, necessary deduction shall be made for plastering not done.

d). The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give bond between concrete and plaster.

e). The surface of RCC slab on which the cement concrete of mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done without disturbing the concrete.

4.6.4.8 Strength of concrete - The compressive strength on work tests for different mixes shall be as given in Table 15 below -

Table 15

Concrete mix	Compressive strength in
--------------	-------------------------

(Nominal mix on volume basis)	(kg/sq cm)	
	7 days	28 days
1:1:2	210	315
1:1 ½ : 3	175	265
1:2:4	140	210

#### 4.6.4.9 Testing of concrete

(1). Regular mandatory tests on the consistency and workability of the fresh concrete shall be done to achieve the specified compressive strength of concrete. These will be of two types

Mandatory Lab. Test

Mandatory Field Test

(3). Results of Mandatory Field Test will prevail over Mandatory Lab. Test.

a) Work Test-Mandatory Lab. Test shall be carried out as prescribed.

b) Mandatory Field Test (Hammer Test), shall be carried out as prescribe in Annexure 4.A.2

(4). Additional test - Additional test, if required, shall be carried out as prescribed in Annexure 4.A.7

(5). Slump test - This test shall be carried out as prescribed in Annexure 4.A.1

(6). Visual inspection test - The concrete will be inspected after removal of the form work as described. The question of carrying out mandatory test or other tests described in Annexure 4-A.2 and 4-A.4 will arise only after satisfactory report of visual inspection.

The concrete is liable to be rejected, if,

(i) It is porous or honeycombed.-

(ii) Its placing has been interrupted without providing a proper construction joint;

(iii) The reinforcement has been displaced beyond tolerance specified; or construction tolerance has not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the engineer at the risk and cost of the contractor.

#### 4.6.4.10 Standard of acceptance

(1). Mandatory lab test - For concrete sample and tested as prescribed in Annexure 4- A.2 the following requirement shall apply.

Out of six sample cubes, three cubes shall be tested at 7 days and remaining three cubes at 28 days, if found necessary.

(2). 7days' tests

(a). Sampling - The average of the strength of three specimens shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than  $\pm 15\%$  of the average. Difference between the maximum and minimum strength should not exceed 30% of average strength of three specimen. If the difference between maximum and minimum strength exceeds 30% of the average strength, then 28 days' test shall have to be carried out.

(a). Strength - If the actual average strength of sample accepted in para 'sampling' above is equal to or higher than specified strength up to 15% then strength of the concrete shall be considered in order. In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days' test shall have to be carried out to determine the compressive strength of concrete cubes.

(3). 28 days' test

(a) The average of the strength of three specimen be accepted as the compressive strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

(b) If the actual average strength of accepted sample exceeds specified strength by more than 30%, the engineer, if he so desires may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.

(c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of specified strength, the concrete may be accepted at reduced rate at the discretion of engineer.

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the engineer shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however, the engineer so desires, he may order additional tests (see Annexure 4-A.4) to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

(4). Acceptance criteria of mandatory field test

(A) Preparation of standard test cubes for calibration of rebound hammer at site

(a) In the beginning the standard test cubes of specified mix shall be prepared by field units before undertaking any concrete work in each project.

(b) At least 18 standard cubes necessary for formation of one specimen of specified mix, shall be cast by site staff well in advance. From these 18 cubes any 3 cubes may be selected at random to be tested for crushing strength of 7 days. The crushing strength obtained should satisfy the specified strength for the mix as per specification or agreement. If the strength is satisfactory then the remaining cubes will form the standard samples for calibration of rebound hammer. In case of failure, the site staff should totally reject the samples and remove them also and then make another set of samples by fresh mixing or alternatively, out of the remaining 15 cubes 3 cubes will be tested on 28 days. If the 28 days' tests are found satisfactory then remaining 12 cubes will form the standard sample for calibration at 28 days' strength otherwise all samples shall be rejected and whole procedure repeated to form a fresh specimen. All the results shall be recorded in a register.

(c) No concreting will be allowed unless the standard specimen cubes are obtained.

The criteria for acceptance and calibration of hammer will be 28 days' strength. the 7 days' strength is only to facilitate the work to start.

(d) No work (for the concrete cast between 8th day) shall be allowed to be paid unless 28 days' cube strength is obtained. For the concrete cast between 8th and 28th day, the decision to make the payment may be taken by the engineer on the basis of existing criteria. Concrete work will be rejected if 28 days' strength falls short as per acceptance criteria. No further work will be allowed till the acceptable standard cubes are obtained.

(e) Frequency - It will be once in each quarter or as per the direction and discretion of engineer. Whenever the acceptance criteria is changed or concrete mix or type of cement is changed or engineer feels it necessary for recorded reasons with the approval of the authority according technical sanction, fresh specimen shall be prepared.

(B) Calibration of hammer

(a) Simultaneously, same three cubes to be tested on 28 days as referred in para A (b) above shall be used to correlate the compressive strength of their concrete with rebound number as per procedure described in para 5.2 of the IS: 13311 (Part 2) "Indian standard for non-destructive testing of concrete Method of test by rebound hammer which is given below in para B (b). the average of values of the rebound number (minimum readings) obtained in respect of same three cubes passing on 28 days' work test shall form the datum reference for remaining cubes for the strength of cubes.

(b) The concrete cubes specimens are held in a compression testing machine under a fixed load, measurements of rebound hammer taken and then compressive strength determined

as per IS: 516. The fixed load required is of the order of  $7\text{N} / \text{mm}^2$  when the impact energy of the hammer is about 2.2 NM.

If the specimens are wet cured, they should be removed from wet storage & kept in the laboratory atmosphere for about 24 hours before testing. Only the vertical faces of the cubes as cast should be tested for rebound number. At least nine readings should be taken on each of the three vertical faces accessible in the compression testing machine when using rebound hammers. The points of impact on the specimen must not be nearer than 20 mm from each other. The same points must not be impacted more than once.

(c) The rebound number of hammer will be determined on each of the remaining (18-3-3=12) cubes. Whenever the rebound number of hammer of any individual cube varies by more than  $\pm 25\%$  from the datum readings referred to in para B(a) above, that cube will be excluded and will not be considered for standard specimen cubes for calibration. It must be ensured that at least 8 cubes out of 12 that is 66.6% are within the permissible range of variation of rebound number i.e.  $\pm 25\%$  or otherwise whole procedure shall have to be repeated and fresh specimen prepared.

These 8 cubes will form one standard sample in the beginning before commencement of work and shall be kept carefully for the visiting officers who will calibrate their hammers on these cubes.

(d) This calibration will be done by field staff with their hammer and then chart of calibration giving the details of the average readings, date & month of casting, mix of the concrete etc. shall be prepared and signed by engineer and will be duly preserved for future reference as and when required.

(C) Preservation of cubes at site - Standard sample cubes cast shall be carefully preserved at site under the safe custody of AE or his representative for making them available together with the charts, to the any other senior departmental officers, during their inspection of the work.

(D) Testing at site - (D-2) Testing will be done generally by non-destructive methods like rebound hammers etc. Each field Division / Sub Division / Unit will purchase rebound hammers and keep them in working order at work site. Testing will be done only by hammers, which are dully calibrated.

(D-3) The relative strength of actual field work will be tested with reference to strength of these standard cubes and calibration charts of a hammer for determining the rebound number on the field work. The hammer will be used as per manufacturer's guidelines at various locations chosen at random. The number of location / reading on each wall, beam or column etc. shall not be less than 12. All the readings should be within the  $\pm 25\%$  range of values prescribed in calibration chart normally. However, reading indicating good strength will be when it is at par with calibrated value between 100% & 125% and very good



if more than 125%. Any value between 100% & 75% of calibrated value shall be considered satisfactory. Values from 75% to 50% shall be considered for fragment at rates reduced on prorata basis. The concrete indicating rebound number less than 50% of calibrated value shall be rejected and not paid for.

(E) Acceptance of field tests and strength - If the relative strength of actual field work is found satisfactory considering the calibration charts with reference to the standard cube test kept at site, the representative work will be considered satisfactory. If the work is considered below satisfactory, the same will be dealt as stated in para D-3 above.

(F) 7 days' Strength in rare cases only - Normally cube crushing strength on 28 days' test shall form the basis of acceptance. However in rare cases of time bound projects / urgent repairs 7 days' cube test strength criteria may be adopted on similar lines using 7 days' standard test cubes and calibration graphs / curves / charts for 7 days' in lieu of 28 days' and testing work done at 7 days'.

(G) Precautions

(G-1) The testing shall be done generally as per the guidelines of manufacturer of the apparatus and strictly in accordance with the procedure laid down in clause 6 of IS: 13311 (part 2) Indian Standard for Non-Destructive Testing of concrete-Method of Test by Rebound Hammer.

(G-2) The rebound hammers are influenced by number of factors like type of cement aggregate, surface conditions, moisture content, age of concrete etc. Hence care shall be taken to compare the cement, aggregate etc. and tested under the similar surface conditions having more or less same moisture content and age. However effect of age can be ignored for concrete between 3 days & 3 months old.

#### 4.6.4.11 Measurement

4.6.4.11.1. Dimensions shall be measured nearest to a cm except for the thickness of slab which shall be measured correct to 0.5 cm.

4.6.4.11.2. The areas shall be worked out nearest to 0.01 sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic meters.

4.6.4.11.3. Reinforced cement concrete whether cast-in-situ or present shall be classified and measured separately as follows.

(a) Raft, footing, bases of columns etc. and mass concrete. (b) walls (any thickness) including attached pilasters, buttresses, plinth and string course, fillets etc. (c) suspended floors, roofs, landings and balconies. (d) Shelves (e) Chajjas (f) Lintel, beams and Bressummers. (g) Columns, pillars, piers, abutments, posts and struts. (h) Stair-cases including waist or waist less slab but excluding landing except in (l) below. (j) Spiral stair-case (including landing). (k) Arches, arch ribs, domes and vaults. (l) Chimneys and shafts.

(m) Well steining. (n) Vertical and horizontal fins individually or forming box, louvers and fascias. (o) Kerbs, steps and the like. (p) String course, bands, coping, bed plates, anchor blocks, plain window sills and the like. (q) Moldings as in cornices window sills etc.

Shell, dome and folded plates. (r) Extra for shuttering in circular work in plan.

4.6.4.11.4 No deduction shall be made for the following -

(a) Ends of dissimilar materials (e.g. joists, beams post girders, rafters, purlin trusses, corbels steps etc.) up to 500 sq cm in cross-section

(b) Opening up to 0.1sq.m.

Note-In calculating area of openings up to 0.1sq.m the size of opening shall include the thickness of any separate lintels or sills. No extra labour for forming such opening or voids shall be paid for.

(c) The volume occupied by reinforcement.

(d) The volume occupied by water pipes, conducts etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

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

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

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

(c) The columns measurement shall be taken through.

(d) Chajjas along with its bearing on wall shall be measured in cubic meter nearest to two places of decimal. When Chajjas is combined with Lintel, slab or beam, the projecting portion shall be measured as Chajjas, built in bearing shall be measured as per item of Lintel, slab or beam in which chhajja bears.

(e) Where the band and Lintels are of the same height and the band serves as Lintel, the portion of the band to be measured as lintel shall be for clear length of opening plus twice the over all depth of band.

4.6.4.12. Tolerances - Subject to the condition that structural safety is not impaired and architectural concept does not hamper, the tolerances in dimensions of R.C.C members

shall be as specified in the drawing by the designer. Whenever these are not specified, the permissible tolerance shall be decided by the engineer after consultations with the Designer, if necessary.

When tolerances in dimensions are permitted, following procedure for measurements shall apply.

(a). If the actual dimensions of R.C.C members do not exceed or decrease the design dimensions of the members plus or minus tolerance limit specified above, the design dimensions shall be taken for the purpose of measurements.

(b). If the actual dimensions exceed the design dimensions by more than the tolerance limit, the design dimensions only shall be measured for the purpose of payment.

(c). If the actual dimensions decrease more than the tolerance limit specified, the actual dimensions of the RCC members shall be taken for the purpose of measurement and payment.

(d). For acceptance of RCC members whose dimensions are not exactly as per design dimension of engineer shall be final. For the purpose of payment, however, the clarification as given in para a, b & c above shall apply

#### 4.6.4.13 Rate

The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering.

On the basis of mandatory lab tests, in case of actual average compressive strength being less than specified strength but upto 70% of specified strength, the rate payable shall be in the same proportion as actual average compressive strength bears to the specified compressive strength.

#### Example

1. Average compressive strength in 80% of specified strength. Rate payable shall be 80% of agreement rate.

2. In case average compressive strength in less than 70% of the specified strength, the work represented by the sample shall be rejected.

3. However, on the basis of mandatory field test, where they prevail, the rates of the work represented by samples showing actual compressive strength less than specified strength shall be worked out as per para above. In addition, engineer may order for additional tests (see Annexure 4-A.4) to be carried out at the cost of contractor to ascertain if the portion of structure where in concrete represented by the samples has been used, can be retained on the basis of these test. Engineer may take further remedial measures as necessary to retain the structure at the risk and cost of the contractor.

Where throating or plaster drip or molding is not required to be provided in RCC Chajjas, deduction for not providing throating or plaster drip or molding shall be made from the item of R.C.C. In Chajjas. The measurement for deduction item shall be measured in running meters direct to a cm of the edge of chhajja.

No extra payment for richer mix which projects into any meter from another member during concreting of junctions of beams and columns etc. will be made except to the extent structurally considered necessary and when so indicated in the structural drawing. The payments for work done under items of different mixes shall be limited strictly to what is indicated in the structural drawings.

#### 4.6.8. SPECIFICATIONS FOR DESIGN MIX CONCRETE.

Definition - Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete.

It will be designed based on the principles given in IS 456-2000 and 23 "Hand book for design mix concrete".

In order to ensure that not more than the specification proportion of test results is likely to fall below the characteristic strength, the concrete mix has to be designed for higher average compressive strength for a specified grade of concrete is defined as target mean strength.

##### 4.6.8.1. Materials

Cement - One of the following types of cement as specified shall be used -

1. Ordinary Portland Cement 33 grade conforming to IS: 269.
2. Ordinary Portland Cement 43 grade conforming to IS: 8112.
3. Ordinary Portland Cement 53 grade conforming to IS: 2269.
4. Rapid hardening Portland Cement Conforming to IS: 8041.
5. Blast Furnace slag cement conforming to IS: 455.

However for severe conditions of sulphate content in sub soil water, special literature on use of sulphate resisting cement may be referred to.

Coarse aggregate - This shall be specified in para 4.1.2 and subparas.

Fine aggregate - This shall be grading zone I, II, or III as specified under para 3.1.4 and subparas.

Water - It shall conform to the requirement as laid down in IS: 456 para and para 4.6.1.1. of this section.

Grades of concrete - The compressive strength of various grades of designation concrete shall be as given in table 16 below -

Table 16

Grades designation	Compressive strength on 15 cm cubes min at 7 days (N/mm <sup>2</sup> )	Specified characteristic compressive strength at 28 days (N/mm <sup>2</sup> )
M 15	10.0	15
M 20	13.5	20
M 25	17.0	25
M 30	20.0	30
M 35	23.5	35

Note - In the designation of a concrete mix letter M refer the mix and the number to the specified characteristic compressive strength of 15 cm-cubes at 28 days expressed in N/mm<sup>2</sup>.

4.6.8.2 Scope - The procedure described below for design mix is for concrete up to grade M-35 which are generally used for reinforced concrete structure. Minimum grade of concrete for design mix will be M-20 normally. However in cases of projects having some parts of M-15 also in addition to M-20 to M-35 grade, then design mix concrete will cover M-15 grade as an exception only.

4.6.8.3 Data for mix design - The following basic data are required to be specified for design of concrete mix.

Characteristic compressive strength of concrete at 28 days.

Degree of workability desired.

Limitation on water cement ratio and minimum cement content to ensure adequate durability.

Type of maximum size of aggregate to be used.

Standard deviation of compressive strength of concrete.

Minimum cement content required in Reinforced cement concrete to ensure durability under specified conditions of exposure, will be in accordance with IS: 456. However it shall not be less than 300 Kgs /m<sup>3</sup> of concrete for 33 grade cement.

(a). Standard Deviation of concrete for each grade shall depend upon the degree of quality control expected to be exercised at site. As per IS: 10262 the values of standard deviation for various grades of concrete for different degree of control shall be specified in Table. 17.

Table 17

Grade of concrete	Standard Deviation for different degree of control in N/mm <sup>2</sup>		
	Very good	Good	Fair
M-15	2.5	3.5	4.5
M-20	3.6	4.6	5.6
M-25	4.3	4.3	6.3
M-30	5.0	6.0	7.0
M-35	5.7	6.7	7.7

Degree of quality control expected under different site conditions are described in Table18

Table 18

Degree of Control	Condition of production of concrete
Very good	Fresh cement from single source and regular test, weigh batching of all materials, aggregates grading and moisture content, control of water added, frequent supervision, regular workability and strength tests and field laboratory facilities,
Good	Carefully stored cement and periodic test, weigh batching of all materials, controlled water, graded aggregate supplied, occasional grading and moisture tests, periodic check of workability and strength, intermittent supervision and experienced workers.
Fair	Proper storage of cement, volume batching of all aggregates allowing for bulking of sand, weigh batching of cement, water content controlled by inspection of mix and occasional supervision and tests

4.6.8.4. Target strength for mix design - The target mean strength for a specified grade concrete depends upon the quality control (expressed by standard deviation) and accepted proportion of results of the strength tests below the characteristic strength ( $f_{ck}$ ) and is given by relation,

$$T_{ck} = f_{ck} + t.s$$

$T_{ck}$  – target mean compressive strength at 28 days

$f_{ck}$  – characteristic compressive strength at 28 days

$s$  – standard Deviation

$t$  – a statistical figure depending upon the accepted proportion of low test results and number of tests.

Note - According to IS: 456 & IS: 1343 the characteristic strength is defined as that value below which not more than 5% (1 in 20) results are expected to fall. In such case value of  $t$  will be 1.65 and equation will reduce to  $T_{ck} = f_{ck} + 1.65 s$ .

Selection of proportions - Since different cement, aggregate, of different maximum size, grading surface texture shape, produce concrete of different compressive strength for the same free water cement ratio, the relationship between strength and free water cement ratio corresponding to 28 days' strength of cement of various grades is given in Fig.1 of IS: 10262 and is reproduced below in chart 1.

28 days strength of cement tested according IS: 4031-1968

A = 31.9 – 36.8 N/mm<sup>2</sup> (325-375 kg /cm<sup>2</sup>)

B = 36.8 – 41.7 N/mm<sup>2</sup> (375-425 kg /cm<sup>2</sup>)

C = 41.7 – 46.6 N /mm<sup>2</sup> (425-475 kg /cm<sup>2</sup>)

D = 46.6 – 51.5 N /mm<sup>2</sup> (475-525 kg /cm<sup>2</sup>)

E = 51.5 – 56.4 N/mm<sup>2</sup> (525-575 kg/cm<sup>2</sup>)

F = 56.4 - 61.3 N /mm<sup>2</sup> (575-625 kg /cm<sup>2</sup>)

Chart 1- Relationship between free water cement ratio and concrete strength for different cement strengths.

(a) The free water cement ratio selected from Chart 1 above should be checked against the limiting water cement ratio for requirement of durability as given in IS: 456 and the lower of the two values is to be adopted.

(b) Estimate of air control - The amount of entrapped air for normal mix (non air entrained) concrete as per IS: 10262 are given in Table 19.

Table 19.

Nominal maximum size of aggregate	Entrapped air as percentage of volume of concrete
10 mm	3.0
20 mm	2.0

40 mm	1.0
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(c) Selection of water content and fine to total aggregate ratio - Based on experience, empirical relationship have been established between quantity of water per unit volume of concrete and ratio of fine aggregate to total aggregate by absolute volume for desired workability. The estimated values for concrete up to M35 grade are given in Table 20.

Table 20.

Nominal maximum size of aggregate in mm	Water content in kgs per cubic meter of concrete	Sand as % age of total aggregate by absolute volume
10	208	40
20	186	35
40	165	30

A) The values given in Table 19. are based on the following conditions -

Crushed coarse aggregate conforming to IS: 383 and para 4.1.2 of this specification

Fine aggregate consisting of natural sand conforming to grading zone II of IS: 383 water cement ratio (by mass) of 0.6 and

Workability corresponding to compacting factor of 0.8.

B) For other conditions of workability, water cement ratio, grading of fine aggregate and for round aggregate, certain adjustment in quantities of mixing water and fine to total aggregate ratio as given in Table 19 are to be made as per IS: 10262. These are explained in Table 21 below -

Table 21.

Change of conditions stipulated for	Adjustment required in	
	Water content	Percentage of fines to total aggregate
For sand conforming to grading Zone I & III of IS -383	0	+1.5% for Zone I -1.5% for Zone III
Increase or decrease in the value of compacting factor by 0.1		
For increase	+3.0 %	0
For decrease	-3.0%	



For each 0.05 increase or decrease in free water-cement ratio		
For increase		
For decrease	0	+1.0 %
	0	-1.0 %
For rounded aggregates	-15 kg / mm <sup>3</sup>	-7

C) Comparison of consistency measurement by various methods-

Workability description	Slump mm	Compacting factor
Extremely dry	--	--
Very stiff	--	0.70
Stiff	0-25	0.75
Stiff plastic	25-50	0.85
Plastic	75-100	0.90
Flowing	150-175	0.95

Calculation of aggregate content - With the quantities of water and cement per unit volume of concrete and ratio of fine to total aggregate content per unit volume of concrete to be calculated from the following equations -

$$V = \left\{ w + \frac{C}{S_c} + \frac{1}{p} \times \frac{fa}{S_{fa}} \right\} \times \frac{1}{1000}$$

$$V = \left\{ w + \frac{C}{S_c} + \frac{1}{1-p} \times \frac{fa}{S_{ca}} \right\} \times \frac{1}{1000}$$

V = absolute volume of fresh concrete which is equal to gross volume (m<sup>3</sup>), minus the volume of entrapped air.

W = mass of water (kg) per m<sup>3</sup> of concrete

C = mass cement (kg) per m<sup>3</sup> of concrete

P = ratio of fine aggregate to total aggregate by absolute volume

S<sub>c</sub> = specific gravity of cement

Fa, Ca = aggregate (kg) per m<sup>3</sup> of concrete respectively (total masses of fine aggregate and coarse aggregate )

Sfa, Sca = Specific gravities of saturated surface dry fine aggregate and coarse aggregate respectively.

Calculation of batch masses - The masses of various ingredients for concrete for design mix of a particular batch size may be calculate as described above.

4.6.8.5 Production of controlled concrete - The calculated mix proportion shall be checked by means of trial batches. Quantities of materials worked out as described above shall be termed as trial mix no.1. The quantities of materials for each trial mix shall be sufficient for at least three 150 mm size cube concrete specimens and concrete required to carry out workability test according to IS: 1199.

Workability of Trial Mix No.1 shall be measured. The mix shall be carefully observed for freedom from segregation and bleeding and its finishing properties. If the measured workability of Trial Mix No.1 is different from the stipulated value, the water content shall be adjusted according to Table 22 corresponding to the required changes in compacting factor. With this adjustment in water content, the mix proportions shall be recalculated keeping the free water-cement ratio at the preselected value which will comprise Trial Mix No.2. In addition, two more Trial Mixes No 3 and 4 shall be made with the water content same as Trial Mix No.2 and varying the free water cement ratio by (+) 10 per cent and (-) 10 per cent of the preselected value. For these two additional trial mixes No.3 and 4, the mix proportions are to be recalculated for the altered condition of free water-cement ratio with suitable adjustments in accordance with Table 22.

Fresh trial mixes are to be made for different types and brands of cement, alternative source of aggregates, maximum size and grading of aggregates.

4.6.8.6. Batching - In proportioning concrete, the quantity of both cement and aggregate should be determined by mass. Cement shall be used on the basis of mass and should be weighed separately from the aggregate. Water should be either measured by volume in calibrated tanks or weighed. Any solid admixture that may be added may be measured by mass. Liquid and paste admixture by volume or mass. Batching plant where used should conform to IS: 4925. All measuring equipment should be maintained in a clean serviceable condition and their accuracy periodically checked.

Except where it can be shown to the satisfaction of engineer that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate should controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the

frequency for a given job being determined by engineer to ensure that the specified grading is maintained.

It is important to maintain the water-cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregate shall be made as frequently as possible, the frequency for a given job being determined by the engineer according to weather conditions. The amount of the water to be added shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregates, IS: 2386 (part 3) may be referred to. The allow for the variation in mass of aggregate due to variation in their moisture content, suitable adjustments in the masses of aggregates shall also be made. In the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in the Table 22.

Table 22 (Surface water carried by aggregate) (Clause 4.6.8.4)

Aggregate	Approximate quantity of surface water	
	Percent by mass	Litres/m <sup>3</sup>
Very wet sand	7.5	20
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel to crushed rock	1.25-2.5	20-40

4.6.8.7. Mixing - Concrete shall be mixed in mechanical mixer. The should mixer comply with IS -1791. It shall be fitted with hopper. The mixing shall be continuous until there is uniform distribution of the material and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete should be remixed. The mixing time shall be not less than 2 minutes.

4.6.8.8. Laying - It shall be done as specified under para 4.2.4 of this specification.

4.6.8.9. Curing - It shall be done as specified under para 4.3.4 of this specification

4.6.8.10. Approval of design mix - The preliminary test for approval of design mix shall consists of three sets of separate tests and each set of test shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. Of the six specimens of each set, three shall be tested at seven days and remaining three at 28 days. The preliminary tests at seven days are intended only to indicate the strength to be attained at 28 days.

4.6.8.11. Work strength test - Work strength test shall be conducted in accordance with IS - 516 on random sampling. Each test shall be conducted on ten specimens, five of which shall be tested at 7 days and remaining five at 28 days. Not less than one work test consisting of testing of test on 10 cubes shall be carried out for every 30 cubic meter of concrete or less as per the lot size as specified below -

Lot size - Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following -

No individual lot shall be more than 30 m<sup>3</sup> in volume.

At least one cube forming an item of the sample representing the lot shall be taken from the concrete of same grade and mix proportions cast in any day.

Different grades or mixes of concrete shall be divided into separate lots.

Concrete of a lot shall be used in the same identifiable unit of the structure.

4.6.8.12. Standard of acceptance

The average strength of group of cubes cast for each day shall not be less than the specified work cube strength. 20 per cent of cubes cast for each day may have values less than the specified strength provided that the lowest value is not less than 85% of the specified strength.

Concrete strength less than specified may as a special case be accepted in a member with the approval of engineer provided that the maximum stress in the member under the maximum design live load does not exceed the permissible safe stress appropriate to the lower strength of the concrete.

Concrete which does not meet the strength requirements as specified but has a strength greater than that of the lowest value of 85% may, at the discretion of the designer, be accepted as being structurally adequate without further testing.

Concrete of each grade shall be assessed separately.

Concrete shall be assessed daily for compliance.

Concrete is liable to be rejected if it is porous or honey combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the engineer.

4.6.8.13. An example illustration the mix design for concrete mix M 20 grade is given below

-

## Design stipulation

a	Characteristic compressive strength required in the field at 28 days	20N/mm <sup>2</sup>
b	Maximum sizes of aggregate	20 MM (angular crushed)
c	Degree of workability	0.9 compacting factor (slump 75 mm)
d	Degree of quality control	Good
e	Type of exposure	Mild

## Test data of material

a	Cement used - ordinary Portland cement satisfying the requirements of IS: 269-1989	
b	Specific gravity of cement	3.15
c	Specific gravity of	
i)	Coarse aggregate	2.60
ii)	Fine aggregate (natural sand)	2.60
d	Water absorption of	
i)	Coarse aggregate	0.5 percent
ii)	Fine aggregate (natural sand)	1.0 percent
e	Free surface moisture of	
i)	Coarse aggregate	Nil (absorbed moisture also nil)
ii)	Fine aggregate (natural sand)	2.0 percent

## Sieve analysis

## a) Coarse aggregate

IS sieve Size mm	Analysis of coarse aggregate fraction (Percent passing)		Percentage of different fraction		
			I	II	Combined
20	100	100	60%	40%	100%
10	0	71.2	60%	40%	100%
4.75		9.4	0	28.5%	28.5%
2.63		0		3.7%	3.7%

The grading of combined fraction I and II in the ratio of 60 and 40 conform to Table 10 described above.

b) Fine aggregate

IS sieve sizes	Fine aggregate (percent passing)
100	-
2.36 mm	100
1.18 mm	93
600 micron	60
300 micron	12
150 micron	2

The sand conforms to grading zone III.

Target mean strength - As described earlier for degree of quality control 'good' the value of standard deviation is 4.6, therefore with a tolerance factor of 1.65 the value of target mean strength for specified characteristic cube strength =  $20 + 1.65 \times 4.6 = 27.6 \text{ N/mm}^2$ .

Selection of water cement ratio - From chart 1, the free water cement ratio required for target mean strength of  $27.6 \text{ N/mm}^2$  is 0.50. This is lower than the maximum value of 0.65 prescribed for mild exposure.

Selection of water and sand content - From Table 8 for 20 mm nominal maximum size aggregate and sand conforming to grading zone II water content as per cum concrete is 186 kg and sand content percentage of total aggregate by absolute volume is equal to 35%. For change in value of water cement ratio compacting factor, and sand belonging to zone III the following adjustment is required.

Change in condition	Adjustment required in	
	Water content	Percentage in total aggregate
For decrease in water cement Ratio by (0.6-0.5) i.e.0.10	0	-2
For increase in compacting Factor by (0.9-0.8) i.e. 0.10	+3	0

For the conforming Grading zone III	0	-1.5
Total	3	-3.5

Therefore, the required water content =  $186 + 186/100 \times 3 = 186 + 3.58 = 191.6 \text{ kg / m}^3$

And required sand content =  $35 - 3.5 = 31.5 \text{ percent}$

Determination of Cement Content

Water-Cement ratio = 0.5

Water = 191.6 kgs

Cement =  $191.6 / 0.5 = 383 \text{ kg / m}^3$

Thus cement content is adequate for mild exposure condition as per IS: 456-2000 as described in table below.

Determination of coarse and fine aggregate content

From Table 18 for specified maximum size of aggregate of 20 mm, the amount of entrapped air in wet concrete is 2 per cent. Taking this into account and applying equations given above.

$$0.98 \text{ m}^3 = 191.6 + 383/3.15 + 1/0.315 \cdot f_a / 2.60 \times 1/1000$$

and

$$0.98 \text{ m}^3 = 191.6 + 383/3.15 + 1/0.315 \cdot C_a / 2.60 \times 1/1000$$

or  $f_a = 546 \text{ kg / m}^3$  and  $C_a = 1187 \text{ kg / m}^3$

The mix proportion now works out -

Water	Cement	Fine aggregate	Coarse aggregate
191.6	383 kg	546 kg	1187 kg
or 0.5	1	1.42	3.0

For 50 kg cement, the quantity of materials are worked out as below -

a)	Cement	= 50 kg.
b)	Sand	= 71 kg
c)	Coarse aggregate	154.5 kg.
	Fraction I - 92.7	

	Fraction II - 61.8	
d)	Water	
1	For water cement ratio of 0.5 quantity	= 25.0 kg.
2	Extra quantity of water to be added for absorption in coarse aggregate at 0.5% by mass	= $154.5 / 100 \times 0.5 = 0.77$ kg.
3	Quantity of water to be deducted for free moisture in sand at 2% by mass	= $(-) 171.0 / 100 \times 2 = (-) 1.42$ kg.

Therefore actual quantity of water =  $25.00 + 0.77 - 1.42 = 24.35$  kg

Actual quantity of sand required after allowing for mass of free moisture

$$= 71.0 + 1.42 = 72.42 \text{ kg}$$

Actual quantity of Coarse aggregate

$$\text{Fraction I} = 92.7 - (0.6 \times 0.77) = 92.24$$

$$\text{Fraction II} = 61.8 - (0.4 \times 0.77) = 61.49$$

Therefore the actual quantities of different constituent required for mix are -

$$\text{Water} = 24.35 \text{ kg}$$

$$\text{Cement} = 50 \text{ kg}$$

$$\text{Sand} = 72.42 \text{ kg}$$

$$\text{Coarse aggregate} \quad \text{Fraction I} = 92.42 \text{ kg} \quad \text{Fraction II} = 61.49 \text{ kg}$$

Measurements shall be done in accordance with paras above.

Tolerances - Paras above shall apply.

Rate - Paras above shall apply with the exception regarding limitations for actual average compressive strength being less than specified strength which shall be governed by para above for acceptance and prorata rates worked out accordingly.

Annexure 4-A.1

#### SLUMP TEST

Apparatus - Mould shall consist of a metal frustum of cone having the following internal dimensions -

Bottom diameter .....20 cm

Top diameter .....10 cm

Height .....30 cm



The mould shall be of a metal other than brass and aluminum of at least 1.6 mm (or 16 BG) thickness. The top and bottom shall be open and at right angles to the axis of the cone. The mould shall have a smooth internal surface. It shall be provided with suitable foot pieces and handles to facilitate lifting it from the moulded concrete test specimen in a vertical direction as required by the test. A mould provided with a suitable guide attachment may be used.

Tamping rod shall be of steel or other suitable material 16 mm in diameter 60 mm long and rounded at one end.

Procedure - The internal surface of the mould shall be thoroughly cleaned and free from superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth horizontal, rigid and non-absorbent surface viz. leveled metal plate. The operator shall hold the mould firmly in place while it is being filled with test specimen of concrete. The mould shall be filled in four layers, each approximately one quarter of height of

mould. Each layer shall be tamped with twenty-five strokes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the underlying layer. The bottom layer shall be tamped through out its depth, after the top layer has been rodded, the concrete shall be struck off level with trowel or the tamping rod, so that the mould be exactly filled. Any mortar, which shall leak out between the mould and the base plate, shall be cleaned away. The mould shall be removed from the concrete immediately after filling by raising it slowly and carefully in a vertical direction. The molded concrete shall then be allowed to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of specimen.

The above operations shall be carried out at a place free from vibration or shock, and within a period of two minutes after sampling.

Result - The slump shall be recorded in terms of millimeters of subsidence of the specimen during the test. Any slump specimen which collapses or shears off laterally gives incorrect result. If this occurs, the test shall be repeated with another sample.

The slump test shall not be used for very dry mixes as the results obtained are not accurate.

Annexure 4-A.2

#### WORK TEST FOR CONCRETE – MANDATORY LAB TEST

A-O One sample (consisting of six cubes 15x15x15 cm shall be taken for every 20 cum or part thereof at concrete work ignoring any part less than 5 cum or as often as considered

necessary by the engineer. The test of concrete cubes shall be carried out in accordance with the procedure as described below. A register of cubes shall be maintained at the site of work in Annexure 4-A.8. The casting of cubes and all other incidental charges, such as curing, carriage to the testing laboratory shall be borne by the contractors. The testing fee for the cubes, if any, shall be borne by the department.

#### A-1 Test procedure

A-1.1 Mould - The mould shall be of size 15 cm x 15 cm x 15 cm for the maximum nominal size of aggregate not exceeding 40 mm. For concrete with aggregate size more than 40 mm, size of mould shall be specified by the engineer keeping in view the fact that the length of size of mould should be about four times the size of aggregate

The moulds for test specimens shall be made of non-absorbent material and shall be substantially strong enough to hold their form during the moulding of test specimens. They shall not vary from the standard dimensions by more than one per cent. The moulds shall be so constructed that there is no leakage of water from the test specimen during moulding. All the cube moulds for particular site should, prior to use, be checked for accuracy in dimensions and geometric form and such test should at least be made once a year.

Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly without leakage. Glass plates not less than 6.5-mm thick or plain metal not less than 12 mm thick shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when molded.

Note - Satisfactory moulds can be made from machine or steel castings, rolled metal plates or galvanized iron.

A-1.2 Sample of concrete - Samples of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge or as directed by engineer. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of concrete. The sampling operation should spread over evenly to the entire discharging operation. The samples thus obtained shall be transported to the place of molding of the specimen. To counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for further reference. In case of paving concrete, samples shall be taken from the batch immediately after deposition of the sub grade. At least five samples shall be taken from different portion of the pile and these samples shall be spread as evenly as possible through out the day. When wide changes occur during concreting, additional samples shall be taken if so desired by the engineer.

A-1.3 Preparation of test specimens - The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. The samples of concrete obtained

as described under the test specimen shall be immediately molded by one of the following methods as indicated below.

When the job concrete is compacted by manual methods, the test specimen shall be molded by placing the fresh concrete in the mould in three layers, each approximately one-third of the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 35 times with 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in uniform manner over the cross section of the mould and shall penetrate into underlying layer. The bottom layer shall be rodded throughout its depth. After the top layer has been struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined plate. The whole process of molding shall be carried out in such a manner as to preclude the change of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or over flow from the top of mould,

When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly molded by hand rodding as described above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrator may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall be of appropriate size and shall penetrate only the layer to be compacted. In compacting the first layer, the mould shall be filled to the extent that there will be no mortar loss during vibration. After vibrating the second layer enough concrete shall be added to bring level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified above. The whole process of molding shall be carried out in such a manner as to preclude the alteration of water cement ratio of the concrete by loss of water, either by leakage from the bottom or over flow from the top of the mould.

A-1.4 Curing and storage of test specimen - In order to ensure reasonably uniform temperature and moisture conditions during the first 24 hours for curing the specimen and to protect them from damage, moulds shall be covered with wet straw or gunny sacking and placed in a storage box so constructed and kept on the work site that its air temperature when containing concrete specimens shall remain 22° C to 33° C. Other suitable means which provide such a temperate and moisture conditions may be used.

Note - It is suggested that the storage box be made of 25 mm dressed tongued and grooved timber, well braced with battens to avoid warping. The box should be well painted inside and should be provided with a hinged cover and padlock.

The test specimen shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within 24° C to 30° C until the time of test. If storage in water is desired, saturated lime solution shall be used.

A-1.5. Testing - The specimens shall be tested in accordance with procedure as described below -

The tests shall be made at an age of concrete corresponding to that for which the strengths are specified.

Compression tests shall be made immediately upon removal of the concrete test specimen from the curing room i.e. the test specimen shall be loaded in damp condition. The dimensions of the test specimens shall be measured in mm accurate to 0.5 mm.

The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

The load shall be applied axially without shock at the rate of approximately 140 kg. sq cm per minute. The total load indicated by the testing machine at failure of test specimen shall be recorded and the unit compressive strength is calculated in kg per sq cm using the area computed from the measured dimensions of the test specimen. The type of failure and appearance of the concrete shall be noted.

Annexure 4-A.3.

#### REBOUND HAMMER TEST. (MANDATORY FIELD TEST)

If a rebound hammer is regularly used by trained personnel in accordance with procedure described in IS: 13311 (part II) and a continuously maintained individual charts are kept showing a large number of readings and the relation between the readings and strength of concrete cubes made from the same batch of concrete, such charts may be used in conjunction with hammer readings to obtain an approximate indication of the strength of concrete in a structure or element. If calibration charts are available from manufacturers, it can be used. When making rebound hammer tests each result should be the average of at least 12 readings. Readings should not be taken within 20 mm of the edge of concrete members and it may be necessary to distinguish between readings taken on a troweled

face and those on a molded face, when making the test on a precast units, special care should be taken to bed them firmly against the impact of the hammer.

#### Annexure 4-A.4

#### ADDITIONAL TESTS FOR CONCRETE

C-0 In case the concrete fails when tested as per the method prescribed in Annexure 4-A.5, one or more of the following check tests may be carried out at the discretion of engineer to satisfy the strength of the concrete laid. All testing expenditure shall be borne by the contractor. The number of additional tests to be carried out shall be determined by the engineer. He shall be the final authority for interpreting the results of additional tests and shall decide upon the acceptance or otherwise. His decision in this regard shall be final and binding. For the purpose of payment, the Hammering test results only shall be the criteria. Some of the tests are outlined below -

C-1 Cutting cores - This method involves drilling and testing cores from the concrete for determination of compressive strength. In suitable circumstances the compressive strength of the concrete in the structure may be assessed by drilling cores from the concrete and testing. The procedure used shall comply with the requirements of IS: 1199 and IS: 516.

The points from which cores shall be taken shall be representative of the whole concrete and at least three cores shall be obtained and tested. If the average of the strength of all cores cut from the structure is less than the specified strength, the concrete represented by the cores shall be liable to rejection and shall be rejected if a static load test (C-4) either cannot be carried out or is not permitted by the engineer.

C-2 Ultrasonic test - If an ultrasonic apparatus is regularly used by trained personnel in accordance with IS: 13311 (part I) and continuously maintained individual charts are kept showing a large number of readings and the relation between number of readings and the relation between the reading and strength of cubes made from the same batch of concrete, such charts may be used to obtain approximate indications of the strength of concrete in the structures. In cases of suspected lack of compaction or low cubes strength the results obtained from the ultrasonic test results on adjacent acceptable sections of the structures may be used for the purpose of assessing the strength of concrete in the suspected portion.

C-3 Load Tests on Individual Precast Units - The load tests described in this clause are intended as check on the quality of the units and should not be used as substitute for normal design procedures. Where members require special testing, such special testing procedures shall be in accordance with the specification. Test loads shall be applied and removed incrementally.

C-3.1. Non-destructive tests - The unit shall be supported at its designed points of support and loaded for five minutes with a load equal to the sum of the characteristic dead load plus

one and a quarter time the characteristic imposed load. The deflection is then recorded. The maximum deflection after application of the load shall be in accordance with the requirements defined by the engineer. The recovery is measured five minutes after the removal of the load and the load then reimposed. The percentage recovery after the second loading shall be not less than that after the first loading nor less than 90% of the deflection recorded during the second loading.

At no time during the tests, shall be unit show any sign of weakness of faulty construction as defined by the engineer in the light of reasonable interpretation of relevant data.

C-3.2. Destructive tests - The units is loaded while supported at its design point of support an must not fail at its design load for collapse, within 15 minutes of time when the test load becomes operative. A Defection exceeding  $1/40$  of the test span is regarded as failure of the unit.

C-3.3. Special tests - For very large units or units not readily amenable to the above test e.g. columns, the precast parts of composite beams and members designed foe continuity or fixity, and the testing arrangement shall be agreed upon before such units are cast.

C-4. Load tests of structures or parts of structures - The tests described in this clause are intended as check where there is a doubt regarding structural strength. Test loads are to be applied and removed incrementally.

C-4.1. Age at tests - The test is to be carried as soon as possible after the expiry of 28 days from the time of placing of the concrete. When the test is for a reason other than the quality of concrete in the structure being in doubt, the test may be carried out earlier, provided that the concrete has already reached is specified characteristic strength.

C-4.2. Test load - The tests loads to be applied for the limit states of deflection and local damage are the appropriate design loads i.e. the characteristic dead and superimposed loads. When the limit state of collapse is being considered the test load shall be equal to the sum of characteristic dead load plus one and a quarter times the characteristic imposed load and shall be maintained for a period of 24 hours. In any of the test temporary supports of sufficient strength to take the whole load shall be placed in position underneath but not in contact with the member being tested. Sufficient precautions must be taken to safeguard persons in the vicinity of the structure.

C-4.3. Measurements during tests - Measurements of deflection and crack width shall be taken immediately after application of the load and, in the case of 24h loaded period, after removal of the load and after 24h recovery period. Sufficient measurements shall be taken to enable side effects to be taken into account. Temperature and weather conditions shall be recorded during the tests.

C-4.0. Assessment of results - In assessing the strength of a structure or a part of the structure following a load test, the possible effects of variation in temperature and humidity during the period of the test shall be considered.

The following requirements shall be met -

The maximum width of any crack measured immediately on application of the test load for local damage, is to be not more than 2/3 of the value of the appropriate limit state requirement.

For members spanning between two supports the deflection measured immediately on application of the test load for deflection is to be not more than 1/500 of the effective span. Limits shall be agreed upon before testing cantilevered portions of structures.

If maximum deflection in mm shown during 24 h under load is less than  $40 L^2 / DD$  where L is effective span in m and D is overall depth of construction in mm, it is not necessary for the recovery to be measured and the requirements (d) does not apply, and

If within 24 hours of the removal of test load for collapse as calculated in clause (a) a reinforced concrete structure does not show a recovery of at least 75 per cent of the maximum deflection shown during the 24 h under load, the loading should be repeated. The structure should be considered to have failed to pass the test if the recovery after second loading is not at least 75 per cent of the maximum deflection shown during the second loading.

Annexure 4-A.5

#### FORMWORK AND SCAFFOLDING

1. Concrete is the most widely used construction material today because of its durability, mouldability and other characteristic. Concrete in its plastic stage has no form and therefore, needs to be molded to the required shape. Formwork includes the mould in contact with the wet concrete and all the necessary supports, hardware and bracing. The hardware supports and bracings are generally referred to as centering or false work. Scaffolding is the structure made to provide access to the point of working.

2. In the early days, formwork was generally rigged up by carpenter with available timber and nails as best as possible, using rule of thumb approach. Along with the growth in the development of concrete construction, formwork techniques have also developed side by side. With the technological advancement and introduction of new materials such as plywood, steel, aluminium, polypropylene, fibre reinforced plastics etc more rational approach is being made in the design of formwork.

3. Formwork - The basic objectives of the formwork designer should be to achieve the following:

4. Safety: to build substantially so that formwork is capable of supporting all dead and live loads, without collapse or danger to workmen and to the concrete structure.
5. Quality: To design and build forms accurately so that the desired size, shape and finish of the concrete is attained.
6. Economy: To build efficiently saving time and money for the contractor and owner.
7. Safety must find the first place in the design, construction, erection and stripping of formwork and centering systems.
8. Design consideration - To achieve the above basic objectives of formwork design the following should be considered.
  - a) Correct assessment of loads that come over forms with due consideration to pressures that arise from wet concrete.
  - b) Selection of proper forming material considering its strength, durability and cost.
  - c) Selection of proper supporting systems, either of wood, steel or aluminium. Proprietary supporting systems that are standardised and proved by tests should be adopted with advantage.
  - d) Provision for proper ties/anchors for the forms and bracing for support.
  - e) Provision of proper and safe working/access platforms for labour and equipment.
  - f) Proper scheduling, stripping and refixing of shores.

It is important to realize that centering design requires the same skill and attention to details as the design of permanent structure of like type.

9. Loads on forms - The loads on vertical forms are to be assessed from consideration of:
  - a. Density of concrete, b. Slump of concrete, c. Rate of pour, d. Method of discharge, e. Concrete temperature, f. Vibration, g. Height of discharge, h. Dimensions of section cast, i. Reinforcement details, j. Stiffness of forms
10. Form material and type - The choice of the form material mainly depends on the availability and cost of the material. Form materials include timber, plywood, hardboard, plastic fiber board, corrugated boxes, steel, aluminium, plaster of Paris etc., Thin metal sheets, neoprene craft paper, hardboard, fibre board and gypsum are generally used as forms liners attached to inside face to improve or alter the surface texture of concrete. Timber, plywood and steel are the main materials used in our country.
11. Timber - Traditional material for formwork has been timber due to its easy availability, relatively low cost and ease for shaping. The disadvantages of timber are warping, twisting, deterioration under stress of heat and contact with wet concrete. It is common practice to support formwork for slab in buildings with timber ballies cut to approximate sizes with



wedges used underneath them for final adjustments. These make weak points and are seldom prevented from displacement. Timber ballies are generally not straight and do not transmit load axially.

12. Plywood - The advantages of plywood are large panels for economical construction and removal, choice of thickness, physical properties, good finish and economy from repeated uses.

13. Steel - Steel has been an important material for fabrication of standard as well as special purpose forms, accessories and hardware. Steel is also extensively used for making horizontal and vertical shores. Because of the known characteristics of steel, design calculations for the system can be precisely made. Steel formwork system also facilitates to maintain accurate alignment, level and dimension with excellent surface finish.

Readymade forms are modular panel systems and accessories that can be adopted to build formwork for various sizes and shapes. Tailor made or special purpose made forms is fabricated to order and include tunnel forms, bridge girder shutters, dam shutters etc.

14. Climbing formwork - Most commonly used formwork system is the Climbing Forms. This system basically consists of form panels assembled with or without walers and supported by vertical strong back members (generally called soldiers) of various designs. The Climbing Form System for large and deep concrete pours may incorporate special features such as, working platforms, adjustable push-pull struts for aligning the formwork and also roller mechanism for shifting the form assembly to allow tying reinforcement and fixing other inserts, in case of thin walls. Various types of anchorage's are used to fix or support the Climbing Form Assembly to the previous concrete lift complete floor height in case of shear walls in buildings, deep pours in piers, abutments of bridges and duct walls are typical examples where such systems are used and generally handled by cranes. For smaller structures and shallow pours, lighter soldiers are used and the Form assembly is usually dismantled in small sections and refixed from pour to pour manually, with external access scaffolding.

15. Slip forms - Slip form construction also known, as sliding forms of construction is similar to extrusion process. The rate of movement of forms is regulated so that when forms leave the concrete it is strong enough to retain its shape while supporting its own weight. Vertical slip form is used for bins, silos, bridge piers etc. where as horizontal slip form is used for canal lining, tunnel invert etc. Recent developments in slip form techniques enable construction of tapered structures like chimneys, cooling towers etc where simultaneously with moving of forms, vertically, mechanical/hydraulic jacks also adjust the forms circumferentially to the required sizes as the slide progresses.

16. Suspended forms - This is a climbing system of formwork used for construction of chimneys, silos etc. the forms for outside of the structure is suspended from a concreting

platform which in turn is suspended from a central scaffold tower by means of chain pulley block. The formwork system incorporates a radial shift mechanism for adjusting the outer form to the required diameter. The inside forms are usually the climbing types.

17. Travelling or moving forms - Travelling or moving forms are usually made of steel and are generally resorted for construction of long stretches of similar section such as tunnel linings, sewers, galleries, culverts etc. Substantial saving in time and labour is possible by using travelling forms. Travelling forms are tailors made form fabricated/assembled to shape and supported by framework or gantry structure which is fitted with wheels for movement either manually or by electric or hydraulic motors. Hinges or other stripping devices are provided in the shutter itself for collapsing the formwork by means of jacks or turnbuckles. In telescopic type the form is so designed that with one mobile gantry several units of formwork can be handled by telescoping one section of formwork through the other.

18. Aluminum forms - Certain aluminium alloys are used for making forms, which are similar to steel forms. They are lightweight and reduce handling costs.

19. Concrete hardware's - Formwork systems generally incorporate a variety of hardware's such as ties and anchors for resisting lateral pressure exerted by green concrete. Form ties are tensile units consisting of an internal tension member and an external holding device. The ties can be continuous single unit or internal disconnecting type. Form anchors are devices embedded in previously poured concrete and are used for securing formwork for the subsequent lifts.

20. Formwork supports or centering - Various types of formwork supports have been developed in steel. They have been specially designed to cut labour cost in erection and stripping and to make them versatile by incorporating an adjustability feature in most cases. Generally formwork supports are either single leg type or multilegged type such as a frame or a tripod or a trestle. The single leg type is called a prop or a shore and is generally tubular and telescopic type. It incorporates adjusting features through a collar or nut to provide infinite adjustment in height. The props are usually used for supporting formwork upto heights of about 5 M. Beyond this height, they may be used in tiers in which case they are properly tied and braced to form a rigid structure. Bracings can be provided by means of tubes and clamps.

Among the multilegged support systems the common ones are of prefabricated tubular frames in a variety of shapes and modular sizes which can be assembled one over other to get the required heights and also spaced at suitable intervals depending on the loads to be carried. The forms are usually braced together by means of ledgers and cross braces to form a rigid structure. For finer adjustments in height, there are special accessories like screw jack either at top or bottom or both.

Like vertical formwork supports or shores there are also many types of horizontal formwork supports available. These are usually latticed or boxed beams which also telescope one into the other and cater for a range of spans. These horizontal supports rest either on beam forms or other shores at ends. The need for intermediate supports is eliminated and free access and working space is obtained during construction.

An important development in the formwork system particularly for flat slab and multistoried construction is the drop head system. Drop head is fitted on top of the prop or supports which continue to support the slab while the remaining form for the decking could be struck for reuse, thereby affecting a great economy in the formwork costs. With this system only an extra set of shores would be required to get faster cycle of slab construction.

Various scaffolding systems may also be adopted and used to act as centering especially when the heights of supports involved is large such as in the case of high industrial buildings, motorway decks, high shell or barrel roof hangers etc.

21. Scaffolding - Practically in all stages of construction, scaffolds are required to provide temporary platforms at various levels to carry out all these works which can not be conveniently and easily carried out either from ground level or any other floor of the building or with the use of a ladder.

22. Timber scaffold - Timber has been used for building scaffold from time immemorial and continues to be used even today. The most common type of scaffolding used in India even today is bally or bamboo scaffold. Barring a few cases where bally or bamboo scaffolding is neatly erected, properly braced and well tied to the building, invariably such scaffolds are in crooked and awkward shapes presenting a dreadful sight particularly on tall building where a stronger and safer scaffolding is called for. The draft revision of IS 3696 suggests limiting bamboo and timber scaffold up to maximum of 18 M. height.

23. Metal scaffold - By and large metal scaffolds are made of steel tubes. Many countries have formulated standard specifications and codes of practice for metal scaffolding. IS: 2750 for steel scaffolding and IS: 4014 parts 1 and 2 for steel tubular scaffolding are relevant Indian Standards.

Metal scaffolds are broadly two types viz. Tubes and fitting type and prefabricated unit frame type.

Tubes and fittings type consists of plain tubes, which are, used for making uprights, transoms, ledger and putlog. Various type of clamps viz. Right angle or double coupler, swivel coupler, putlog coupler, joint pins etc are available for connecting tubes.

Many designs of prefabricated unit type of scaffold have been developed by proprietary concerns and are now being extensively used in most of the construction sites through out the world. Units have been designed incorporating the following basic features.

- i) Prefabrication of adjustable components with few or no loose parts.
- ii) Simple and fool-proof devices as far as practical to ensure maximum safety.
- iii) Speed and ease in erection and dismantling at site by unskilled workers.
- iv) Known characteristics of each component enabling complete calculation of loading to ensure use of minimum materials.
- v) High degree of versatility and durability enables hundreds of uses for a wide range of applications.

Some of the prefabricated types of scaffoldings available are as follows:

24. Unit frame or three pieces frame - This consists of two verticals and one horizontal member with specially designed end fittings and when three are assembled together it forms a H frame. The end fittings on the horizontal also incorporate a fixing device for the longitudinal ledger. The unit frames can be erected one above the other and are spaced at suitable intervals depending on the duty of the scaffolding. The manufacturers provide complete data on loading capacities. The advantage of this type of three piece frame is that the units can be spaced at any required intervals and also the platforms can be had at any required levels and hence scaffold of this type may be truly called as all purpose type.

25. Welded frame type - These scaffold frames are made as welded units consisting of two uprights and one or more cross members to form a rectangular or H frame. Such frames can be erected one over the other to the required height. Lengthwise such frames are connected either by scissors type cross braces or ledgers. In this system the length of the ledger or cross braces decides the longitudinal spacing of the frame. Accessories such as base plate, adjustable stirrup head etc are also supplied to complete the system. The frames are made of tubes in different grades viz. Light duty or heavy duty as required.

26. Wedge lock or collar grip type - Wedge lock type scaffold consists of verticals, ledgers, transoms and diagonals. The uprights have housing welded on them at regular intervals. The transoms, ledgers and diagonals have specially designed wedge lock assemblies fitted at ends, which engage in the housing on the uprights. This type of scaffolding can be erected very fast and does not require any special tool except a small hammer to drive the wedges in. Necessary accessories are also supplied to complete the system. This is extensively used for building scaffold towers inside chimneys, silos etc and also in ship building.

29. Scaffold boards - Scaffold boards for platform are generally in timber, particularly in pinewood because of its lightweight and strength. Apart from timber boards, Steel planks are also available. They are generally made with thin M.S. Sheet with pressed or cold-formed flanges and provided with anti-skid surface treatment. It may be noted that steel planks would not be suitable for platform in extreme tropical climate and also where oil/grease or such other slippery materials are likely to fall on platforms.

30. Safety requirements - Codes of practice specify the construction details of scaffolding and also give guidelines for bracketing and tying of scaffolds for stability. Single pole scaffolds shall be braced longitudinally and the double pole scaffold shall be braced both longitudinally and transversally, so that the scaffolds form a rigid and stable structure. The scaffold shall be effectively tied to a building or adjacent structure to prevent movement of the scaffold either towards or away from the building or structure. In extreme wind conditions, it may be necessary to provide additional ties, guys or other suitable supports as decided by the engineer.

31. Scaffolding systems.

1. Metallic scaffolding is mainly of steel although aluminum is also finding increasing use as a raw material. Steel scaffolding generally includes the following.

2. Tubes & fittings. This is the commonest type of metallic scaffold first used in 1908 by a British company. This system is versatile but cumbersome and time-consuming to use since it involves a lot of joints and several loose components, which necessitate safety precautions during erection. It is recommended only for limited applications such as access scaffold for not a very tall building and for old structures/connections.

3. Welded frame-Type-Fabricated - Steel frames and cross braces systems frames are placed at regular intervals one over the other and inter-connected by cross braces for rigidity and stability. This is sturdier and safer, easy to erect and dismantle, and is suited for most staging and scaffolding jobs. But the system has some limitations in use due to the fixed size of components. It is ideal for access scaffold, heavy staging of industrial buildings, bridges, flyovers, aqueducts, etc.

4. All-purpose units / Wedge-lock type scaffolds: These scaffolds are fairly versatile but require more time to erect and dismantle compared to the welded frame type of scaffold. They are suited for access scaffolding and slab staging of industrial structures. All-purpose units consist of two vertical and one horizontal unit which are interconnected by ordinary 40 mm. NB M.S. tubes called ledgers.

5. CUPLOK systems - This is among the most versatile modular scaffolding arrangements in the world. Its unique node point connection makes it a fast assembly scaffolding. The absence of loose parts and a unique cup action allows four horizontal units to be fixed or released in a single operation by means of only a hammer. Careful selection of raw materials for various components such as higher grade YST-240 tube, malleable cast iron top cups, deep drawn steel of bottom cups and drop-forged ledger blades makes it a sturdy and yet light scaffolding system. It is ideally suited for all access scaffolds and slab staging for any type of construction. The prime feature of CUPLOK is that since its vertical member has cup joints at every 500 mm. One has to just change the location of the horizontal units (thereby reducing or increasing l/r ratio) for different loading conditions without changing

the size or thickness of the vertical tubes. Modular scaffolding systems have been effectively used for boiler maintenance, chimneystacks, access, flyovers, silos as well as offshore structures/ship building and repairs. These systems prove economical as they cut down erection time significantly.

6. Slab shuttering & support systems - From the days of timber shuttering & wooden props, slabs shuttering and centering have come a long way. The various slab shuttering systems are:

a) Conventional span-prop arrangements: Adjustability of the components makes the system versatile for normal slab shuttering.

b) Shuttering for heavier slab/deck slab - Specially designed shutters are made for jobs such as slab of industrial building, flyovers, bridges, etc.

c). Metriform unit – Decking arrangements: These consist of modular Metriform beams and panels while supporting the slab on drop-heads fitted over steel props or scaffolds. Slab shuttering can be removed in three days instead of the regular seven days thereby considerably increasing the rotation of shuttering materials. It is thus ideal for today's time-bound projects.

d) Shuttering for waffles troughs - Made out of moulded plastic materials to give architectural finish.

e) Flying form - This includes the crane-handled formwork of a complete floor slab of a building for speedy completion. All the slabs of the building should be identical in this case.

f) Support staging - Slab/beam staging is normally effected through adjustable steel props or any type of system scaffold depending on the height and load of the structure to be taken on support staging.

7. Wall / column shuttering - The construction of RCC walls/columns requires sturdy shuttering to take care of concrete pour pressures. The systems generally available are:

a) Conventional channel/heavy duty soldier - This consists of steel panels connected side by side with soldiers. Heavy duty soldiers are used for one-sided shuttering such as for RCC piers, retaining walls, etc. these are ideal for lift walls, shear walls, RCC piers, columns etc.

b) Heavy duty/ strong back arrangement - This is meant for a pour height of up to 5 m. using J-4 or Slimlite back-up soldiers. Shuttering can be of steel/ply with soldiers provided as back-ups, behind the shutters. It is ideal for fast concreting, with the help of pumps and can be crane-handled.

8. Special shuttering - Construction of special structures also requires suitable formwork. Some of the applications are:

a) Slip form of chimneys/silos: Hydraulically lifted complete shuttering by means of heavy duty jacks enables concreting of a tall chimney in hardly any time as more often the slipping (or concreting) is continuous once it starts.

b) Dam shuttering: Special heavy duty hinged soldiers along with heavy shutters are used to match the profile of a dam.

c) Canal lining: Mobile shutters are specially designed to move along the canal, for the concrete lining.

d) Bridge shuttering: Shutters for girders are specially designed to take care of concreting loads.

9. Conclusion - It is obvious that modern shuttering and scaffolding systems, which are continuously evolving, are among the most important aspects of construction and maintenance. Unfortunately, so far neither the industry nor the engineering institutions have really gone into the relevance and details of this equipment are which should be utilized for effecting proper and economical designs for particular applications. With the advent of professional scaffolding organisations and realisation of the need on the part of the industry for safer, faster and economical construction, one hopes for the development of this long-neglected but important area in the near future is going to be a reality.

#### Annexure-4-A.7

##### CONCRETE WORK --- LIST OF BUREAU OF INDIAN STANDARDS

SI No	IS No.	Subject
1	306-1983	Tin bronze ingots and castings (3rd revision) Reaffirmed 1993.
2	383-1970	Coarse and fine aggregate from Natural source for concrete (2nd revision) Reaffirmed 1990.
3	456-2000	Code of practice for plain and reinforced concrete (3rd revision) (Amendments 2) Reaffirmed 1991.
4	516-1959	Method of sampling and analysis of concrete. Reaffirmed 1991.
6	1200 (Part II) 1974	Method of measurement of building and civil engineering work Part 2 (concrete works). (3rd revision) (Amendments 2) Reaffirmed 1991.
7	1322-1993	Bitumen felt for water proofing and damp proofing (4th revision) (previously 13220-1982)
8	1791-1985	Batch type concrete mixers. (2nd revision) Reaffirmed 1990.

9	2386-1963	Method of test for aggregate for concrete work. Part 1 particle size and shape (Amendments 2) Reaffirmed 1990
		Part 2 Estimation of deleterious materials and organic impurities (Amendments 1) Reaffirmed 1990.
		Part 3 Specific gravity, density, voids, absorption and bulking - Reaffirmed 1990.I
		Part 4 Mechanical properties (Amendments 3) Reaffirmed 1990.
10	2505-1980	General requirements for concrete vibrators immersion type. Reaffirmed 1993.
11	2505-1985	General requirements for screed board concrete vibrators. (1st revision) Reaffirmed 1990.
12	2645-1975	Integral cement water proofing components (1st revision) (Amendments 1) Reaffirmed 1992.
13	2686-1977	Cinder as fine aggregate for use in lime concrete (1st revision) (Amendments 1) Reaffirmed 1992.
14	3068-1986	Broken butnt (clay) coarse aggregate for use in lime concrete. (2nd revision) Reaffirmed 1991.
15	3812-1981	Flyash for use as pozzolana and admixtures (1st revision) Reaffirmed 1992.
16	4643-1984	Section wrenches for fire bridge use (1st revision) Reaffirmed 1992.
17	4656-1968	Form vibrators for concrete. Reaffirmed 1991.
18	7861 (Part 1) 1981	Code of practice for extreme weather concreting (Part 1) recommended practice for hot weather concreting (Amendments 1) Reaffirmed 1990.
19	7861 (Part 2) 1975	Code of practice for cold weather concreting (Part 2) Recommended practice for cold weather concreting (Amendments 1) Reaffirmed 1992.
20	9103-1979	Admixture for concrete Reaffirmed 1990.

### 3. STEEL, IRON AND ALLUMINIUM WORKS

#### 7.1 Materials

7.1.1. **Steel** - All finished steel shall be well and cleanly rolled to the dimensions and weight specified by Bureau of Indian Standards subject to permissible tolerances as per IS: 1852. A List of BI Standards applicable to this section is Annexure 7-A.1. The finished materials



shall be reasonably free from cracks, surface flaws laminations, rough and imperfect edges and all other harmful defects.

7.1.2. Steel sections, shall be free from excessive rust, scaling and pitting and shall be well protected. The decision of the engineer regarding rejecting any steel section on account of any of the above defects shall be final and binding.

7.1.3. Structural steel work shall conform to the following requirements. The following varieties of steel should be used for structural purposes

7.1.4. **S.T. 42S** - The standard quality steel designated as ST-42S, conforming to IS: 226 shall be used for all types of structure (riveted or bolted) including those subject to dynamic loading and where fatigue, wide fluctuation of stresses are involved, as for example crane gantry girders, road and rail bridges etc. It is also suitable for welded structures provided that the thickness of materials does not exceed 20 mm.

7.1.5. **S.T. 42W** - The fusion welding quality steel designated as S.T. 42W, conforming to IS: 2062 shall be used for structures subject to dynamic loading (Wind load is not to be considered as dynamic load for this purpose) where welding is employed for fabrication and where fatigue, wide fluctuation of, stresses reversal of stress and great restraint are involved as for example, crane gantry girders and road and rail bridges.

7.1.6. **S.T. 420** - The ordinary quality steel designated as S. T. 420 conforming IS: 1977 shall be used for structures not subjected to dynamic loading other than wind loads where welding is not employed or / and structures not situated in earth quake zones or / and design has not been based on plastic theory.

7.1.7. **S.T. 320** - The ordinary quality steel designated as S. T. 420 conforming to IS: 1977 shall be used for doors, window frames, window bars, grills, steel gates, hand railing, builders hardware, fencing post, tie bars etc.

7.1.8. Casting shall be cast from cast iron of grade FG 150 conforming to IS: 210-1978, Specification for grey iron castings. The castings shall be sound, clean and free from porosity, blow holes, hard spots, cold shuts (i.e. irregularities due to casting at too low a temperature), distortion and other harmful defects. They shall be well dressed and fettled, accurately moulded in accordance with the pattern/drawing and shall be of uniform thickness except where the design necessitates variation. Abrupt changes in the section of adjoining members shall be avoided as far as possible. Unless otherwise indicated edges of castings shall be rounded and internal angles finished with an angle fillet. No welding or repairs shall be carried out, unless otherwise indicated.

7.1.9. **Rivets** - Rivets shall be made from rivet bars of mild steel as per IS: 1148-1982. High tensile rivet bars shall conform to IS: 1149-1982.

7.1.10. **Bolts** - These are of two type's namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for

turned bolts is adopted. They shall conform to IS: 1367 Technical supply conditions for threaded steel fasteners.

7.1.11. **Electrodes** - The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS: 814-1991.

## 7.2. Workmanship – General

7.2.1. Structural steel work riveted, bolted or welded shall be carried out described in IS: 800-1984, Code of practice for use of structural steel in general building construction.

7.2.2. **Straightening and bending** - All material shall be straight and if necessary, before being worked shall be straightened and flattened by pressure, unless required to be of curvilinear form and shall be free from twists. Straightening of steel by hammer blows is not permitted. All bending and cutting shall be carried out in cold condition, unless otherwise directed, in such manner as not to impair the strength of the metal.

7.2.3. **Cutting and machining** - Member shall be cut mechanically by saw or shear or by oxyacetylene flame. All sharp rough or broken edges and all edges of joints which are subjected to tensile or oscillating stresses shall be grounded. No electric metal arc cutting shall be allowed. All edges cut by oxyacetylene pores shall be cleaned of impurities and slag prior to assembly, cutting tolerance shall be as follows (a) For member connected at ends  $\pm 1$  mm. (b) Elsewhere  $\pm 3$  mm.

When compression members depend on contact surfaces for stress transmission, then ends of columns and bases together with gussets, angles and channels (after riveting / welding together) shall be accurately measured so that the parts connected butt over the entire surfaces of contact. Columns at bases or at caps or at butt joints need to be machined.

7.2.4. **Holes** - All holes shall be accurately marked and drilled. Holes through more than one thickness shall preferably be drilled together after the members are assembled and tightly clamped or bolted together. In such cases, if required, these parts shall be separated after drilling and burrs removed. For thickness of materials less than 16 mm the holes may be punched 3 mm less in diameter than the required size and may be reamed to the full diameter after assembly. Finished holes for rivets and black bolts shall be more than 1.5 mm (2.0 mm for rivets and bolts of diameter more than 25 mm) in diameter larger than the diameter of rivets and bolts passing through them. All matching holes for rivets shall be so prepared that a gauge 0.8 mm diameter less than the hole can pass freely through the members assembled for riveting. Holes other than those required for close tolerance may be punched full size through material not less than 12 mm thick.

All holes shall have their axis perpendicular to the surface bored through Holes through two or more members shall be truly concentric. No rivet or bolt hole shall be nearer the edge of the member than a distance equal to its own diameter. Holes shall not be formed by gas cutting process.

## 7.2.5. Assembly

7.2.5.1. **Laying out** - Steel structure shall be laid out on a level platform to full scale and to full size or in parts as shown on working drawings or as directed by engineer. Wooden templates 12 mm to 19 mm thick or metal sheet templates shall be made to correspond to each member and part; rivet holes shall be marked accurately on them and drilled. The templates shall be laid on the steel members and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting. The base of steel columns and the positions of anchor bolts shall be carefully set out. The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified cambers, if any, are provided. All box sections shall be sealed so as to prevent the access of moisture to the inside of the members.

Assembly shall be done by using assembly fixtures, jigs and stands which facilitate high quality assembly with proper safety. Misalignment and distortion of parts after assembly shall not be allowed; only thoroughly straightened parts free from burrs, grease, rust, etc. shall be allowed for assembly.

Temporary connection of parts during assembly shall be done in the following way:

- a) For welded structures joining shall be done by means of tack weld, fastening devices and fixtures.
- b) For riveted and bolted structures joining shall be done by adequate number of bolts. If tack welding is permitted, in such cases the same shall be removed after the work is over.
- c) For riveted structures in which holes are to be drilled after assembly, joining shall be done by appropriate fixtures.

Tack welding shall be done on the side and along the line of the weld. Tack weld dimension all be minimum, welding being carried out with similar electrodes as the final welding and the tacks shall completely fuse with the final weld metal. In case splicing is necessary, the individual members shall be spliced first before assembly and before final welding with other members.

For riveted structures, members shall be well tightened by assembly bolts in every third hole maximum distance between bolts shall not exceed 500 mm. To prevent stiffening drift pins shall be used 30 per cent of the assembly bolts. After tightening, the gap between members to be jointed shall be checked by 0.2 mm thick feeler gauge which should not go inside by more than 2 mm, looseness of bolts shall be checked by tapping with a test hammer.

#### 7.2.6. **Riveting**

Riveting shall be done by pneumatic riveting or hydraulic riveting equipment, riveting of diameter less than 10 mm may be fitted cold. In cold riveting the rivets are driven with the aid of powerful pneumatic or electrical clamps and the holes filled with sufficient tightness. However where such facilities are not available, hand riveting may be permitted by the engineer.

Members to be riveted shall be properly pinned, or bolted and rigidly held together while riveting. Rivets shall be heated uniformly throughout the length without burning or excess scaling and shall be of sufficient length to provide ahead of standard dimension. They shall, when driven, completely fill the holes and if countersunk, the countersinking shall be fully filled by the rivet. Any proudness of countersunk head shall be dressed off flush. All loose, burnt and badly formed or otherwise defective rivets shall be cut out and replaced before the structure is loaded. The heads of rivets shall be central to shanks and shall grip the assembled members firmly. In cutting out rivets care shall be taken so as not to injure the assembled members. Caulking or recupping shall not be permitted.

#### **7.2.7. Bolting**

Bolt heads and nuts shall be of such length as to project one clear thread beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Round washers shall be placed under the heads and nuts of permanent bolts. Maximum two washers for one nut and one for each bolt head shall be used. Both threads shall be outside the limits of joining members and unthreaded portion of bolt shall not be outside the washer.

Where there is risk of the nuts being removed or becoming loose due to vibration or reversal of stresses, these shall be secured from slackening by the use of lock-nuts or spring washers, as directed by the engineer. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil before use. Quality of lightening of bolts shall be inspected by tapping them with a hammer. The bolt shall not be shaken or shifted. The bolts shall be tightened starting from centre of the joint towards the edge.

#### **7.2.8. Welding**

Welding shall be done by metal arc process unless otherwise permitted by the engineer, in writing, in accordance with IS: 816-1969 Code of Practice for use of metal arc welding of general construction in mild steel, and IS: 9595-1980. Recommendation of Metal Arc Welding, regarding workmanship welding method, welding procedure with suitable electrodes and wire flux, combinations, quality of welds, correction of weld faults etc.

#### **7.2.9. Preparation of members for welding**

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axis, nodes etc.).

Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped or ground or filed over the length of the affected area, deep enough to remove faults completely. Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint. Generally no special edge preparation shall be required for members under 8 mm thick.

Edge preparation (beveling) denotes cutting of the same so as to result in V, X, K or U seam shapes as per IS: 9595-1980.

The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter, likely to get into the gaps between members to be welded.

Before assembly, the edges to be welded as well as adjacent areas extending for at least 20 mm shall be cleaned (Until metallic polish is achieved). When assembling members proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure. The elements shall be got checked and approved by the engineer before assembly wherever it is specified. The permissible tolerances for assembly of members preparatory to welding shall be as per IS: 9595. After assembly has been checked, temporary tack welding in position shall be done by electric welding; keeping in view finished dimensions of the structure. Preheating of members to be joined to be carried out as per standards wherever necessary.

#### 7.2.10. **Butt welds** (Fig. 1)

The form of joint, angle between fusion faces, gap between parts and the welding procedure shall be such that the welded joint shall comply with the design requirements. The ends of butt joints in plate shall be welded so as to provide full throat thickness. In the gas welded condition, the weld face shall be proud of the surface of the parent metal. Where a flush surface is required, the excess metal shall be dressed off. Where no dressing is to be carried out, the permissible weld profile shall be as specified in the relevant IS.

For butt weld, where these are to be welded for both sides, certain welding procedures allow this to be done without back going, but where complete penetration cannot be achieved, the back of the first run shall be gouged out to clean sound metal before welding is started on the gouged outside.

#### 7.2.11. **Fillet Welds** (Fig. 1)

A fillet weld as deposited shall be not less than the specified dimensions indicated as throat thickness and/or leg thickness taking into account penetration or partial penetration. For concave fillet welds the actual throat thickness shall be not less than 0.7 times the specified leg length. For convex fillet welds, the actual throat thickness shall be not less than 0.9 times the specified leg length.

#### 7.2.12. **Preparation of joint faces**

If preparation or cutting of material is necessary, this shall be done by shearing, chipping, grinding, machining, thermal cutting or thermal gouging. When shearing is used the effect of work hardening shall be taken care of to ensure that there is no cracking of the edges. Removal of 1 mm to 2 mm from a cut face normally eliminates the layer of hardness.

#### 7.2.13. **Fusion faces**

Fusion faces and adjacent surfaces shall be free from cracks, notches or other irregularities which might be the cause of defects or would interfere with the deposition of the weld. They shall also be free from heavy scale, moisture, oil, paint and any other substance which might affect the quality of weld or impede the progress of welding.

**7.2.14. Assembly for welding**

Jigs and manipulators should be used, where practicable, so that the welding can be carried out in the most suitable position. Jigs shall maintain the alignment with the minimum restraint so as to reduce the possibility of lock in stresses.

**7.2.15. Alignment of butt joint**

The root edges or root faces of butt joints shall not be out of alignment by more than 25 per cent of the thickness of the thinner material for material up to 12 mm thick or by more than 3 mm for thicker material. For certain applications closer tolerances may be necessary for proper alignment.

**7.2.16. Fit up of parts jointed by fillet welds**

The edges and surfaces to be jointed by fillet welds shall be in as close contact as possible since any gap increases the risk of cracking but in no case should the gap exceed 3 mm.

**7.2.17. Tack welds (Fig.1)**

Tack welds shall be not less than the throat thickness or leg lengths of the root run to be used in the joint. The length of the tack weld shall not be less than four times the thickness of the thicker part or 50 mm whichever is similar. If smaller tack welds are desired, these shall be so indicated.

Where the tack weld is incorporated in a welded joint, the shape of the tack shall be suitable for incorporation in the finished weld and it shall be free from cracks and other deposition faults.

**7.2.18. Protection from weather**

Surface to be welded shall be dry. When rain or snow is falling or during periods of high wind, necessary precautions shall be taken for outdoor welding arc. Warming shall be carried out at all ambient temperatures below 10 degree C.

**7.2.19. Inter-run cleaning**

Each run of weld bead and each layer of weld shall be thoroughly cleaned of slag, spatters, etc. before depositing subsequent bead or weld with particular reference to thorough cleaning of toes of the welds. Visible defects such as cracks, cavities and other deposition faults, if any, shall be removed to sound metal before depositing subsequent run or layer of weld.

**7.2.20. Welding procedure**

Welding shall be carried out only by fully trained and experienced welders as tested and approved by the engineer. Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS: 823-1964. The nature of test for performance qualification for welders shall commensurate with the quality of welding required on this work as judged by the engineer. The steel structures shall be automatically, semi automatically or manually welded. Welding shall be only after the checks have been carried out. Welding procedures and Tests for welders shall be conducted as per IS: 9595 and approved by the engineer. The welder shall mark with his identification mark on each

element welded by him. When welding is carried out in open air steps shall be taken to protect the places of welding against wind or rain. The electrodes wire and parts being weld on shall be dry. Before beginning the welding operation each joint shall be checked to assure that the parts to be welded are clean and root gaps provided as per IS: 9595. For continuing the welding of seams discontinued due to some reasons the end of the discontinued seam shall be melted in order to obtain a good continuity. Before resuming the welding operation the groove as well as the adjacent parts shall be well cleaned for a length of approximately 50 mm. For single butt welds (in V, ½ V or U) and double butt welds (in K, double U, etc.) the re-welding of the root butt is mandatory but only after the metal deposition on the root has been cleaned by back gouging or chipping. The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any method. For multilayer welding before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed. The order and method of welding shall be so that (a) no unacceptable deformation appears in the welded parts. (b) due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses. The defects in welds must be rectified according to IS: 9595-1980 and as per instruction of engineer.

#### 7.2.21. Approval and testing of welders

The contractor shall satisfy the engineer that the welder is suitable for the work upon which they will be employed.

#### 7.2.22. Weld inspection

The weld seems shall satisfy the following

a) Shall correspond to design shapes and dimensions.(b)Shall not have any defects such as cracks, incomplete penetration and fusion under cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible. During the welding operation and approval of finished elements inspections and tests shall be made as shown in Table 1 below

Table 1 Extent of inspection and testing

Sl .N o	Inspection of test	Coverage	Procedure	Evaluation and remedy of defects
1	Inspection of weld seam Appearance	All welds	Naked eye or lens	All faulty welds shall be rectified.
2	Checking of sizes	Atleast one for each weld seam	Ordinary measuring instruments (Rule template)	Should faulty weld be found, all welds shall be checked and all defects shall be rectified.

	Mechanical test for welding procedure, performance & electrodes.		As per IS: 9595	As per IS: 9595
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The mechanical characteristics of the welded joints shall be as in IS: 9595.

#### 7.2.23. Quality of welds and corrections

Welded joints shall be free from defects that would impair the service performance of the construction. All welds shall be free from incomplete penetration, incomplete fusion, slag inclusion, burns, un-welded craters, undercuts and cracks in the weld metal or in the heat affected zone, porosity etc. Unacceptable undercutting shall be made good by grinding. In case of shrinkage cracks, cracks in parent plate and crater, defective portions shall be removed down to sound metal and re-welded. Whenever corrections necessitate the deposition of additional weld metal, electrode of a size not exceeding 4 mm may be used. Rectification of welds by caulking shall not be permitted.

7.2.24. **Cleaning** - All welds shall be cleaned of slag and other deposits after completion; till the work is inspected and approved, painting shall not be done.

#### 7.2.25. Plaining of ends

Plaining of ends of members like Column ends shall be done by grinding where so specified. Plaining of but welded member shall be done after these have been assembled and the edges be removed with grinding machine or file.

The following tolerances shall be permitted on members that have been plained

- a) The length of member having both ends plained max  $\pm 2$  mm with respect to design.
- b) Level difference between plained surface = 0.3 mm.
- c) Deviation between plained surface and member axis = max  $1/5000$ .

#### 7.2.26. Safety and health

The contractor shall ensure that the safety requirements and health provisions laid down in IS: 818-1968 Code of Practice for safety and health requirements in electric and gas welding and cutting operations are complied with during welding operations. The contractors shall also provide equipment for eye and face protection during welding as laid down in IS: 1179-1967. Fire precautions shall be taken in accordance with IS: 3016-1982 Code of Practice for fire precautions in welding and cutting operations.

#### 7.2.27. Erection

Erection works shall be performed in accordance with the general construction schedule. A scheme shall be worked before the commencement of the erection which shall also contain rules for safety precautions as detailed in IS: 7205-1973. (Safety Code for erection of structural steel work).

Anchor bolts for fastening of steel structures shall be set in designed position and grouted along with foundations. Alternatively anchor bolts should be provided in the concrete



foundations with bolt boxes and anchor channels for the purpose of flexibility and grouted after final alignment and leveling of column. The gaps between the bearing surface of foundation and bottom of the structures to be erected shall be filled properly by cement grouting. Grouting shall be done after the verification and proper positioning of the structures but before encasing the structures with concrete if specified. Damaged structural members shall be examined and rectified or replaced as directed. The erected parts of the structure shall be stable during all the stages of erection; and structural elements to be erected shall be stable and strong to bear erection loads. Working on the already erected structures is permitted only after they are finally fixed. Erection of structures of each tier high structures shall be executed only after the relevant fastening of lower tier by the permanent or temporary fastening devices as per schedule of execution of work and certified for safety. The joint and mating surface including the mating planes, strips and filler or spacers shall be cleaned of dust, rust and water.

Erected structural members shall be firmly fastened by bolts and drifts, permanent or provisional tacking, crossing bars and so on before the erection crane hook is removed. The trusses shall be lifted only at nodes. The trusses above 12 m span shall not be slinged at the apex, as it will develop compression stresses in the bottom tie member. It shall be lifted by slinging at two mid points of rafters, which shall be temporarily braced by a wooden member of suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible. The end of truss which faces the prevailing winds shall be fixed with holding down bolts and the other end kept free to move. In case of small truss of span say up to 12 m the free end of the truss shall be laid on steel plate as per design and the holes for holding down bolts shall be made in the form of oblong slot so as to permit the free movement of the truss end. For large spans, the free end of the truss shall be provided with suitable rocker and roller bearing where indicated.

#### **7.2.28. Erection joints**

While erecting, holes to be riveted shall be fitted with temporary bolts and drifts of diameters equal to those of the holes. It is necessary to initial drifts for accurate matching of holes. Number of bolts and drifts shall not be less than 40 per cent of total number of holes. Forces applied to drifts shall be same as approved for rivets. Number of drifts shall be 10 per cent of number of holes.

The number, size and length of tack welds in erection joints bearing erection forces shall be as indicated. For the erection joints which do not bear the erection forces the length of tack welds shall be minimum 10 per cent of the designed weld length of the joints.

Welding, riveting and final fastening or permanent bolts shall be done only after the inspection of the structural elements for their positions. Head bolts and nuts shall perfectly be in touch with the surfaces of structures and washers.

#### **7.2.29. Tolerance allowed in erection**

**Building without crane** - The maximum Tolerance for line and level of steel structure shall be  $\pm 3.00$  mm on any part of the structure. The structure shall not be out of plumb more than 5.00 mm each 10 metre section in height and not more than 7.00 mm per 30 metre section. These tolerances shall apply to all parts of structure unless otherwise specified.

Tolerance allowed in erection of steel structure containing cranes shall be as per following Table.

Table

Component	Description		Tolerance allowed
Main columns And roof posts	a	Shifting of columns axis at foundation level with respect to building line:	$\pm 5.00$ mm
	i	In longitudinal direction	
	ii	In lateral direction	$\pm 5.00$ mm
	b	Deviation of both major column axis from vertical between foundation and other member connection levels:	
	i	For a column upto and including 10 m height	$\pm 5.00$ mm from true vertical.
	ii	For a column greater than 10 m but less than 40 m height	$\pm 5.00$ mm from True vertical for any 10 M length measured between connection levels but not more than $\pm 8.00$ mm for 30 m length.
	c	For adjacent pairs of columns across the width of the building prior to placing of truss.	$\pm 5.00$ on true span
	d	For any individual column deviation of any bearing or resting level from levels shown on drawings.	$\pm 5.00$ mm
	e	For adjacent pairs of columns either across the width of buildings or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	5.00 mm

Trusses	a	Deviation at centre of span or upper chord member from vertical plane running through centre of bottom chord.	1/500 of the span or 10 mm whichever is less.
	b	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is less.

### 7.3. Steel reinforcement

**Steel reinforcement for concrete** - Steel reinforcement shall be mild steel bars, deformed bars, steel wire fabrics and of grade / types as indicated.

Mild Steel Bars shall be of grade I or grade II indicated and conforming to IS: 432 (Part I)-1982 and (part II) (Annexure 7-A.7 & 7-A.8) Specification for mild steel and medium tensile steel bars. Alternatively mild steel shall be of grade Fe 410S conforming to IS: 226-1975 or of grade Fe 4100 conforming to IS: 1977-(1975) as indicated. The limitations, on the use of mild steel bars or of grade Fe 4100 as given under structural steel shall apply. Deformed Bars shall conform to IS: 1786-1979 Specifications for High strength deformed bars and wires for concrete reinforcement- enclosed as Annexure 7-A.9. Fabric reinforcement shall conform to IS: 1566-(1982) Specification for hard drawn steel wire fabrics for concrete reinforcement.

#### 7.3.5. Tolerance on size of reinforcement bars

The tolerance on diameter of the mild steel bars shall be  $\pm 0.5$  mm for bars up to and including 25 mm with a total margin of 1mm and  $\pm 0.75$  mm for bars above 25 mm dia with total margin of 1.5 mm. The tolerance on the diameter in the case of coiled round bars shall be  $\pm 0.5$  mm up to and including 12 mm diameter with a total margin of 1 mm. Measurement shall be taken at point sufficiently away from the ends ensuring exclusion of heavy ends.

#### 7.3.6. Tolerance on weight

The tolerance on weight of plain and deformed round shall be  $\pm 4$  per cent with a total margin of 8 per cent for bars up to and including 8 mm diameter and  $\pm 2.5$  percent for bars over 8 mm diameter with a total margin of 5 percent.

Tolerance on weight of fabric reinforcement shall be  $\pm 6$  per cent.

#### 7.3.7. Freedom from defects

All finished bars shall be well and cleanly rolled to the dimensions and weights specified; these shall be sound and free from cracks, surface flaws, laminations and rough, jagged and imperfect edges and other defects and shall be finished in a workman like manner.

Steel reinforcement shall be stored as to prevent distortion and corrosion. Any reinforcement that has deteriorated or corroded or is considered defective by the engineer shall not be used in the work. Bars of different classification, sizes and lengths shall be

stored separately to facilitate use in such sizes and lengths as to minimise wastage in cutting from the standard lengths.

#### 7.3.8. **Bends and hooks forming end anchorages**

Ends of plain round mild steel bars shall be bent to radius of not less than 2 diameters and the straight portion beyond the curve shall not be less than 4 diameters unless otherwise indicated. In the case of deformed bars, bends shall be made to radius of 4 times the diameter of the bar and straight portion beyond the curve shall not be less than 4 diameters, unless otherwise indicated. Ends of deformed bars are not bent to form hooks. In the case of binders, stirrups, links, etc., the straight portion beyond end of the curve at the end shall be not less than 8 times the nominal size of the bar

Bars specified to be formed to radii exceeding those given in Table X of IS 2502-1963 Code of practice for bending and fixing of bars for concreting, need not be bent but the required curvature may be obtained during the placing.

#### 7.3.9. **Bending of bars**

Bars shall be bent to shape cold except that bars larger than 25 mm in size may be bent hot at cherry red heat (not exceeding 850 degree C). Hot bar shall not be cooled by quenching. A bar which shows any sign of cracks at a bend shall be rejected.

Fig. 1 Welds and Rivets

#### 7.3.10. **Splicing**

Where bars required are longer than those carried in stock, splices shall be provided as far as possible, away from the section of maximum stress and be staggered. The use of short length bars shall not be permitted. IS: 456-1978 Code of practice for plain and reinforced concrete recommends

that splices in flexural members should not be at sections where the bending moment is more than 50 per cent of the moment of resistance ; and not more than half the bars shall be spliced at a section.

#### 7.3.11. **Lap splices**

Lap splices shall not be used for bars larger than 36 mm dia, larger diameter bars may be welded, in cases where welding is not practicable, lapping of bars larger than 36 mm dia may be permitted in which case additional spirals shall be provided around the lapped bars. Lap length shall be not less than 30 diameters for flexural tension and direct tension and not less than 24 diameters for compression. When bars of two different diameters are to be spliced the lap length shall be calculated on the basis of diameter of the smaller bar. End bearing splices shall be used only for the bars in compression. The ends of the bars shall be square out and concentric bearing ensured by suitable devices. When larger diameters have to be welded to avoid congestion rather than lapped for splicing, the method of welding shall be as directed. The location of staggered welds at heights or position shall be convenient for welding.

#### 7.3.12. **Spiral reinforcement**

Spirals shall be provided with one and a half extra turns at both top and bottom. Where necessary to splice the spiral it shall be done by a lap of one and a half turns or by shop welding.

#### **7.3.13. Placing and fixing of bars**

Reinforcements shall be placed in position as per detailed design drawing and shall be secured at that position. In case of delay occurring between fixing of reinforcement and concreting, the position of the reinforcement shall be checked prior to concreting. Bars crossing each other shall be secured by binding wire (annealed) of size not less than 0.9 mm, and conforming to IS: 280-1977. Specification for mild steel wire, in such a manner that they will not slip over each other at the time of fixing and concreting. Every compression bar shall be tied at least in two perpendicular directions.

#### **7.3.14. Cover blocks**

Cover blocks generally of cement mortar shall be used to ensure the required cover for the reinforcement. The mortar or concrete used for the cover blocks or rings shall be not leaner than the mortar or concrete in which they would be embedded.

#### **7.3.15. Spacers**

Where multiple rows of reinforcement are provided distances between successive rows shall be properly maintained while concreting by providing suitable spacer bars.

#### **7.3.16. Placing reinforcements**

All mill scale, loose or scaly rust, oil and grease or any coating that will destroy or reduce bond shall be thoroughly cleaned off the steel reinforcement with a stiff wire brush or other approved means before it is placed in forms. Steel reinforcement when placed in the forms shall be properly braced, supported, or otherwise held firmly in position so that placing and ramming / vibrating of concrete does not displace it. It shall be ensured that all the reinforcement can be properly placed. Congestion of steel shall be avoided at points where members intersect.

#### **7.3.17. Tolerance in placing of reinforcement**

Unless otherwise indicated, reinforcement shall be placed within following tolerance.

(a) For effective depth 200 mm or less  $\pm 10$  mm (b) For effective depth more than 200 mm or  $\pm 15$  mm

The cover shall in no case be reduced by more than 1/3 of specified cover or 5 mm whichever is less.

#### **7.3.18. Steel wire fabric reinforcement**

Hard drawn steel fabric shall conform to IS 1566-1982 – Specification for hard drawn steel wire fabric for concrete reinforcement, MESH size, weight, size of wire for square and oblong welded shall be indicated. The fabric shall be formed by spacing the main and the cross wire, which shall be fixed at the point of intersection by electric welding.

Since fabric is supplied in long rolls it is rarely necessary to have a joint of the main wires. In structural slab laps in regions, of maximum stress shall be avoided. When splicing of

welded wire fabric is to be carried out, lap splices of wires shall be made so that overlap measured between the extreme cross wires shall be not less than the spacing of cross wires plus 10 cm. For edge laps a lap of 5 cm shall be provided.

#### 7.3.19. **Welding of reinforcement**

Welding of bars where indicated or agreed to by the engineer, in writing, in lieu of lapping shall be done in accordance with IS: 2751-1979, Code of practice for welding of concrete construction. Welding in general shall be done as described for structural steel work.

Bars up to and including 20 mm dia shall be lap welded and those larger than 20 mm dia shall be butt welded. In case of lap welds, the length of lap shall be five times the dia or 100 mm whichever is greater. The throat thickness shall not be less than 3 mm for bars up to 16 mm dia and 5 mm for bars over 16 mm dia and up to 20 mm dia.

#### 7.3.20. **Butt welding**

Where it is not possible to rotate bars for welding in flat positions the axis of the bars shall be horizontal and the respective axis of welds shall be vertical. The edge preparation for inclined bars shall be such that welding is done only on sides. All the bars to be butt welded shall be aligned and set up in position with their axis in one straight line. This may be done in a jig or by means of a clamp or by using guides. Rotation of the bars shall be avoided, until they are adequately welded.

#### 7.3.21. **Lap welding**

Edge preparation is not necessary for lap welds.

#### 7.3.22. **Finish**

The profile of the welds shall be uniform, slightly convex and free from overlap at the toes of the welds. The weld face shall be uniform in appearance throughout its length. The welded joint shall be free from undercut. The joints in the weld run shall be as smooth as practicable and shall show no pronounced hump or crater in the weld surface. The surface of the weld shall be free from porosity, cavities and trapped slag.

### 7.4. **SPECIFICATIONS FOR STEEL WORK IN SINGLE SECTION FIXED INDEPENDENTLY WITH CONNECTING PLATE**

7.4.1. The steel work in single sections of R. S. joists, flats, Tees Angles fixed independently with or without connecting plate, is described in these clauses.

#### 7.4.2. **Fabrication**

The steel sections as specified shall be straightened and cut square to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

#### 7.4.3. **Painting**

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible

after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer i.e. red oxide zinc chrome primer conforming to IS: 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

#### 7.4.4. Erection

Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc shall be used. The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the engineer.

#### 7.4.5. Measurements

The work as fixed in place shall be measured in running metres correct to a millimeter and weights calculated on the basis of standard tables correct to the nearest kilogram.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm, gussets (taking overall square dimensions) fish plates, etc., shall be added to the weight of respective items. In riveted work, allowance is to be made for weight of rivet

heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures.

No deduction shall be made for rivet / or bolt holes (excluding holes for anchor or holding down bolts).

Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm.

The weight of steel sheets, plates and strips shall be taken from relevant Indian Standards based on 7.85 kg/m<sup>2</sup> for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### 7.4.6. Rate

Rate includes the cost of labour and materials required for all the operations described above.

### 7.5. SPECIFICATIONS FOR STEEL WORK RIVETTED AND BOLTED BUILT UP SECTIONS.

The steel work in built up sections (Riveted and bolted such as in trusses, framed work etc. is specified in this clause.

#### 7.5.2. Laying out

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the engineer. Steel tape shall be used for measurements.

#### 7.5.3. Fabrication

Fabrication shall generally be done as specified in IS: 800-1984.

In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details of rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the engineer. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints.

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

The steel section shall be straight or be straightened or flattened by pressure unless required to be of curvilinear form and shall be free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No two pieces shall be welded or joined to make up for the required length of member.

#### **7.5.4. Making holes**

Holes through more than one thickness of material for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

#### **7.5.5. Rivet holes**

The diameter for rivets and blank holes shall be taken as the nominal diameter of a rivet plus 1.5 mm for rivets of nominal diameter less than or equal to 25 mm and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be

formed by gas cutting process. Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

#### **7.5.6. Assembly**



Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall bear tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover plates, shall have their ends flush with the tops and angles unless otherwise required. The web plates when spliced shall have clearance of not more than 5 mm. The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary suitably designed seating shall be provided.

Column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining.

The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

#### **7.5.7. Riveting**

Rivets shall be used, where the connection is such that slip under load has to be avoided.

#### **7.5.8. Preliminaries before riveting**

Members to be riveted shall have all parts firmly drawn and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

#### **7.5.9. Process of riveting**

The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the engineer. The rivets shall be heated red hot, care being taken to control the temperature of heating so as to not to burn the steel. Rivets of diameter less than 10 mm may be driven cold. Rivets shall be finished neat, with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly. All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recupping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar. Where so specified, other tests shall be carried out to ensure the

soundness of rivets. All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

#### 7.5.10. Bolting

The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads, Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS: 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nuts, spring washers as directed by the engineer.

#### 7.5.11. Erection

Steel work shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the engineer in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used. The work may be erected in suitable units as may be directed by the engineer. Fabricated members shall be lifted at such points as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over -turning or collapse by suitable means. During execution, the steel work shall be securely bolted or otherwise fastened and when necessary temporarily braced to provide for all loads to be carried safely by the structure during erection including those due to erection equipment and its operations. The steel work shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done after proper alignment has been checked and confirmed.

Trusses shall be lifted only at nodes. The trusses above 10 mm in span not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member

of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans up to 10 m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For large spans the truss shall be provided with proper bearing as per design.

Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement 3 coarse sand) or as specified.

#### **7.5.12. Bedding of column, stanchions etc.**

Bedding shall not be carried out until the steel work has been finally leveled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoreyed buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made up to 25 mm shall then be pressure grouted with cement grouts.

With small columns, if permitted by the engineer, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

#### **7.5.13. Painting**

Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified.

#### **7.5.14. Measurements**

The work as fixed in place shall be measured in running metres correct to a millimetre and their weight calculated on the basis of standard tables correct to the nearest kilogram.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivet heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made of shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m<sup>2</sup>.

The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m<sup>2</sup> for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### 7.5.15. Rate

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

### 9.33. SPECIFICATIONS FOR DOOR, WINDOW AND VENTILATOR FRAMES

9.33.1. Timber for door, window and ventilators frames shall be as specified. Timber shall be sawn in the direction of the grains. All members of a frame shall be of the same species of timber and shall be straight without warp or blow. Frames shall have smooth, well-planed (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn. Rebates, rounding or moulding shall be done before the members are jointed into frames. The depth of the rebate for housing the shutters shall be 15 mm, and the width of the rebates shall be equal to the thickness of the shutters. A tolerance of +/- 3 mm and 2 mm shall be permitted in the specified finished dimensions of timber sections in frames.

9.33.2. **Joints** - The frames shall have dovetail joints Fig. 1. The Jamb posts shall be through tenoned in to the mortise of the transoms to the full thickness of the transoms and the thickness of the tenon shall be not less than 2.5 cm. The tenons shall closely fit into the mortise without any wedging or filling. The contact surface of tenon and mortise before putting together shall be glued with polyvinyl acetate dispersion based adhesive conforming to IS: 4835 or adhesive conforming the WBP or MR grade of IS: 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins. The joints shall be at right angles when checked from the inside surfaces of the respective members. The joints shall be pressed in position. Each assembled door frame shall be fitted with a temporary stretcher and a temporary diagonal brace on the rebated faces.

9.33.3. **Fixing of frames** - The frames shall be got inspected approved by the engineer before being pinned, oiled or otherwise treated and before fixing in position. The surface of the frames abutting

masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar. Frames shall be fixed to the abutting masonry or concrete with hold

fasts or metallic fasteners as specified. After fixing, the jamb posts of the frames shall be plugged suitably and finished neat. Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be warping during construction. A minimum of three hold fasts shall be fixed on each side of door and window frames one at centre point and other two at 30 cm from the top and bottom of the frames. In case of window and ventilator frames of less than 1 m in height two hold fasts shall be fixed on each side at quarter point of the frames. Hold fasts and metallic fasteners shall be measured and paid for separately.

9.33.4. **Measurements** - Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension without any allowance for the wastage or for dimension beyond specified dimensions. However, in case of members having mouldings, roundings or rebates and members of circular or varying sections, finished dimensions shall be taken as the sides of the smallest square or rectangle from which such a section can be cut. Length of each member shall be measured over all to the nearest cm so as to include projection for tenons. Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit of 10 cubic decimetre in whole numbers.

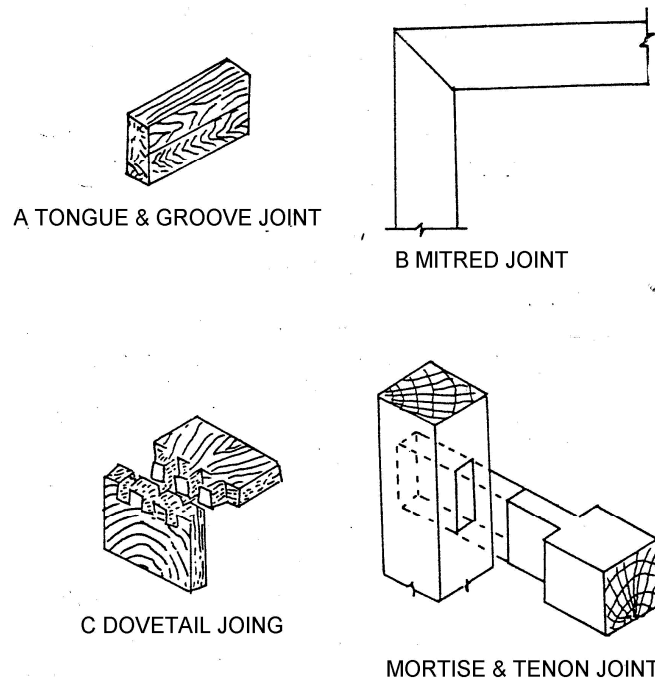


Fig. 1 Joints in timber

9.33.5. **Rate** - The rate shall include the cost of material and labour involved in all the operational described above except the hold fasts or metallic fasteners which will be paid for separately.

### 9.34. SPECIFICATIONS FOR PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS

9.34.1. Paneled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fibre board wire gauze or sheet glass. The shutters, single or multi-paneled, as shown in the drawings or as directed by the engineer. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters

shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other. Any warp or bow shall not exceed 1.5 mm. The right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than +/- 3 mm.

9.34.2. **Frame work** - Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one-third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

9.34.3. **Gluing of joints** - The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS: 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and aminoplastic) conforming to IS: 848 or polyvinyl acetate dispersion based adhesive conforming to IS: 4835 and pinned with 10 mm dia hardwood dowels or bamboo pins or star shaped metal pins ; after the frames are put together and pressed in position by means of press.

Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be out of one or more pieces of timber. The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

Dimensions of components of frame work

Sl.No.	Description	Width mm	Thickness mm	
A. Door shutters				
a.	Stile, top and free rail	100	35 or	40
b.	Lock rail	150	35 or	40

c.	Bottom rail	200	35 or	40
d.	Muntin	100	35 or	40
e.	Glazing bar	40	35 or	40
B. Window, ventilator & cupboard shutters				
a.	Stile, top and freeze rail	80	20, 25 or	30
b.	Bottom rail	80	20, 25 or	30
c.	Muntin	60	20, 25 or	30
d.	Glazing bar	40	20, 25 or	30

Muntin and glazing bars where required shall be sub-tenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm whichever is less. Unless otherwise specified the finished dimensions of the components of frame works of shutters shall be as given in Table 7. Tolerance on widths of stiles and rails shall be +/- 3 mm. The thickness of all components of frame work shall be the same as the thickness of the shutter. Tolerance on over all dimensions of the shutter shall be +/- 3 mm.

9.34.4. **Rebating** - The shutters shall be single-leaf or double leaved as shown in the drawings or as directed by the engineer. In case of double leaved shutters, the meeting of the stiles shall be rebated by one-third the thickness of the shutter. The rebating shall be either sprayed or square type as shown in Fig. 2.

9.34.5. **Paneling** - The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, hard board and particle board panels shall be fixed only with

grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the

grooves of stiles and rails to the full depth of the groove leaving on space of 1.5 mm. Width and depth of the rebate shall be equal to half of the thickness of stiles and rails. Glass panels, asbestos panels

wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

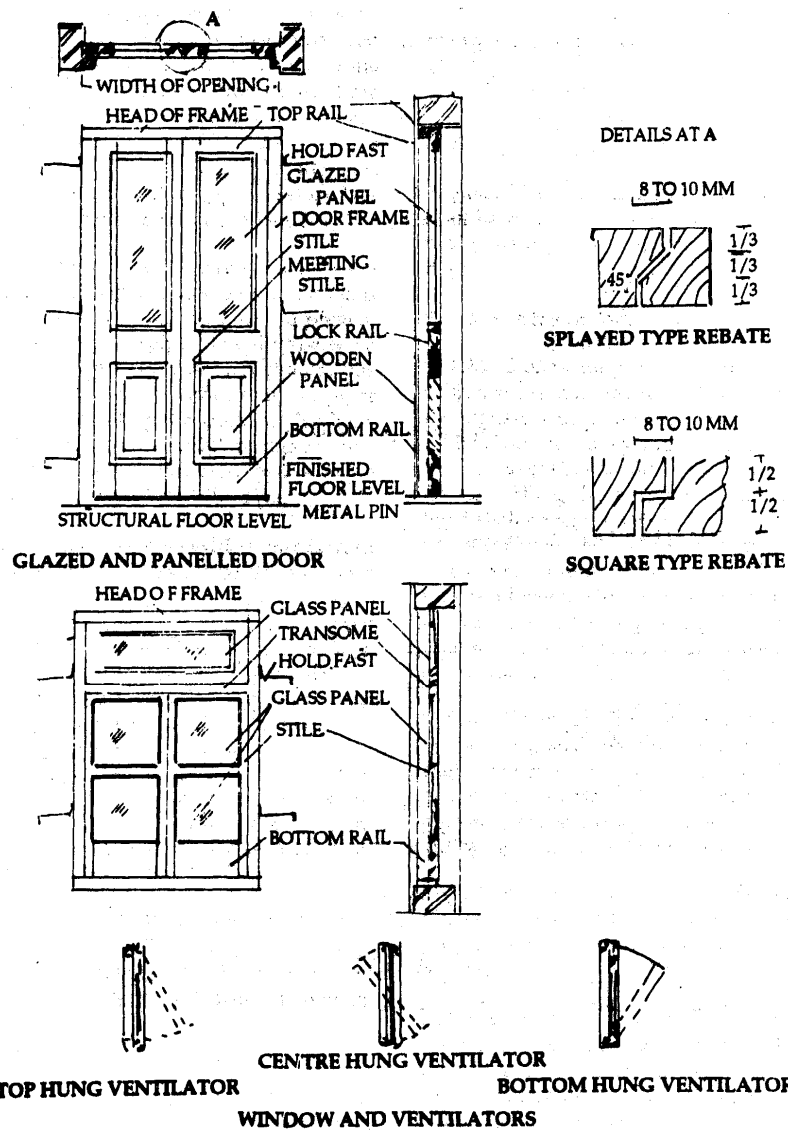


Fig. 2 Terminology timber door, window & ventilator components

9.34.6. **Timber panels** - Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 150 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metres in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

9.34.7. **Plywood panels** - Plywood panels used for paneling of shutters shall be BWP type or grade as specified in 9.2.8. Each panel shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm for single panel construction unless otherwise specified.

9.34.8. **Block board panels** - Block Board used for paneling of shutters shall be Grade 1 (Exterior Grade) bonded with BWP Type Synthetic resin adhesives as specified. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.



9.34.9. **Veneered particle board panels** - Veneered Particle board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

9.34.10. **Fibre board panels** - Fibre board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified. Each fibre board panel shall be a single piece of thickness 10 mm unless otherwise specified.

9.34.11. **Wire gauze panels** - Wire Gauze used for paneling of shutters shall be woven with 0.63 mm dia galvanised mild steel wire to form average aperture size of 1.40 mm as specified. Wire gauze shall be securely housed into the rebates of stiles and rails by giving right angles bend turned back and fixed by means of suitable staples at intervals of 75 mm and over this wooden beading shall be fixed. The space between the rebate and the beading shall be fixed with putty to give a neat finish. Each wire gauze panel shall be as single piece, and the panels shall be so designed that no single panels exceeds 0.5 sqm in area. However, care shall be taken to prevent sagging of wire gauge, of panel by providing and fixing 20 x 20 mm square or equivalent beading on the external face in the required patterns as decided by the engineer.

### 9.35. **SPECIFICATIONS FOR FLUSH DOOR SHUTTERS** (FIG. 3)

9.35.1 Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS: 2202-1991 (Part I)). Nominal thickness of shutters may be 25, 30, or 35 mm. Thickness and type of shutters shall be as specified.

Width and height of the shutters shall be as shown in the drawings or as indicated by the engineer. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS: 1708-1986.

9.35.2. **Core** - The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails shall not be less than 75 mm and not more than 100 mm. The width of each wooden strip shall not exceed 25 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles.

End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be one species only but it may or may not be same species as that of the stiles and rails.

9.35.3. **Face panel** - The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall between 0.5 mm and 1.5 mm for commercial veneers and between 0.5 mm and 1.0 mm for decorative veneers. The

direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture.

9.35.4. **Lipping** - Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 cm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

9.35.5. **Rebating** - Rebating shall be as specified.

9.35.6. **Opening for glazing** - Where specified the opening for glazing shall be 25 cm in height and 20 cm in width unless directed otherwise. The bottom of the opening shall be at a height of 140 cm from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm. Opening for glazing shall be provided where specified or shown in the drawing.

9.35.7. **Venetian opening** - Where specified the height of the Venetian opening shall be 30 cm from the top of the bottom rail unless directed otherwise. The width of the opening shall be as directed but

shall provide for a clear space of 75 mm between the edge of the door and Venetian opening but in no case the opening shall extend beyond the stiles of the shutter. The top edge of the opening shall be lipped internally with wooden battens of width not less than 25 mm. Venetian opening shall be provided where specified or shown in the drawing.

9.35.8. **Tolerance** - Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be +/- 1.2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

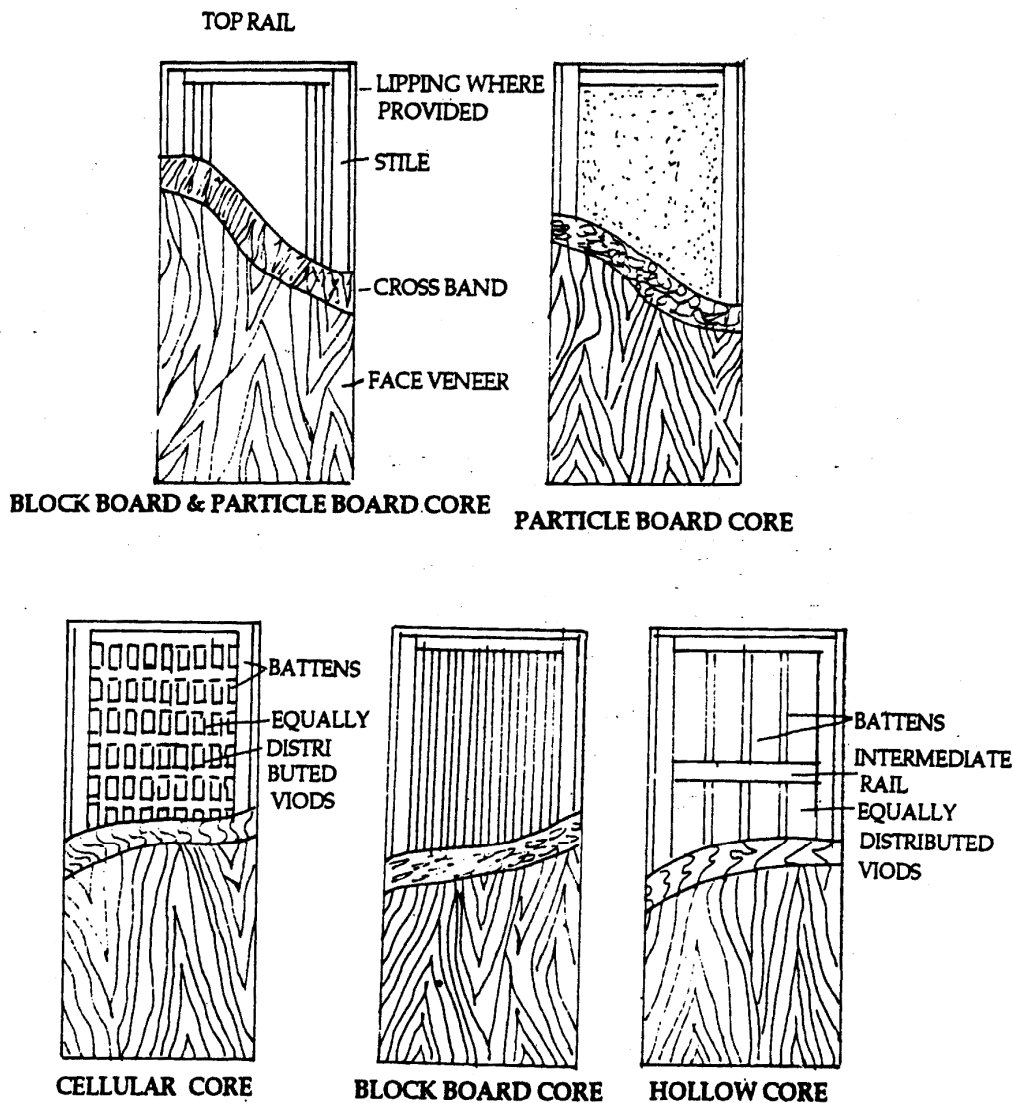


Fig. 3 Wooden flush doors shutters

9.35.9. **Adhesive** - Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

9.35.10. **Tests** - Samples of flush door shutters shall be subjected to the following tests -

(a) **End Immersion Test** (b) **Knife Test** (c) **Glue Adhesion Test**

One end of each sample shutter shall be tested for End Immersion Test. Two specimens of 150 x 150 mm size shall be cut from the two corners at the other end of each sample shutter for carrying out

**Glue Adhesion Test.** Knife Test shall be done on the remaining portion of each sample shutter. Test shall be done as laid down in IS standards.

9.35.11. **Sample size** - Shutters of decorative and non-decorative type from each manufacturer, irrespective of their thickness, shall be grouped separately and each group shall constitute a lot. The

number of shutters (sample size) to be selected at random from each lot for testing shall be as specified in Table given below. If the total number of shutters of each type in a work (and not the lot) is less than twenty five, testing may be done at the direction of the engineer and in such cases extra payment shall be made for the sample shutter provided the sample does not fail in any of the test specified.

Lot Size	Sample Size
Upto 50	1
50 – 150	2
151 – 300	3
301 – 500	4
501 and above	5

9.35.12. **Criteria for conformity** - All the samples shutters when tested shall satisfy the requirements of the tests laid down in Annexure 9-A.5. If the number of sample shutters found unsatisfactory for a test is one, twice the number of samples initially tested shall be selected and tested for the test. All sample shutters so tested shall satisfy the requirement of the test. If the number of samples found unsatisfactory for a test is two or more, the entire lot shall be considered unsatisfactory.

9.35.13. **Fixing of shutters** - For side hung shutters of height upto 1.2 m, each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m, each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screwdriver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 mm shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. For shutter of more than 40 mm thickness butt hinges of size 125 x 90 x 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

9.35.14. **Measurements** - Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured.

All work shall be measured net as fixed and area calculated in square metres to nearest two places of decimal. No deduction shall be made for providing Venetian opening and opening for glazing.

9.35.15. **Rates** - The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters.

#### 14.15. SPECIFICATIONS FOR GLAZED TILE FLOORING

14.15.1. White glazed tiles - The tiles shall be of approved make and shall generally conform to IS: 777. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as indicated in Appendix of IS: 777. The tiles shall be square or rectangular of nominal size such as 150 x 150 mm, 100 x 100 mm, 100 x 200 mm or as directed by the engineer. The thickness of the tiles shall be 5 mm, or 6 mm as specified. The length of all four sides shall be measured correct to 0.1 mm and average length breadth shall not vary more than  $\pm 0.8$  mm from specified dimension. The variation of individual dimension from average value of length/breadth shall not exceed  $\pm 0.5$  mm. Tolerance in thickness shall be  $\pm 0.4$  mm.

Note 1: Where tiles of nominal sizes of 150 x 150 mm or 100 x 100 mm are not available tiles of nominal sizes 152 mm x 152 mm or 108 mm x 108 mm may be allowed to be used with prior approval of the engineer.

Note 2: The actual size of tiles supplied shall be 1 mm less so that with 1 mm joint, the tile when laid shall conform to the nominal size.

The top surface of the tiles shall be glazed and glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50 per cent of the surface area of the edges.

14.15.2. Coloured tiles - Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

14.15.3. Decorative tiles - The type and size of the decorative tiles shall be as follows

a) Decorated white black ground tiles

The size of these tiles shall be 152 x 152 x 6 mm and / or 108 x 108 x 6 mm.

ii) Decorated and having coloured back ground

The sizes of the tiles shall be 152 x 152 x 6 mm and / or 108 x 108 x 6 mm.

14.15.4. Preparation of surface and laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:3 (1cement: 3 coarse sand) or as specified. The average thickness of the bedding shall be 10 mm while the thickness under any portion of the tiles shall not be less than 5 mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square meter over such an area as would accommodate about twenty tiles.

Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado. After tiles have been laid surplus cement slurry shall be cleaned off.

14.15.5. Pointing and finishing - The joints shall be cleaned off the grey cement slurry with wire / coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

14.15.6. Measurements - Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square meter correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deductions shall be made not extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square meter.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

14.15.7. Rate - The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

#### 14.16. SPECIFICATIONS FOR GLAZED TILES IN SKIRTING AND DADO

14.16.1. The tiles shall be of approved make and shall generally conform to IS: 777. The tiles shall be of earthenware covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze; however, any glaze if unavoidable shall be permissible on only up to 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one meter. The glaze shall be either glossy or matt as specified. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the engineer. There may be more than one colour on a tile.

14.16.1(a) Dimensions and tolerances - Glazed earthenware tiles shall be made square or rectangular in sizes such as 149 x 149 mm and 99 x 99mm or 99 x 199 mm or as specified and shall Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

Note: Commonly manufactured sizes include 108 x 108 mm, 152 x 152 mm, 200 x 200 mm, 200 x 150 mm and 200 x 100 mm. The thickness of the tiles shall be 5 mm or 6 mm as specified.

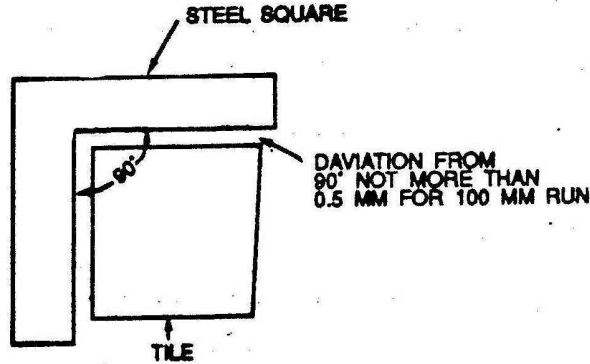
The dimensions of fittings associated with the glazed tiles namely cove base, round edge tile, angles corner cups, ridge and legs, cornices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

#### 14.16.1 (b) Tolerances

Facial dimensions – The lengths of all the four sides of the tile shall be measured to the nearest 0.1 mm. The average value of lengths / breadth shall not vary more than  $\pm 0.8$  mm from the above specified dimension.

The variation of individual dimensions from average value of length / breadth shall not exceed  $\pm 0.5$  mm. Tolerances on thickness shall be  $\pm 0.4$  mm.

Tiles shall be checked for squareness and warpage as described thereafter.



Method of checking squareness of tiles

Fig. A – Trueness of Shape (Squareness) [Clause 14.16.1(c)]

14.16.1 (c) Trueness of shape (Squareness) - Any variation from a right angle in the angle contained by any two adjoining sides shall be limited so that if a builder’s steel square is placed against the angle, the distance between the inner edge of the square and the adjacent side of the tile or fitting shall not be more than 0.5 mm per 100 mm run.

14.16.1 (d) Warpage - The tiles when tested for warpage on the edges and on the diagonal as per Appendix – A of IS: 777 shall not have warpage exceeding the value as specified below

Size of tile (mm)	Warpage (mm)
149 x 149	- 0.4
	+ 0.7
99 x 99	- 0.3
	+ 0.5

14.16.1 (e) Performance requirements water absorption - The average water absorption of the tiles when tested and evaluated in accordance with IS: 777 shall not exceed 20 per cent.

Crazing - Tiles subjected to two cycles of crazing test as per IS: 777 shall not show any sign of crazing.

Impact resistance - Tiles when tested for impact resistance as per IS: 777 shall remain intact, apart from surface marking.

Chemical resistance - When tested as per IS: 777, the glazed surface of tiles and / or the fittings having a white or cream coloured glossy glaze shall show no modification.

14.16.2. Preparation of surfaces - The joints shall be raked out to a depth of at least 15 mm in masonry walls.



In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

14.16.3. Laying - 12 mm thick plaster of cement mortar 1:3 (1cement: 3 coarse sand) mix as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth.

14.16.4. Curing and finishing - The joints shall be cleaned off the grey cement grout with wire / coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then

be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

14.16.5. Measurements - Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square meter, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

In addition to payment for areas of skirting and dado, specials such as coves, internal and external angles and beads shall be measured separately and paid for in running meters. Cornices shall also be similarly measured for payment in running meters. Areas where coloured tiles or different types of decorative tiles are used will be measured separately to be paid extra over and above the normal rate for white tiles.

14.16.6. Rates - The rate shall include the cost of all materials and labour involved in all the operations described above. The specials such as coves, internal and external angles and beading shall be measured and paid for separately. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

**14.17. SPECIFICATIONS FOR GLAZED TILE SPECIALS**

14.17.1. Specials - The specials consist of coves, internal and external angles, beads, cornices and their corner pieces.

Cover beads and angles shall be of thickness not less than the thickness of the tiles with which they are used. The size of coves, beads, angles refer to the greatest width of the special measured in a straight line. The stipulated size of cornices is their height. The lengths of specials shall be 15 cm, 10 cm or other standard size available conforming to the size of tiles available.

In other respects the general specifications as described in 14.15.1 shall be applicable.

14.17.2. Preparation of surface, laying, curing and finishing shall be as specified in 14.16.2, 14.16.3, 14.16.4 as far as applicable.

14.17.3. Measurements - Special tiles to form coved internal angles of any radius, rounded external angles, architraves moulding, ceiling ribs, cornices and the like shall each be measured in running meters correct to a cm. Railing members and vertical members shall each be so described. Ends, angles and internal sections shall be enumerated separately.

14.17.4. Rate - It shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for corner pieces at junctions of coves, beads, cornices etc. or for using cut lengths of specials.

**14.26. SPECIFICATIONS FOR STONE SLABS FLOORING-SECOND CLASS**

14.26.1. The plinth filling shall be brought to the proper level, watered and thoroughly consolidated by ramming. For inner floor, the surface of the consolidated plinth filling shall be perfectly levelled, but for verandahs it shall be at a slope of 1 in 40 which is also to be the slope of the finished flooring. Slab shall be laid on 75 mm of concrete, (if so specified). The slabs shall be laid so as to cover the inner plinth. For this purpose, the inner plinth should be built about 150 mm lower than the floor level.

14.26.2. Stone slabs for flooring shall be obtained from the quarry specified or approved. They shall be of the best quality available, hard even sounding, durable, free from cracks or flaws and 75 mm thick (unless otherwise specified). They shall be rectangular or square in shape with clean square edges. The bottom face of the stone may be left quarried but the top surface shall be either one or two line dressed as specified. The joints shall be dressed back square with the top surface at least two inches without hollows. A sample of the stone shall be got approved by Executive Engineer. The sizes of the slabs shall be described in the specification of work.

14.26.3. The slabs shall be laid in courses of uniform width parallel to the shorter side of the room or verandah. They shall break joints.

14.26.4. Each slab shall be thoroughly wetted by water before being laid. It is to be well bedded in sand or lime mortar as the case may be and tapped down with a wooden mallet so that it cannot be shaken, and so that no hollow is left beneath it.

14.26.5. For second class work, the slab stone shall be chisel-dressed on the edges and made to the rectangular shape. For third class work, quarry faced surfaces may be used when they are smooth and even. For second class work, the surface should be evened by being dressed one or two lines according to specifications. Joints must not be more than 15 mm in width, and must be dressed true and square and pointed with cement mortar 1:3.

14.26.6. The cement pointing should be kept thoroughly watered for 7 days after it is laid.

14.26.7. The above specification will suit floors of offices; but for floors of machine shops and stores subject to heavy loads it may be necessary to adopt slabs of larger area and thickness, laid on 100 mm to 150 mm of concrete.

14.26.8. The specification for 1<sup>st</sup> class slab stone flooring shall be as for 2<sup>nd</sup> class except that all stones are to be laid in squares of uniform size measuring not less than 350 mm x 350 mm or any other size ordered. All surfaces and edges are also to be fine chisel-dressed. Joints are to be not more than 6 mm in width, and are to be dressed true and square. They are to be set in lime or cement mortar as specified.

14.26.9. Dressing of underside of stone slabs is necessary when laid on lime or cement concrete.

## **7.6. SPECIFICATIONS FOR STEEL WORK IN WELDED BUILT UP SECTION**

The steel work in built up sections (welded) such as in trusses, framed work etc. is specified in this clause.

### **7.6.2. Laying out**

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the engineer. Steel tape shall be used for measurements.

### **7.6.3. Fabrication**

Straightening, shaping to form, cutting and assembling, shall be as per 7.5.3 as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

### **7.6.4. Welding**

Welding shall generally be done by electric arc process as per IS: 816 and IS: 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only be resorted to using oxyacetylene flame with specific

approval of the engineer. Gas welding shall not be permitted for structural steel work. Gas welding requires heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperatures stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plane and shops drawings shall be according to IS: 813.

As far as possible every effort shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc., apart from the aspect of economy. The maximum dia of electrodes for welding any work shall be as per IS: 814 and appendix "B" of IS: 823. Joint surfaces which are to be together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

**7.6.5. Precautions** -All operations connected with welding and cutting equipment shall conform to the safety requirements given in IS: 818 for Safety Requirements and Health Provisions in electric and gas welding and cutting operations. Operation, Workmanship and Process of Welding shall be as described in this section. Inspection and testing of welds shall be as per IS: 822.

#### **7.6.6. Assembly**

Before welding is commenced, the members be welded shall first be brought together and firmly clamped or tack welded to be held in position. The temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to final weld in quality and shall be cleaned off before final weld is made.

#### **7.6.7. Erection**

The specifications shall be as described except that while erecting a welded structure adequate means shall be employed for temporary fastening of the members together and bracing the frame work until the joints are welded. Such means shall consists of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

#### **7.6.8. Painting**

Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified.

#### 7.6.9. Measurements

The mode of measurements shall be the same as specified except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

#### 7.6.10. Rate

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

#### List of Bureau of Indian Standards (IS) \*\*

Sl. No	IS No.	Subject
1	63-1978	Whiting for paints and putty (2 <sup>nd</sup> revision) (Amendment 2) (Reaffirmed 1994)
2	198-1978	Varnish gold size (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 1991)
3	226-1975	Structural steel (standard quality) (5 <sup>th</sup> revision) superseded by IS 2062:1992.
4	277-2003	Specification for galvanized steel sheets (plain and corrugated) (5 <sup>th</sup> revision) (Amendments 2)
5	800-1984	Code of practice for use of structural steel in general in steel construction (2 <sup>nd</sup> revision) (Amendments 2) (Reaffirmed 1991)
6	806-1968	Code of practice for use of steel tubes in general building construction (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 1991)
7	812-1978	Glossary of terms relating to welding and cutting of metals (Reaffirmed 1991)
8	813-1986	Scheme of symbols for welding (revised) (Reaffirmed 1991)
9	814-2004	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel (5 <sup>th</sup> revision)
10	815-1974	Classification and coding of covered electrodes for metal arc welding of structural steels (2 <sup>nd</sup> revision) (Supersedes by IS 8141:1991).
11	816-1969	Code of practice for use of metal arc welding for general construction in mild steel (1 <sup>st</sup> revision) (Amendments 2) (Reaffirmed 1992)
12	817-1966	Code of practice for training and testing of metal arc welders (revised) (Reaffirmed 1991) Part I-1992, Part-II-1996
13	818-1968	Code of practice for safety and healthy requirements in electric and gas welding and cutting operations (1 <sup>st</sup> revision) (Reaffirmed 1991)
14	822-1970	Code of procedure for inspection of welds (Reaffirmed 1991)
15	823-1964	Code of procedure for manual for metal arc welding in mild steel

		(withdrawn)
16	1038-1983	Steel doors, windows and ventilators (3 <sup>rd</sup> revision) (Amendment 1) (Reaffirmed 1991)
17	1081-1960	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators (Amendment 1) (Reaffirmed 1991)
18	1148-1982	Hot rolled steel rivet bars (upto 40 mm diameters) for structural purposes (3 <sup>rd</sup> revision) (Reaffirmed 1992)
19	1161-1979	Steel tubes for structural purposes (3 <sup>rd</sup> revision) (Amendments 2) (Reaffirmed 1998)
20	1182-1983	Recommended practice for radiographic examination of fusion welded butt joints in steel plates (2 <sup>nd</sup> revision) (Reaffirmed 1991)
21	1200-1993 (Part 8)	Method of measurements of building and civil engineering works Part 8 steel work and iron works (4 <sup>th</sup> revision) Part I,II & III 2002
22	1363-1992	Hexagonal head bolts, screws and nuts of product grade C 2002
	Part-1	(Hexagon head bolt) (size range M5 to M64) (3 <sup>rd</sup> revision) 2002
	Part-2	(Hexagon head screws) (size M5 to M64) (3 <sup>rd</sup> revision) 2002
	Part-3	(Hexagon nuts) (size range M5 to M64) (3 <sup>rd</sup> revision) 2002
23	1367-1980	(Part 1-19) Technical supply conditions for threaded steel fasteners (Part 1 to 19)
24	1599-1985	Method for bond test for steel products other than sheet, strip, wire and tube (2 <sup>nd</sup> revision) (superseding IS 1692 : 1974, IS 3260 : 1960, 815, 4598 : 1968) (Reaffirmed 1991)
25	1608-2005	Method of tensile testing for steel products (1 <sup>st</sup> revision) (Amendments 1) (Reaffirmed 1991)
26	1821-1987	Dimensions for clearance holes for bolts and screws (3 <sup>rd</sup> revision) (Reaffirmed 1992)
27	1852-1985	Rolling and cutting tolerances for hot rolled steel products (4 <sup>th</sup> revision) (Amendment 1) (Reaffirmed 1991)
28	1894-1972	Method for tensile testing of steel tubes (1 <sup>st</sup> Revision) (Reaffirmed 1991)
29	1977-1975	Structural steel (ordinary quality) (2 <sup>nd</sup> revision) (Amendments 4) (Reaffirmed 1996)
30	2062-1992	Steel for general structural purposes (4 <sup>th</sup> revision) (Supersedes IS 226:1975) (Amendment 1) 1999
31	2074-1992	Ready mixed paint, air drying red oxide-zinc chrome, priming (2 <sup>nd</sup> revision)
32	4351-1976	Specification for steel door frames (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 2003) 2003
33	4454-1981 (Part 1)	Steel wires for cold formed springs. Patented and cold drawn steel wires unalloyed (2 <sup>nd</sup> revision) (Reaffirmed

		1992) Part I -2001, Part II -2001, Part II – 1975 & Part IV 2001
34	4736-1986	Hot-dip zinc coatings on mild steel tubes (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 1992)
35	6248-1979	Metal rolling shutters and rolling grills (1 <sup>st</sup> revision) (Reaffirmed 1991)
36	7452-1990	Specifications for hot rolled steel sections for doors, windows and ventilators (2 <sup>nd</sup> revision).

**Annexure 7-A.2**

**SPECIFICATIONS FOR STEEL FOR GENERAL STRUCTURAL PURPOSES**

(Extract of IS: 2062-1999)

**1. Scope**

1.1. This Indian Standard covers the requirements of steel plates, strips, sections, flats, bars, etc, for use in structural work.

1.1.1. The steels are suitable for welded, bolted and riveted structures, and for general engineering purposes.

1.2. Where welding is employed for fabrication and guaranteed weld ability is required, welding procedure should be as specified in IS: 9595-1996 Metal arc welding of carbon and carbon manganese steels-Recommendations (first revision)

**2. References** - The following Indian Standards are necessary adjuncts to this standard:

IS.No.	Title
228	Methods of chemical analysis of steel
1599-1955	Method for bend test (second revision)
1608-1995	Mechanical testing of metals Tensile testing (second revision)
1757- 1988	Method for Charpy impact test (V notch) for metallic material (second revision)
1852-1985	Rolling and culling tolerances for hot-rolled steel products (third revision)
1956	Glossary of terms relating to iron and steel
3803 (Part1) - 1989	Steel - Conversion of elongation values: Part I Carbon and alloy steels (second revision)
8910-1978	General technical delivery requirements for steel and steel products
9595=1996	Metal arc welding of carbon and carbon manganese steels Recommendations (first revision)
10842-1984	Testing and evaluation procedure for Y groove crackability test

**3. Terminology** - For the purpose of this standard, the following definitions in addition to those given in the relevant parts of IS: 1956 shall apply.

3.1. **Micro-alloying elements** - Elements, such as niobium, vanadium and titanium, added singly or in combination to obtain higher strength levels combined with better form ability,

weldability and toughness as compared with non-alloyed steel produced to equivalent strength levels.

3.2. **Weldability** - A metallic substance is considered to be weldable by a given process and for the given purpose, when metallic continuity to a stated degree can be obtained by welding using a suitable procedure, so that the joints comply with the requirements specified in regard to both their local properties and their influence on the construction of which they form a part.

4. **Supply of material** - General requirements relating to supply of weldable structural steel shall conform to IS 8910.

5. **Grades** - There shall be three grades of steel as given in Tables 1 and 3.

Grade-A steel specified in this standard is intended for use in structures subject to normal conditions for non-critical applications. The use of Grade A steel is generally justified for these structural parts which are not prone to brittle fracture on account of its thickness, size and shape adopted and/or because of the fabrication and / or service conditions.

Grade-B steel specified in this standard is intended for use in structures subject to critical loading applications, where service temperatures do not fall below 0°C. Use of Grade B steel is generally specified for those structural parts which are prone to brittle fracture and/or are subjected to severe fluctuation of stresses.

Grade-C steel specified in this standard, is supplied with guaranteed low temperature impact properties. This grade is intended to be used in structures or structural parts, where the risk of brittle fracture requires consideration due to their design, size and/or service conditions. In cases where owing to increased thicknesses, loading conditions and general design of the structures, higher resistance to brittle fracture is required, use of steel of Grade C with a guarantee of impact properties at 0°C or -20°C or -40°C will be advisable.

The steel products conforming to the requirements of this specification can be rolled from the cast billet ingots, billets, blooms, slabs and continuously cast billets, blooms or slabs conforming to IS: 2830:1992 Carbon steel cast billet ingots, billets, blooms and slabs for re-rolling into steel for general structural purposes (second revision).

6. **Manufacture** - The processes used in making the steel and manufacturing hot rolled steel plates, strips, sections, flats, bars, etc, are left to the discretion of the manufacturer. If required, secondary refining may follow steel making.

7.1. All finished steel shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/jagged and imperfect edges: and all other harmful defects.

7.2. Minor surface defects may be removed by the manufacturer by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent, but not exceeding 7 percent, may be made subject to mutual agreement between the purchaser and the manufacturer.



7.2.1. Subject to agreement with the purchaser. Surface defects which cannot be dealt with as in 7.2 may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that: (a) after complete removal of the defects and before welding, the thickness of the item is in no place reduced by more than 20 percent; (b) welding is carried out by approved procedure by competent operators with approved electrodes and that the welding is ground smooth to the correct nominal thickness; and (c) subsequent to the Finish grinding, the item may be required to be normalized or otherwise heat-treated at the purchaser's direction.

7.3. However, welding as mentioned in 7.2.1 is not permissible for Grade C material.

7.4. The material may be subjected to non-destructive testing to determine soundness of internal subject to mutual agreement between the purchaser and the manufacturer.

### 8. Chemical compositions

8.1. The ladle analysis of the steel, when carried out by the method specified in the relevant parts of IS 228 or any other established instrumental / chemical method, shall be as given in Table I. In case of dispute. The procedure given in IS: 228 and its relevant parts shall be the referee method.

However, where the method is not given in IS: 228 and its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

8.2. **Product analysis** - The product analysis shall be carried out on the finished product from the standard position.

Permissible limits of variation in case of product analysis from the limits specified in Table 1 shall be as given in Table 2.

Table 1 Chemical composition (Clause 5.8.1 and 8.2)

Grade composition	Ladle Analysis, Percent, Max					Carbon equivalent (CE) Max	Deoxidation Mode	Supply condition
	C	Mn	S	P	Si			
A Fe 41 O W A	0.23	1.50	0.050	0.050	0.40	0.42	Semi-killed or killed	As rolled
B Fe 41 O W	0.22	1.50	0.045	0.045	0.40	0.41	Killed	As rolled Plates above 12 mm may be normalized / controlled cooled if

	B								agreed to between the purchaser and the manufacturer
C	Fe 41 0 W C	0.20	1.50	0.040	0.04 0	0.4 0	0.39	Killed	As rolled Plates above 12 mm shall be normalized / controlled cooled

Notes:

$$1. \text{ CE based on ladle analysis} = \text{C} + \frac{\text{Mn}}{6} + \frac{\text{Cr} + \text{Mo} + \text{V}}{5} + \frac{\text{Ni} + \text{Cu}}{15}$$

2. When the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02 percent. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10 percent. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.

3. When micro-alloying elements like Nb, V and Ti are used individually or in combination, the total content shall not exceed 0.20 percent.

4. if mutually agreed to between the purchaser and the manufacturer, the steel may be supplied in the copper bearing quality in which case the copper shall be present between 0.20 to 0.35 percent on ladle analysis. In case of product analysis, the copper content shall be between 0.17 and 0.38 percent. The copper bearing quality steel shall be designated with a suffix Cu, for example Fe 410 Cu-WA.

5. Nitrogen content of the steel should not exceed 0.012 percent, which shall be ensured by the manufacturer by occasional check analysis.

6. Details of elements other than those specified may be specified if agreed at the time of inquiry and order

Table 2 Permissible variations for product analysis (Clauses 5 and 8.2)

Constituent	Permissible variations over the specified limit, percent, max
Carbon	0.02
Manganese	0.05
Silicon	0.03
Sulphur	0.005
Phosphorus	0.005

## 9. Selection and preparation of test samples

9.1. The position from which test samples are taken shall be so located in the product as to

yield the clearest possible information regarding properties in the cross-sectional and longitudinal planes. The recommended locations for taking test samples for plates, sections and bars are indicated in Fig. 1. Alternatively, in case of sections, the samples may be taken from the web.

9.2. Wherever practicable, the rolled surface of the steel shall be retained on the two opposite sides of the test samples.

9.3. In case of flat test samples for tensile test, both surfaces are normally to be left on the test samples for strips and plates up to 32 mm thick. At least one rolled surface shall be left on rectangular test samples taken from plates exceeding 32mm in thickness. Round test samples are permitted, but should only be adopted for thickness exceeding 28 mm.

9.4. In case of flats up to 16mm thick, the test sample shall undergo, if possible, no machining whatever, prior to use as a test piece. If this is not possible, the test sample shall undergo the minimum amount of machining.

9.5. Bars below 28 mm shall be tested without machining. In case of bars having diameters or thickness between 28 mm and 71 mm. the bars may, be symmetrically reduced by machining. For bars having diameters or thicknesses exceeding 71 mm. The test sample may be taken from the position shown in Fig. 1.

9.6. In case of plates, strips, sections and flats, bend tests shall be carried out on rectangular test samples which, as far as possible, should be of the full thickness of the product. In case of plates, sections and flats exceeding 28 mm in thickness, it is permissible to remove metal from one side of the test sample before using it as a test piece. The rolled surface of the test piece shall be on the outer side of the bend during the test.

9.7. Before-test samples are detached, full particulars regarding cast number, size and mass of

plates, strips, sections, flats and bars in each cast shall be furnished by the manufacturer to the purchaser. In case of plates, the number of plates in each cast shall also be given.

9.8. Test samples shall be cut in such a manner that the deformation is avoided as far as possible. If shearing or flame-cutting is employed; an adequate allowance shall be left for removal by machining.

9.9. Test samples shall not be subjected to heat treatment unless the material from which they are cut is similarly treated, in which case the test samples shall be similarly and simultaneously treated with the material before testing. Any slight straightening of test samples which may be required shall be done cold.

## 10. Tensile-test

### 10.1. Number of tensile tests

10.1.1. Plates, Strips, Sections (Angles, Tees, Beams, beams, Channels, etc and Flats) - One tensile test shall be made from finished steel for every 50 tonnes or part thereof rolled continuously from each cast, a separate test being made for each class of steel product (namely, plates, strips, sections and flats) rolled from a cast.

10.1.1.1. Where plates, strips, sections or flats of more than one thickness are rolled from the same cast, one additional tensile test shall be made from the material in each class of product for each variations in thickness of 6 mm.

10.1.2. **Bars (Round, Square and Hexagonal)** - One tensile test shall be made from finished product for each 50 tonnes or part thereof. If more than one diameter or thickness of the bar is processed, one or additional tensile test shall be made for each variation of 3 mm above or below the diameter or thickness of the bar ordered.

10.2. **Tensile test pieces** - The tensile strength, yield strength and percentage elongation of steel shall be determined from standard test pieces cut crosswise from plates and strips and lengthwise from sections, flats and bars. The test shall be carried out on the standard test pieces prepared in accordance with IS 1608.

10.2.1. As a rule, test pieces with a non-proportional gauge length complying with the requirements to  $L_0 = 5.65 \sqrt{S_0}$  should be used for the tensile test, where  $L_0$  is the gauge length and  $S_0$  is the cross sectional area of the test piece.

10.2.1.1. Test pieces with a non-proportional gauge lengths, other than  $5.65 \sqrt{S_0}$ , may also be used in which case the elongation values shall be converted  $5.65 \sqrt{S_0}$  in accordance with IS: 3503 (Part 1).

10.3. **Tensile test** - Tensile strength, yield strength and percentage elongation when determined in accordance with IS: 1608 shall be as given in Table 3.

10.1.1. In case of sections the thick ness of which is not uniform throughout the profile, the limits of sizes given in Table 3 shall be applied according to the actual maximum thickness of the piece adopted for testing.

10.3.2. Should a tensile test piece break-outside the middle half of the gauge length (see IS: 1608) and the percentage elongation obtained is less than the specified, the test may be discarded at manufacturer's option and another test made from the sample plate, strip, section, flat or bar.

## 11. Bend test

### 11.1. Number of bend tests

Bend test shall be made from finished steel from each cast. The number of tests for every 50 tonnes material or part thereof, rolled continuously, shall as even below. One additional test shall be made 1 to each class of product and for each variation of thickness.

11.2. **Bend test piece** - The test pieces shall be cut crosswise from plates and strips and length wise from sections, flats and bars. When section permits, these shall be not less than

40 mm wide. If the manufacturer so desires, round, square, hexagonal and flat bars and structural sections shall be bent in the full section as rolled.

11.2.1. In all bend test pieces, the rough edge or arris resulting from shearing may be removed by filing or grinding or machining but the test pieces shall receive no other preparation.

11.3. **Bend test** - Bend test shall be conducted in accordance with IS: 1599.

Table 3 Mechanical properties (Clauses 5, 10.3, 10.3.1, 11.3.1, 12.1.1, 12.2 and 12.4)

Grade	Designation	Tensile strength Min, Mpa	Yield stress, Min, MPa			Percent elongation at gauge length $5.60\sqrt{S_0}$	Internal diameter of bend	Charpy V-notch impact energy J, Min
			<20 mm	20-40 mm	>40 mm	Min	Min	
A	Fe 410 WA	410	250	240	230	23	3t	-
B	Fe 410 WB	410	250	240	230	23	2t for less than or equal to 25 mm thick products 3t for more than 25 mm thick products	27 (see Note 1)
C	Fe 410 WC	410	250	240	230	23	2t	27

**Notes**

1. For Grade B material, the minimum Charpy V-notch impact energy is to be guaranteed at 0°C, if agreed to between the manufacturer and the purchaser.
2. For Grade C materials, the minimum Charpy V-notch impact energy shall be guaranteed at any one of the three temperatures, namely 0°C, or -20°C or -40°C, as specified by the purchaser.
3. 't' is the thickness of the material.
4. The impact values are given for a standard test piece. When tested with subsidiary test pieces, the values shall not be less than the following:

Impact Energy	Test piece size	Charpy V-notch
	Mm	J, Min
	10 x 7.5	22
	10 x 5	19.5

11.3.1. For bend test, the test piece at room temperature shall withstand bending through 180° to an internal diameter not greater than that given in Table 3 without cracking.

**12. Impact test**

12.1. Impact test shall normally be carried out on products having thickness/diameter greater than or equal to 12 mm. The test specimen shall be so machined that the axis of the test specimen is parallel to the direction of rolling and the base closer to the rolled

surface is more than 1mm from it. The notch axis shall be perpendicular to the rolled surface.

12.1.1. If stated in the order, impact tests may be carried out on products having a thickness less than 12 mm the dimensions of the test pieces shall be in conformity with IS 1757 (see also Note 4 of Table 3).

12.2. This test is carried out using a V-notch test piece (see IS 1757) the value for consideration being the arithmetic mean of the results obtained on three test pieces taken side by side from the same product (see Table 3).

12.3. The test sample shall be taken from the thickest product. If the test sample taken from the thickest product rolled from a cast meets the requirements, the whole cast shall be deemed to meet the requirements of the test. If not, the test shall be performed on a section of next lower thickness rolled from the same cast and if it meets the requirements specified. This particular thickness as also other sections of lower thickness shall be deemed to satisfy the specification. If this thickness also does not meet the requirements. The test shall be carried out on the next lower thickness and so on, because the toughness of the product will be dependent on the rolling direction as well as on the section size.

12.3.1. A test sample shall be taken from each 50 tonnes or part thereof from the same cast.

12.4. The material represented shall be deemed to comply with the standard, if the average value of 3 test specimens, meets the requirements given in Table 3 provided no individual value shall be less than 70 percent of the specified value. If the average value of the three Charpy impact tests fails to comply by an amount not exceeding 15 percent of the specified minimum average value, three additional test pieces from the same sample shall be tested and the results added to those previously obtained and a new average calculated. Provided this new average complies with the specified requirement, the material represented shall be deemed to comply with this standard.

13. **Y Groove crackability test** - Y groove crackability tests may be carried out in accordance with IS: 10842 for products of only Grade C material having thickness above 12 mm, if specifically agreed to between the manufacturer and the purchaser.

NOTE: The V groove crackability test will not be applicable for rounds and it is mainly for plates and sections.

14. **Dimensions** - Unless otherwise agreed to between the purchaser and the manufacturer the nominal dimensions of rolled products conforming to this standard shall be in accordance with the relevant Indian Standard. The Currently available Indian Standards are listed in Table 4.

#### 15. **Tolerances**

The rolling and culling tolerances for steel product 2 conforming to this standard shall be those specified in IS: 1852. Stricter tolerances may be followed if agreed to between the purchaser and the manufacturer.

16. **Retest** - Should any one of test pieces first selected fail to pass (see any of the tests specified in this standard, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirements of that particular test. Should the test pieces from either of these additional samples fail, the material represented by the test samples shall be considered as not having complied with this standard.

Table - 4 Indian Standards which give nominal dimensions of rolled steel products (Clause 14)

Product	Relevant Indian Standard
Beam, column, channel and angle sections	IS:808-1899 dimensions for hot rolled steel beam, column, channel and angle sections (third revision)
Tee-bars	IS: 1173-1978 Hot rolled slit steel tee bars (second revision)
Bulb angles	IS: 1252 – 1991 Hot rolled steel bulb angles – Dimensions (first revision)
Plates, strips and flats	IS:1730 – 1989 Steel plates sheets, strips and flats for structural and general engineering purposes (second revision)
Round and square bars	IS:1732-1989 Dimensions for round and square steel bars for structural and general engineering purposes (first revision)
Bulb flats	IS:1863-1979 Hot rolled steel bulb flats (first revision)
Sheet piling sections	IS:2314-1986 Steel sheet piling sections (first revision)
Channel sections	IS: 3954-1991 Hot rolled steel channel sections for general engineering purposes (first revision)
Track shoe sections	IS:10182 (Part 1)-1982 Dimensions and tolerances for hot rolled track shoe sections: Part 1 Section TS-L1 IS:10182 (Part 2)-1985 Dimensions and tolerances for hot rolled track shoe sections :Part 2 Section TS-H1

17. **Calculation of mass** - The mass of steel shall be calculated on the basis that steels weighs 7.85 g/cm<sup>3</sup>

18. **Delivery** - Subject to prior agreement between the purchaser and the manufacturer, suitable protective treatment may be given to the material after rolling.

#### 19. **Marking**

19.1. Each product, with the exception of round, square and hexagonal bar and flats, shall carry or be marked with the manufacturer's name or trade-mark. Bars and flats shall carry a tag bearing manufacturer's name or trade-mark, Designation of steel should also be similarly marked on the product or tag,

19.2. Every heavy and medium structural mill product and each plate of thickness 10 mm and over shall be marked with the cast number. In case of plates 10 mm thickness, the top plate of each pile (which consist of approximately 16 plates) shall be marked with the cast

number and the remaining plates have suitable identification marking.

19.3. The ends of the rolled product shall be painted with a colour code as given below:

Grade A	Green
Grade B	Grey
Grade C	Orange

19.3.1. For the copper bearing quality, in addition the colour code as specified in 19.3, a white colour band shall be painted.

19.4. **BIS certification marking** - The material may also be marked with standard mark.

19.4.1. The use of the Standard Mark is governed by the provisions of Bureau of Indian Standard Act 1986 and the Rules and Regulations made there under. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the of Bureau of Indian Standard

#### Annexure 7-A.4

### SPECIFICATIONS FOR HIGH STRENGTH DEFORMED STEEL BARS AND WIRES FOR CONCRETE REINFORCEMENT (Extract of IS: 1786-1985)

0.1. Deformed bars for concrete reinforcement are being produced in the country for many years, the main processes being hot rolling or hot rolling followed by cold twisting. In the past decade there has been an increasing demand for higher strength deformed bars (415 N/m<sup>2</sup>, Min, yield strength/0.2 percent proof stress being the most common). This high yield strength was being first achieved by raising carbon and manganese and to a great extent by cold twisting.

0.2. Micro-alloying with Nb, V, Ti and B, in combination. Individually, and thermo-mechanical treatment process are worth mentioning in tills field. With these two processes higher strength values could be achieved at low carbon levels even in large diameter bars.

#### 1. Scope

1.1. This annexure covers the requirements of deformed steel bars and wires for use as reinforcement in concrete, in the following three strength grades:

(a) Fe 415, (b) Fe 500, and (c) Fe 550

Note: The figures following the symbol Fe indicates the specified minimum 0.2 percent proof stress or yield stress in N/mm<sup>2</sup>.

#### 2. Glossary of terms

2.1. **Batch** – Any quantity of bars / wires of same size and grade whether in coils or bundles presented for examination and test at one time.

2.2. **Bundle** – Two or more coils or a number of lengths properly bound together.

2.3. **Elongation** - The increase in length of a tensile test piece under stress. The elongation at fracture is conventionally expressed as a percentage of the original gauge length of a standard test piece.

2.4. **Longitudinal rib** – A rib of uniform cross-section, parallel to the axis of the bar/wire



(before cold working, if any).

2.5. **Nominal diameter or size** - The diameter of a plain round bar/wire having the same mass per metre length as the deformed bar / wire.

2.6. **Nominal perimeter of a deformed bar/wire** – 3.14 times the nominal diameter.

2.7. **Nominal mass** – The mass of the bar / wire of nominal diameter and of density 0.007 kg/mm<sup>2</sup> per metre run.

2.8. **0.2 Percent proof stresses** – The stress at which a non-proportional elongation equal to 0.2 percent of the original gauge length takes place.

2.9. **Tensile strength** – The maximum load reached in a tensile test divided by the effective cross sectional area of the gauge length portion of the test piece, also termed as ultimate tensile stress.

2.10. **Transverse rib** - Any rib on the surface of a bar wire other than a longitudinal rib.

2.11. **Yield stress** - Stress (that is, load per unit cross-sectional area) at which elongation first occurs in (lie test piece without increasing the load during tensile test. In the case of steels with no such definite yield point, proof stress shall be applicable.

### 3. Manufacture and chemical composition

3.1. Steel shall be manufactured by the open hearth, electric, duplex, basic oxygen, or a combination of these processes. In case the manufacturer employs any other process, prior approval of the purchaser should be obtained.

3.1.1. Steel shall be supplied semi-killed or killed.

3.1.2. The bars/wires shall be manufactured from properly identified heats of mould cast, continuously cast steel or rolled semis.

3.1.3. The steel bars/wires for concrete reinforcement shall be manufactured by the process of hot-rolling. It may be followed by a suitable method of cooling and/or cold working.

3.2. **Chemical composition** - The ladle analysis of steel when made as per relevant parts of IS: 228 shall be as follows:

Constituent	Percent, maximum		
	Fe 415	Fe 500	Fe 550
Carbon	0.30	0.30	0.30
Sulphur	0.060	0.055	0.055
Phosphorus	0.060	0.055	0.050
Sulphur and phosphorus	0.11	0.105	0.10

Note: 1) For guaranteed weldability, the percentage of carbon shall be restricted to 0 -25 percent, maximum.

Note: 2) Addition of micro alloying elements is not mandatory for any of the above grades. When strengthening elements like Nb, V, B and Ti are used individually or in combination, the total contents shall not exceed 0-30 percent; in such case manufacturer shall supply the purchaser or his authorized representative a certificate slating that the total contents of the strengthening elements in the steel do not exceed the specified limit.

3.2.1. In case of product analysis, the permissible variation from the limits specified under 3.2 shall be as follows:

Constituent	Variation, over specified maximum limit, percent, max
Carbon	0.02
Sulphur	0.005
Phosphorus	0.005
Sulphur and phosphorus	0.010

3.2.2. For welding of cold-worked deformed bars, the recommendations of IS: 9417-1979 shall be followed.

3.2.3. In case of deviations from the specified maximum, two additional test samples shall be taken from the same batch and subjected to the test or tests in which the original sample failed. Should both additional test samples pass the test, the batch from which they were taken shall be deemed to comply with this standard. Should either of them fail, the batch shall be deemed not to comply with this standard.

### 3.3. Rolling and cold-working of bars/wires

3.3.1. All bars/wires shall be well and cleanly rolled and shall be round and free from surface defects and pipe, or oilier defects detrimental to its subsequent processing and to its end use. Rust, seams, surface irregularities or mill scale shall not be the cause for rejection provided hard wire brushed test specimen fulfils all the requirements of this specification.

3.3.2. Stretching may or may not be combined with cold working. The unworked length at each end of the bar/wire shall not exceed 100 mm or 4 times the nominal diameter, whichever is greater.

## 4. Requirements for bond

4.1. High strength deformed bars/wires shall satisfy the requirements given in either 4.2 or 4.7.

4.2. **Deformation and surface characteristics** - For high strength deformed bars/wires, the mean area of ribs ( in mm<sup>2</sup> ) per unit length (in mm) above the core of the bar/wire, projected on a plane normal to the axis of the bar/wire calculated in accordance with 4.4 shall not be less than the following values: 0.12  $\phi$  for  $\leq 10$  mm, 0.15  $\phi$  for  $10 \text{ mm} < \phi \leq 16$  mm, 0.17  $\phi$  for  $\phi > 16$  mm, where  $\phi$  is the nominal diameter of bar/wire in mm.

The mean projected area of transverse ribs alone shall be not less than one-third of the values given above.

4.3. The ribs contributing to the projected area considered in 4.2 shall consist of:

- a) Longitudinal ribs in the form of continuous or discontinuous helix; and
- b) Transverse ribs which after hot-rolling or cold-working are uniform in size and shape along the length of the hardwire, and are spaced along the bar/wire at substantially

uniform distances.

4.4. The mean projected rib area per unit length  $A_r$  ( in  $\text{mm}^2$  per mm ) may be calculated from the following formula : Where

$$A_r = \frac{n_{tr} A_{tr} \sin O}{s_{tr}} + \frac{m_r d_{tr} \pi \phi}{s_p}$$

$n_{tr}$  = number of rows of transverse ribs ;

$A_{tr}$  = area of longitudinal section of a transverse rib on its own axis (see Fig.1) in  $\text{mm}^2$

$O$  = including of the transverse rib to the bar axis (after twisting for cold – worked twisted bars)

in degrees. Average value of two ribs from each row of transverse ribs shall be taken;

$s_{tr}$  = spacing of transverse ribs in mm ;

$m_r$  = number of longitudinal ribs;

$d_{tr}$  = height of longitudinal ribs in mm ;

= nominal diameter of the bar / wire in mm ; and

$s_p$  = pitch of the twist in mm.

Note: 1. In the case of hot rolled bars / wires which are not subjected to cold twisting, the value of  $s_p$  in the second term of the expression for  $A_r$  shall be taken as infinity rendering the value of the second term to zero.

Note: 2.  $A_{tr}$  may be calculated as  $2/3 l_{tr} d_{tr}$  where  $l_{tr}$  and  $d_{tr}$  are shown in Fig.1

Note3. In the case of cold – worked bars / wires with some discontinuous longitudinal ribs, the number of longitudinal ribs,  $n_{1r}$  shall be calculated as an equivalent number using the following formula and accounted for in the expression for  $A_r$  :

$$m_r \frac{m_r' l' d_{tr}'}{s_{tr}' d_{tr}} + \text{Number of continuous longitudinal ribs}$$

Where

$m_r'$  = number of discontinuous longitudinal ribs,

$l'$  = average length of discontinuous longitudinal ribs

$d_{tr}'$  = height of discontinuous longitudinal ribs

$s_{tr}'$  = averaged spacing of discontinuous longitudinal ribs, and

$d_{tr}$  = height of continuous longitudinal ribs.

Note: 4. The average length of discontinuous longitudinal ribs shall be determined by dividing a measured length of the bar equal to at least  $10 \phi$  by the number of discontinuous longitudinal ribs in the measured length,  $\phi$  being the nominal diameter of the bar. The measured length of the bar shall be the distance from the center of one rib to the center of another rib.

4.5. The heights of longitudinal and transverse ribs shall be obtained in the following manner

a) The average height of longitudinal ribs shall be obtained from measurements made at not less than 4 points, equally spaced, over a length of  $10\phi$  or pitch of rib, whichever is greater.

b) The height of transverse ribs shall be measured at the centre of 10 successive transverse ribs.

4.6. The average spacing of transverse ribs shall be determined by dividing a measured length of the bar / wire equal to at least  $10\phi$  by the number of spaces between ribs in the measured length,  $\phi$  being the nominal diameter of the bar / wire. The measured length of the bar / wire shall be the distance from the centre of one rib to the centre of another rib.

4.7. When subjected to pull-out test the bond strength calculated from the load at a measured slip of 0.025 mm and 0.25mm for deformed bars / wires shall exceed that of a plain round bar of the same nominal size by 40 percent and 80 percent respectively.

4.7.1. The pull-out test shall be conducted in accordance with IS: 2770 (part 1)-1967\* unless otherwise modified.

4.7.2. Bonded length of the bar embedded in the concrete shall be 5 times the diameter of the bar; the rest of the embedded length shall be made unbounded by providing plastic sleeve for that portion.

## 5. Nominal sizes

5.1. The nominal sizes of bars / wires shall be as follows :

Nominal size, 4,5,6,7,8,10,12,16,18,20,22,25,28,32,36,40,45 and 50mm.

Note: Other sizes may also be supplied by mutual agreement.

5.2. The exact values for the cross-sectional area and nominal masses of individual bars / wires, shall be as given in Table 1.

5.3. **Effective cross-sectional area of deformed bars and wires**

5.3.1. For bars / wires whose pattern of deformation is such that by visual inspection, the cross-sectional area is substantially uniform along the length of the bar / wire, the effective cross-sectional area shall be the gross sectional area determined as follows, using a bar / wire not less than 0.5 m in length :

$$\frac{1.03 w'}{0.00785 L} = \frac{W}{0.00785L}$$

Gross cross sectional area in  $\text{mm}^2 =$

Where

W = mass in kg weighed to a precision of  $\pm 0.5$  percent, and

L = length in m measured to a precision of  $\pm 0.5$  percent.

5.3.2. For a bar / wire whose cross-sectional area varies along its length, a sample not less than 0.5 m in long shall be weighed (w) and measured to a precision of  $\pm 0.5$  percent in

the as rolled and / or

Fig. 1 Determination of longitudinal sectional area  $A_{lr}$  of A transverse  $R_{1B}$

cold – worked condition, and after the transverse ribs have been removed, it shall be re-weighed ( $w'$ ). The effective cross-sectional area shall then be round as follows:

Table d1 cross sectional area and mass ( clause 5.2 )

Nominal sized	Cross sectional area	Mass per meter
Mm	Mm <sup>2</sup>	kg
1	2	3
4	12.6	0.099
5	19.6	0.154
6	28.3	0.222
7	38.5	0.302
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
18	254.6	2.00
20	314.3	2.47
22	380.3	2.98
25	491.1	3.85
28	616.0	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.85
45	1591.1	12.50
50	1964.3	15.42

a) Where the difference between the two masses ( $w - w'$ ) is less than 3 percent of  $w'$ , the effective cross-sectional area shall be obtained as in 5.3.1., b) Where the difference is equal to or greater than 3 percent, the effective cross-sectional area in mm<sup>2</sup> shall be taken as:

Where

$W'$  = mass in kg of the bar with transverse ribs removed, and  $L$  = length in m.

For routine test purposes, a nominal ratio of effective to gross cross-sectional area of bars / wires covered by (b) shall be declared and used by the manufacturer.

## 6. Tolerances on dimensions and nominal mass

6.1. **Specified lengths** - If bars / wires are specified to be cut to certain lengths, each bar / wire shall be cut within deviations of  $\pm 75$  25 mm on the specified length, but if minimum lengths are specified, the deviations shall be + 50mm and – 0 mm.

## 6.2. Nominal mass

6.2.1. For the purpose of checking the nominal mass, the density of steel shall be taken as 0.007 85 kg /mm<sup>2</sup> of the cross-sectional area per metre run.

6.2.2. Unless otherwise agreed to between the manufacturer and the purchaser, the tolerances on nominal mass shall be as in Table 2. For bars / wires whose effective cross-sectional areas is determined as in 5.3.2 (b), the nominal mass per metre run shall correspond to the gross mass and the deviations in Table 2 shall apply to the nominal mass.

Table 2 Tolerances on nominal mass

Nominal size Mm	Tolerance on the nominal mass, percent		
	Batch	Individual sample*	Individual sample for coils only†
Up to and including 10	± 7	- 8	± 8
Over 10 up to and including 16	± 5	- 6	± 6
Over	± 3	- 4	± 4

\* For individual sample plus tolerance is not specified.

† For coils batch tolerance is not applicable.

6.2.3. The nominal mass per metre of individual sample, batch and coil shall be determined as given in 6.2.3.1 to 6.2.3.3.

6.2.3.1. **Individual sample** – The nominal mass of an individual sample shall be calculated by determining the mass of any individual sample taken at random as specified in 10.1 and dividing the same by the actual length of the sample. The sampled shall be of length not less than 1.5 meter.

6.2.3.2. **Batch** – The nominal mass of a batch shall be calculated from the mass of the test specimens taken as specified in 10.1 and dividing the same by the actual total length of the specimens. Each specimen shall be of length not less than 0.6 meter.

6.2.3.3. **Coils** – The nominal mass of a coil shall be calculated by determining the mass of two samples of minimum one meter length taken from each end of the coil and dividing the same by the actual total length of the samples.

## 7. Physical properties

7.1. Proof stress, percentage elongation and tensile strength for all sizes of deformed bars / wires determined on effective cross – sectional area (see 5.3) and in accordance with 8.2 shall be specified in Table 3.

Table 3 Mechanical properties of high strength deformed bars and wires

Sl. No.	Property	Grade		
		Fe 415	Fe 500	Fe 550
1	0.2 percent proof stress / yield stress, Min, N/mm <sup>2</sup>	415.0	500.0	550.0
2	Elongation, percent, Min,	14.5	12.0	8.0

	on gauge length $5.65 \sqrt{A}$ , where A is the cross-sectional area of the test piece			
3	Tensile strength, Min	10 percent more than the actual 0.2 percent proof stress but not less than 485.0 N/mm <sup>2</sup>	8 percent more than the actual 0.2 percent proof stress but not less than 545.0 N/mm <sup>2</sup>	6 percent more than the actual 0.2 percent proof stress but not less than 585.0 N/mm <sup>2</sup>

7.2. The bars / wires shall withstand the bend test specified in 8.3 and the rebend test specified in 8.4

7.3. **Bond** – Bars / wires satisfying the requirements given in 4 shall be deemed to have satisfied the bond requirements of a deformed bar / wire.

## 8. Tests

8.1. Selection and preparation of test sample – Unless otherwise specified in this standard, the requirements of IS: 226-1975 shall apply.

8.1.1. All test pieces shall be selected by the purchaser or his authorised representative, either;

(a) from the cuttings of bars / wires ; or (b) if, he so desires, from any bar / wire after it has been cut to the required or specified size and the test piece taken from any part of it. In neither case, the test piece shall be detached from the bar / wire except in the presence of the purchaser or his authorised representative.

8.1.2. The test pieces obtained in accordance with 8.1.1 shall be full sections of the bars / wires and shall be subjected to physical tests without any further modifications. No reduction in size by machining or otherwise shall be permissible, except in case of bars of size 28mm and above (see 8.1.2.1. No test piece shall be annealed or otherwise subjected to heat treatment except as provided in 8.1.3 Any straightening which a test piece may require shall be done cold.

8.1.3. Notwithstanding the provisions in 8.1.2 test pieces may be subjected to artificial ageing at a temperature not exceeding 100° C and for a period not exceeding 2 hours.

8.1.4. Before the test pieces are selected, the manufacturer or supplier shall furnish the purchaser or his authorised representative with copies of the mill records giving the mass of bars / wires from that cast can be identified.

8.2. **Tensile test** - The tensile strength, 0.2 percent proof stress and percentage elongation of bars / wires shall be determined in accordance with requirements of IS: 1608-1972 read in conjunction with IS : 226-1975

8.2.1. Alternatively and by agreement between the purchaser and the supplier, for routine

testing, the proof stress may be determined in conjunction with the tensile strength test and may be taken as the stress measured on the specimen whilst under load corresponding to an increase measured by an extensometer of 0.4 percent for Fe 415 bars / wires, 0.45 percent for grade Fe 500 bars / wires and 0.47 percent for grade Fe 550 bars / wires the total strain on any convenient gauge length.

8.2.2. The stresses shall be calculated using the effective cross – sectional area of the bar / wire.

8.3. **Bend best** - The bend test shall be performed in accordance with the requirements of IS: 1599 – 1974 and the mandrel diameter shall be considered to have passed the test if there is no transverse crack in the bent portion.

Table 4 mandrel diameter for bend test

Nominal size mm	Mandrel diameter for different grades		
	Fe 415	Fe 500	Fe 550
Up to and including 22	3 Ø	4 Ø	5 Ø
Over 22	4 Ø	5 Ø	6 Ø

Where Ø is the nominal size in mm of the test piece.

8.4. **Rebend test** - The test piece shall be bent to an included angle of 135° ( see Fig.2 ) using a mandrel of appropriate diameter ( see 8.4.1 ) The bent piece shall be aged by keeping in boiling water ( 100° C ) for 30 minutes and then allowed to cool. The piece shall then be bent back to have an included angle of 157½°. The specimen shall be considered to have passed the test if there is no fracture in the bent portion.

8.4.1 The diameter of the mandrel shall be as given below:

Nominal size of specimen	Dia of mandrel for Fe 415 and Fe 500	Dia of mandrel for Fe 550
Up to and including 10 mm	5 Ø	7 Ø
Over 10 mm	7 Ø	8 Ø

8.5. **Retest** - Should any one of the test pieces first selected fail to pass any of the tests specified in this standard, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirements of that particular test. Should the test piece from either of these additional samples fail, the material presented by the samples shall be considered as not having complied with this standard.

## 9. Routine inspection and testing

9.1. All material shall be subject to routine inspection and testing by the manufacturer or supplier in accordance with this standard and a record of the test results of material conforming to this standard shall be kept by the manufacturer or the supplier. The records shall be available for inspection by the purchaser or his representative.

In the case of material delivered to a supplier, the manufacturer shall supply a certificate



containing the results of all the required tests on samples taken from the delivered material.

#### 10. Selection of test specimens

10.1. For checking nominal mass, tensile strength, bend test and rebend test, test specimen of sufficient length shall be cut from each size of the finished bar / wire at random at a frequency not less than that specified in Table 5.

Table 5 Frequency for nominal mass, tensile, bend and rebend tests

Nominal size	Quantity	
	For casts / heats below 100 tonnes	For casts / heats over 100 tonnes
Under 10 mm	1 Sample from each 25 tonnes or part thereof	1 Sample from each 40 tonnes or part thereof
10 mm to 16 mm inclusive	1 Sample from each 35 tonnes or part thereof	1 Sample from each 45 tonnes or part thereof
Over 16 mm	1 Sample from each 45 tonnes or part thereof	1 Sample from each 50 tonnes or part thereof

10.2. **Bond test** - The frequency of bond test as required in 4.7 shall be as agreed to between the manufacturer and the purchaser / testing authority.

#### 11. Delivery, inspection and testing facilities

11.1. Unless otherwise specified, general requirements relating to the supply of material, inspection and testing shall conform to IS: 1387-1968. (General requirements for the supply of metallurgical materials (first revision))

11.2. No material shall be dispatched from the manufacturer's or supplier's premises prior to its being certified by the purchaser or his authorized representative as having fulfilled the tests and requirements laid down in this standard except where the bundle containing the bars / wires is marked with the ISI certification mark.

11.3. The purchaser or his authorised representative shall be at liberty to inspect and verify the steel maker's certificate of cast analysis at the premises of the manufacturer or the supplier. When the purchaser requires an actual analysis of finished material, this shall be made at a place agreed to between the purchaser and the manufacturer or the supplier.

11.4. **Manufacturer's certificate** - In the case of bars/wires which have not been inspected at the manufacturer's works, the manufacturer or supplier, as the case may be, shall supply the purchaser or his authorized representative with the certificate stating the process of manufacture and also the test sheet signed by the manufacturer giving the result of each mechanical test applicable to the material purchased and the chemical composition, if required. Each test sheet shall indicate the number of the cast to which it applies, corresponding to the number or identification mark to be found on the material.

#### 12. Identification and marking

12.1. The manufacturer or supplier shall have ingots, billets and bars or bundles of bars / wires marked in such a way that all finished bars / wires can be traced to the cast from

which they were made. Every facility shall be given to the purchaser or his authorized representative for tracing the bars/wires to the cast from which they were made.

12.2. For each bundle / coil of bars / wires a tag shall be attached indicating cast No. / lot No., grade and size.

12.3. Distinguishing mark shall be given to identify the different grades of bar / wire.

12.3.1. Identification marks like brand name, trade mark etc., that are introduced during rolling shall be designed and located in such a manner that the performance in use of the bar is not affected.

12.3.2. Each bundle containing the bars / wires may also be suitably marked with the ISI certification mark in which case the concerned test certificate shall also bear the ISI certification mark.

Note - The use of the ISI certification mark is governed by the provisions of the Indian standards institution (certification marks) act and the rules and regulations made there under. The ISI mark on products covered by an Indian standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a license for the use of the ISI certification mark may be granted to manufacturers or processors, may be obtained from the Indian standards institutions.

#### 4. SPECIFICATIONS FOR ALUMINIUM WINDOWS

##### (Extract of IS: 1949-1961)

1. **Scope** – Deals with aluminium windows suitable for use in industrial buildings and designed to suit openings based on a module of 10 cm.

2. **Designation** – By symbols IN (to indicate industrial window) x Width expressed in number of modules x Type (F = fixed sash; C = centre hung sash; B = bottom-hung sash; T = top-hung sash) x Height expressed in number of modules.

Examples:

a) IN 10 C 15 indicate window for opening 10 module wide (100 cm) by 15 module high (150 cm) with centre-hung ventilator.

b) Composite windows

IN 10 C 10/IN 10 C 10

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IN 10 C 15/IN 10 C 15

Indicates the combination of four windows, two of the type IN 10 C 10 on top and two of the type IN 10 C 15 at bottom, all the four of them coupled both horizontally and vertically.

##### 3. Sizes and tolerances

a) Sizes

IN10C10

IN22C10

IN16C15

IN10C20

IN22C20

IN16F10

IN10T10	IN22T10	IN16T15	IN10T20	IN22T20	IN16F15
IN10B10	IN22B10	IN16B15	IN10B20	IN22B20	IN16F20
IN16C10	IN10C15	IN22C15	IN16C20	IN10F10	IN22F10
IN16T10	IN10T15	IN22T15	IN16T20	IN10F15	IN22F15
IN16B10	IN10B15	IN22B15	IN16B20	IN10F20	IN22F20

b) Ventilators (opening part of a sash) shall be of one size and designed to fit into outer frame of IN 10 C 10 and with 1.2-mm clearance.

c) Tolerance for overall dimensions  $\pm 3$  mm.

Note – The overall width and height of window is smaller than dimensions of modular opening by 2.5 cm, allowing a clearance of 1.25 cm all round. Thus, width and height of INC10C5 = 97.5 x 147.5 cm.

#### 4. Material

- Aluminium extruded section: IS Designation HE9 – WP. Hollow sections shall conform to IS Designation HV9 – WP.
- Cord-eyes, pulleys, brackets and catch plates shall be of aluminium or galvanized or cadmium plated steel.
- Pivots, peg stays and spring catches shall be of non-ferrous metal.
- Glass panes - Shall weigh 7.5 kg/m<sup>2</sup>. Sizes of glass panes shall be as given below:

Pane Designation	a	b	c	d	e	f
Width (mm)	265	300	290	300	300	290
Height (mm)	420	420	455	455	490	490

Note: For number of glass panes for each type of window sees Fig.5 of the standard.

5. **Holes for fixing, coupling and glazing** – Holes for fixing and coupling sashes shall be provided in the web of the outside frame sections and of outer ventilator frame sections where these occur at the perimeter of the sash. Holes for glazing chips shall also be provided, one hole being located in web of the section or tee, on each side of each pane.

#### 6. Fitting and fixing materials

6.1. Centre-hung ventilators shall be mounted on a pair of cup-pivots made out of aluminium alloy sheet or chromium plated brass and each pivot consisting of a inner and outer cup, permitting the swinging of the ventilator through at least 85°. The ventilator shall be so balanced that it can remain open in any desired position.

6.2. Centre-hung and bottom-hung ventilators shall have cast aluminium or bronze spring catch in the centre of the top section, suitable for operation by hand or pole (chord in case of centre-hung).

6.3. Bottom-hung and top-hung ventilators shall be hung on aluminium alloy hinges. The former shall be provided with a pair of aluminium alloy folding side arms (to limit the opening) and the latter with a 300 mm long peg stay. Alternatively, top-hung ventilator may be provided with 30-cm cam opener.

6.4. Two spring glazing clips per pane shall be provided

7. **Composite windows** – Shall be dispatched unassembled, but complete with necessary components. Each coupling member will increase the overall height or width by 25 mm.

8. **Finish** - Matt, scratch-brush or polished may be anodized additionally. A thick layer of transparent lacquer, based on methacrylates or cellulose butyrate, shall be applied, by the suppliers, to protect the surface from action of wet cement during installation. This lacquer coating shall be removed after installation is completed.

#### STONE WORK

##### 5.1. Stone

5.1.1. Requirements of a good structural stone - Structural stones should primarily be (a) strong against crushing, (b) durable, (resistance to weather), (c) good in appearance (colour), (d) susceptible of being quarried in large sizes, and (e) fire resisting.

The strength of a stone depends upon its density and weight.

5.1.12.6. Mortar - The mortar used for joining shall be as specified.

5.1.12.7. Laying - All stones shall be wetted before use. Each stone shall be placed close to the stones already laid so that the thickness of the mortar joints at the face is not more than 20 mm. Face stones shall be arranged suitably to stagger the vertical joints and long vertical joints shall be avoided. Stones for hearing or interior filling shall be hammered down with wooden mallet into the position firmly bedded in mortar. Chips or sprawls of stones may be used for filling of interstices between the adjacent stones in heartening and these shall not exceed 20% of the quantity of stone masonry. To form a bond between successive courses plum stones projecting vertically by about 15 to 20 cm shall be firmly embedded in the heartening at the interval of about one meter in every course. No hollow space shall be left anywhere in the masonry.

The masonry work in wall shall be carried out true to plumb or to specified batter.

Random rubble masonry shall be brought to the level course at plinth, windowsills, lintel and roof levels. Leveling shall be done with concrete comprising of one part of the mortar as used for masonry and two parts of graded stone aggregate of 20 mm nominal size.

The masonry in structure shall be carried out uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45 degree.

5.1.12.8. Bond stones - Bond or through stones running right through the thickness of walls, shall be provided in walls up to 60 cm thick and in case of wall above 60 cm thickness, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from the face of the wall to the back. In case of highly absorbent types of stones (porous lime stone and sand stone etc.) single piece bond stones may give rise to dampness. For all thickness of such walls, a set of two or more bond stones overlapping

each other by at least 15 cm shall be provided. Length of each such bond stone shall not be less than two-third of the thickness of the wall.

Where bond stones of suitable lengths are not available precast cement concrete block of 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) of cross section not less than 225 square centimeters and length equal to the thickness of wall shall be used in lieu of bond stones. (This shall be applicable only in masonry below ground level and where masonry above ground level is finally required to be plastered). At least one bond stone or a set of bond stones shall be provided for every 0.5 sq m of the area of wall surface. All bond stones shall be marked suitably with paint as directed by the engineer.

5.1.12.9. Quoin and jamb stones - The quoin and jamb stones shall be of selected stones neatly dressed and hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15 cm.. Quoins shall be laid header and stretcher alternatively.

5.1.12.10. Joints - Stone shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20 mm thick.

The joints shall be struck flush and finished at the time of laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

5.1.12.11. Scaffolding - Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one meter in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 stone aggregate 20 mm nominal size).

5.1.12.12. Curing - Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

5.1.12.13. Protection - Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

5.1.12.14. Measurements

5.1.12.14.1 The length, height and thickness shall be measured correct to a cm. The thickness of wall shall be measured at joints excluding the bushing. Only specified

dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic metre nearest to two places of decimal.

5.1.12.14.2. The work under the following categories shall be measured separately.

From foundation to plinth level (level one): (a) Work in or under water and /or liquid mud, (b) Work in or under foul positions.

From plinth level (Level one) to floor two level.

From floor two levels to floor three level and so on.

Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

Note :( 1) Floor 1 is the lowest floor above ground level in the building unless otherwise specified in a particular case. The floors above floor 1 shall be numbered in sequence as floor 2, floor 3 and so on. Number will increase upwards. (2) For floor 1, top level of finished floor shall be the floor level and for all other floors above floor 1, top level of structural slab shall be the floor level. (3) Floor level or 1 or 1.2 m above the ground level whichever is less shall be the plinth level.

5.1.12.14.3. No deduction shall be made nor extra payment made for the following

Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters purlins, trusses, corbels, steps etc.) up to 0.1 sqm in section.(ii)Openings each up to 0.1 sqm in area. In calculating the area of openings, any separate lintels or sills shall be included along with the size of opening but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any, shall also be excluded. (iii) Wall plates and bed plates, and bearing or chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

Note: The bearing of floor and roof shall be deducted from wall masonry. (iv) Drain holes and recess for cement concrete blocks to embed hold fasts for doors, windows, etc.(v) Building in masonry, iron fixture, pipes up to 300 mm dia, hold fasts of doors and windows etc. (vi)Forming chases in masonry each up to section of 350 sq cm.

Masonry (excluding fixing brick work) in chimney breasts with smoke or air flues not exceeding 20 sq dm (0.20 sq m) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20 sq dm (0.20 sq m) sectional area, deduction shall be made for the same and pargetting and coring flues shall be measured in running meters stating size of flues and paid for separately. Aperture for fire place shall not be deducted and no extra payment made for splaying of jambs and throatings.

5.1.12.14.4. Apertures for fireplaces shall not be deducted and extra labour shall not be measured for splaying of jambs, throating and making arch to support the opening.

5.1.12.14.5. Square or rectangular pillars - These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed two and a half times the thickness.

5.1.12.14.6. Circular pillars (columns) - These shall be measured as per actual dimensions, but extra payment shall be allowed for stone work in circular pillars over the rate for stone work in walls. The diameter as well as length shall be measured correct to a cm.

5.1.12.14.7. Tapered walls - shall be measured net, as per actual dimensions and paid for as other walls.

5.1.12.14.8. Curved masonry - Stone masonry curved on plan to a mean radius exceeding 6 meters shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6 meters shall be measured separately and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

5.1.12.15. Rate - The rate shall include the cost of materials and labour required for all the operations described above and shall include the following:

Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds. (b) Preparing tops and sides of existing walls for raising and extending. (c) Rough cutting and waste for forming gables cores, skew backs or spandrels of arches, splays at eaves and all rough cutting in the body of walling unless otherwise specified. (d) Bond stones or cement concrete bond blocks. (e) Leading and making holes for pipes etc. (f) Bedding and pointing wall plates, lintels, sills etc., in or on walls, bedding roof tiles and corrugated sheets in or on walls. (g) Building in ends of joists, beams, lintels etc.

## 5. SPECIFICATION FOR FINISHING WORKS

### 15.5. SPECIFICATIONS FOR CEMENT PLASTERING

15.5.0. The cement plaster shall be 12 mm, 15 mm or 20 mm thick as specified in the item.

15.5.1. Scaffolding and preparation of surface shall be as specified in 15.1

15.5.2 **Mortar** - The mortar of the specified mix using the type of sand described in the item shall be used. It shall be as specified. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

15.5.3. **Application** - The specifications as in 15.1.4 shall apply except in the following respects -

- a) Beating with thin bamboo strips shall not be done on the cement plaster, and
- b) No lime putty solution shall be applied on the face when finishing. Further the plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

15.5.4. **Thickness** - Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15 mm while in case of stone work the minimum thickness over the bushings shall be not less than 12 mm.

15.5.5. **Curing** - Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the engineer may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

Specifications for Finish, Precautions, Measurements and Rate shall be as described in 15.1

#### **15.6. SPECIFICATIONS FOR CEMENT PLASTER WITH A FLOATING COAT OF NEAT CEMENT**

15.6.0. The cement plaster shall be 12, 15 or 20 mm thick, finished with a floating coat of neat cement, as described in the item.

15.6.1. Specifications for this item of work shall be same as described except for the additional floating coat which shall be carried out as below.

When the plaster has been brought to a true surface with the wooden straight edge (clause 13.5.3) it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications as described in 15.5.3 shall apply.

#### *15.27. SPECIFICATIONS FOR WHITE WASHING WITH WHITING*

15.27.1. Preparation of Mix - Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form thin slurry which shall then be screened through a clean coarse cloth. Two kg of gum and 0.4 kg of copper sulphate dissolved separately in hot water shall be added for every cum of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use.



15.27.2. Other specifications described shall apply in this case also.

*15.29. SPECIFICATIONS FOR DRY DISTEMPERING*

15.29.1. Materials - Dry distemper of required colour (IS-427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using 6 decilitres (0.6 litre) of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency.

Distemper shall not be mixed in larger quantity than is actually required for one day's work.

**15.29.2. Preparation of Surface**

15.29.2.1. Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

15.29.2.2. New plastered surfaces shall be allowed to dry for at least two months, before applying distemper.

15.29.2.3. In the case of old work, all those pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

15.29.2.4. Pitting in plaster shall be made good with Plaster of Paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

15.29.3. Priming Coat - A priming coat of whiting shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper.

The treated surface is allowed to dry before distemper coat is given.

**15.29.4. Application**

15.29.4.1 In the case of new work, the treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface attains an even colour.

15.29.4.2 For old work, the surface prepared as described shall be applied one or more coats of distemper till the surface attains an even colour.

15.29.4.3. The application of each coat shall be as follows - The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash

brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

15.29.4.4. The subsequent coats shall be applied only after the previous coat has dried.

15.29.4.5. The finished surface shall be even and uniform and shall show no brush marks.

15.29.4.6. Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

15.29.4.7. After each day's work, the brushes shall be washed in hot water and hung down to dry. Old brushes which are dirty or caked with distemper shall not be used.

15.29.5. The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described.

### *15.33. SPECIFICATIONS FOR PAINTING*

15.33.1. Materials - Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint the brand of thinner recommended by the manufacturer or as instructed by the Engineer shall be used.

Approved paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the engineer. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the engineer.

15.33.2. Commencing Work - Painting shall not be started until the engineer has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the paint work being started.

15.33.3. Preparation of Surface - The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the engineer after inspection, before painting is commenced.

#### 15.33.4. Application

15.33.4.1. Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its containers, when applying also, the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

15.33.4.2. The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over the paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

15.33.4.3. Where so stipulated, the painting shall be done by spraying. Spray machine used be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed to the requisite consistency by adding a suitable thinner.

15.33.4.4. Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next-coat is applied. This should be facilitated by thorough ventilation. Each one except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

15.33.4.5. No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

15.33.4.6. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings etc. shall be left on the work.

15.33.4.7. In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need not be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

15.33.4.8. On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

14.33.4.9. The additional specifications for primer and other coats of paints shall be as according to the detailed specifications under the respective headings.

15.33.5. Brushes and containers - After work, the brushes shall be completely cleaned of paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is

ruined and shall on no account be used for painting work. The containers when not in use shall be kept closed and free from air so that paint does not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

#### 15.33.6. Measurements

15.33.6.1. The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated.

15.33.6.2. Small articles not exceeding 10 sq. decimeter (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

15.33.6.3. Painting up to 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running meters and shall include cutting to line where so required.

Note: Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sq. meters irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

15.33.6.4. In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

Table 1 Equivalent plain areas of uneven surface

Sl. No.	Description of work	How measured	Multiplying coefficients
1	2	3	4
I.	Wood work doors, windows etc.		
1	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2	Ledged and battened or ledged, battened and braced doors, windows etc.	Frame, edges chocks, cleats, etc. shall be deemed to be included in the item.	
3	Flush doors etc.	- do -	1.20 (for each side)
4	Part panelled and part glazed or gauzed doors, windows etc. (Excluding painting of wire gauze	- do -	1.00 (for each side)

	portion)		
5	Fully glazed or gauged doors, windows etc. (Excluding painting of wire gauze portion)	- do -	0.80 (for each side)
6	Fully venetianed or louvered doors,	- do -	1.80 (for each windows etc. side)
7	Trellis work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2 ( for painting all over)
8	Carved or enriched work	Measured flat	2 ( for each side)
9	Weather boarding	Measured flat (not girthed supporting frame work shall not be measured separately)	1.20 (for each side)
10	Wood shingle roofing	Measured flat (not girthed)	1.10 (for each side)
11	Boarding with cover fillets and	Measured flat (not girthed)	1.05 (for each match boarding side)
12	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.80 (for painting all over)
<b>II.</b>	Steel Work Doors, Windows, etc.		
13	Plain sheeted steel doors or windows	Measured flat (not girthed including frame edges etc.)	1.10 (for each side)
14	Fully glazed or gauzed steel doors and windows (excluding painting of wire gauze portion)	- do -	0.50 (for each side)

	Partly panelled and partly glazed doors and windows (excluding painting of wire gauze portion)	- do -	0.80 (for each side)
16	Corrugated sheeted steel doors or windows	- do -	1.25 (for each side)
17	Collapsible gates	Measured flat	1.50 (for painting all over)
18	Rolling shutters of interlocked laths	Measured flat (size of opening) all over ; jamb guides, bottom rails and locking arrangement etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)
III.	<b>General</b>		
19	Expanded metal, hard drawn steel Wire fabric of approved quality, grill works and gratings in guard Bars, balustrades, railing partitions and MS bars in windows frames	Measured flat overall, no deduction shall be made for open spaces; supporting members shall not be measured separately.	1 (for paint all over)
	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel.	- do - (see note No. 12)	1 (for paint all over)
	Corrugated iron sheeting in roofs, side cladding etc.	- do - Measured flat (not girthed)	1.14 (for each side)
	AC semi-corrugated sheeting in roofs, side cladding etc.	- do -	1.20 (for each side)
	AC semi-corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets	- do -	1.10 (for each side)
	Wire gauze shutters including painting of wire gauze.	- do-	1.00 (for each side)

**Explanatory notes for Table 1:**

- 1) Measurements for doors windows etc., shall be taken flat (and not girthed) over all including frames, where provided. Where frames are not provided, the shutter measurements shall be taken.
- 2) Where doors, windows, etc., are of composite types other than those included in Table 1 the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.
- 3) The coefficients for door and windows shall apply irrespective of the size of frames and shutter members.
- 4) In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.
- 5) When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer and measurement of this will be deemed to be included in the measurement of the face treated with that finish.
- 6) In the case where shutters are fixed on both faces of the frames, the measurement for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.
- 7) Where shutters are provided with clearance at top or / and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.
- 8) Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
- 9) Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings, etc.
- 10) Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.
- 11) The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.
- 12) For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the

palisades, if they project below the lowest rail), up to the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or the palisades.

15.33.6.5. Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.

15.33.6.6. For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas shall be measured in sq. meters and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

15.33.6.7. Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for those or for painting brackets, clamps etc.

15.33.6.8. Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

15.33.6.9. Flag staffs, steel chimneys, aerial masts, spires and other each objects requiring special scaffolding shall be measured separately.

15.33.7. **Precautions** - All furnitures fixtures, glazing, floors, etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damages done shall be made good by the contractor at his cost.

15.33.8. **Rate** - Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items.

#### SPECIFICATIONS FOR CLEARING AND GRUBBING

200.1.1. Scope - This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., which in the opinion of the engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications.

200.1.2. **Preservation of property/amenities** - Roadside trees, shrubs, any other plants, pole, lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from



injury or damage. The contractor shall provide and install at his own expense, suitable safeguards approved by the engineer for this purpose.

During clearing and grubbing, the contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide clause 300.6. Before start of operations, the contractor shall submit to the engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc., and the schedules for carrying out temporary and permanent erosion control works as stipulated in clause 300.6.3.

**200.1.3. Methods, tools and equipment** - Only such methods, tools and equipment as are approved by the engineer and which will not affect the property to be preserved shall be adopted for the Work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation to the satisfaction of the engineer. On areas beyond these limits, trees and stumps required to be removed as directed by the engineer shall be cut down to 1m below ground level so that these do not present an unsightly appearance.

All branches of trees extending above the roadway shall be trimmed as directed by the engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Anti-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres, shall be suitably treated.

**200.1.4. Disposal of materials** - All materials arising from clearing and grubbing operations shall be the property of government and shall be disposed of by the contractor as hereinafter provided or directed by the engineer.

Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in road construction shall be neatly stacked as directed by the engineer. Stacking of stumps, boulders, stones, etc., shall be done at specified spots with all lifts and upto a lead of 1000m.

All products of clearing and grubbing which, in the opinion of the engineer, cannot be used or auctioned shall be cleared away from the roadside in a manner as directed by the engineer. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixed up with the materials meant for embankment, subgrade and road construction.

200.1.5. **Measurements for payment** - Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same. Cutting of trees upto 300 mm in girth including removal of stumps and roots after obtaining prior clearance from the forest department/authorities and trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps left over after trees have been cut by any other agency shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots if trees of girth above 300 mm and backfilling to required compaction shall be measured in terms of number according to the sizes given below :-

- (v) Above 300 mm to 600 mm
- (vi) Above 600 mm to 900 mm
- (vii) Above 900 mm to 1800 mm
- (viii) Above 1800 mm

For this purpose, the girth shall be measured at a height of 1 metre above ground or at the top of the stump if the height of the stump is less than one metre from the ground.

#### 200.1.6. **Rates**

200.1.6.1. The contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm in girth as well as stumps left over after cutting of trees carried out by another agency, excavation and back-filling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m.

200.1.6.2. The contract unit rate for cutting (including removal of stumps and roots) of trees of girth above 300 mm shall include excavation and backfilling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m.

200.1.6.3. Where a contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the contract unit prices for the same shall be considered as including clearing and grubbing operations.

### **1.EARTH WORKS**

#### 1.1 General

Before beginning excavation or filling, the Engineer-in-Charge and Contractor shall jointly survey and record all ground levels on the site. The area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, tree and saplings of girth up

to 30 cm measured at a height of one metre above ground level and rubbish removed up to a distance of 50 meters outside the periphery of the area under clearance. The roots of trees and saplings shall be removed for the stilt floor construction level, whichever is lower, and the holes or hollows filled up with the earth, rammed and leveled.

## 1.2 Excavation

Excavation for roads, pavements, concrete drains, outfalls, various foundations, etc. shall be considered under this category.

The whole of the excavation for the works shall be carried out to the required widths, lengths and depths and within the approved lines and levels or as directed by the Engineer-in-Charge. Any excavation beyond such limits or instructions shall be made good by filling with M-10 concrete or other approved materials to the required compaction, by the Contractor, at his own expense to the satisfaction of the Engineer-in-Charge.

The Contractor shall provide all shoring, timbering or other approved support to the sides of the excavations as may be necessary to prevent any ground movement. The Contractor shall bear all responsibility connected with such shoring including dewatering notwithstanding the Engineer-in-Charge's Approval. Cost of all such shoring, etc. shall be deemed to be included in the prices.

All excavation except where otherwise noted shall be required to be kept completely free from water, from whatever source it may come at all times to the entire satisfaction of the Engineer-in-Charge. Cost of dewatering shall be deemed to have been included in the rates quoted.

The bottom of all excavations shall be trimmed and leveled and compacted properly to the satisfaction of the Engineer-in-Charge. A bottom layer of 150 mm thick shall be left undisturbed and removed only when concrete is about to be placed in order to prevent softening or deterioration of the surface of the bottom of the excavation due to exposure.

A masonry pillar to serve as a bench mark will be erected at a suitable point in the area, which is visible from the largest area. This bench mark shall be constructed and connected with the standard bench mark as approved by the Engineer-in-Charge. Necessary profiles with strings stretched on pegs, bamboos or "Burjis" shall be made to indicate the correct formation levels before the work is started. The contractor shall supply labour and material for constructing bench mark, setting out and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or "Burjis" and the bench mark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

The ground levels shall be taken at 5 to 15 metres intervals (as directed by the Engineer-in-Charge) in uniformly sloping ground and at closer intervals where local mounds, pits or

undulations are met with. The ground levels shall be recorded in field books and plotted on plans. The plans shall be drawn to a scale of 5 metres to one cm or any other suitable scale decided by the Engineer-in-Charge. North direction line and position of bench mark shall invariably be shown on the plans. These plans shall be signed by the contractor and the Engineer-in-Charge or their authorized representatives before the earth work is started. The labour required for taking levels shall be supplied by the contractor at his own cost.

During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

In firm soils, the sides of the trenches shall be kept vertical up to a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal: 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping, sloping or shoring to be done for excavation deeper than 2 metres.

The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge shall be measured and recorded for payment.

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

The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge considering feasibility, urgency of work, availability of labour/mechanical equipments and other factors involved. Contractor shall ensure every safety measure for the workers. Neither any deduction nor extra payment will be made on this account.

#### 1.2.1 Safety and Emergency Procedures

The Contractor shall take all necessary precautions to ensure stability of his excavations and shall take all necessary precautions and be responsible for the safety of personnel in the area of operation. He shall maintain, available for immediate use, a sufficient quantity of slurry to allow for any sudden loss. Should the loss continue despite the addition of the slurry and the stability of the trench be placed at risk, the Contractor shall backfill with lean mix concrete to preserve the stability of the trench and ensure the safety of neighbouring structures and utility services.

#### 1.2.2 Obstructions

An obstruction is defined as material, the excavation of which hinders normal progress and the existence of which could not have been foreseen. Upon encountering an obstruction, the Contractor shall determine the method to be employed in removing the obstruction.

#### 1.3 Disposal

Excavated materials deemed suitable by the Engineer-in-Charge for filling in other areas within a lead of five kilometers, shall be filled as directed by the Engineer-in-Charge.

Unsuitable or excess excavation material and debris shall be transported to spoil areas within a lead of five kilometers as defined and approved by the Engineer-in-Charge. Material shall be end dumped, graded and leveled at these areas to the grades and levels specified by the Engineer-in-Charge. Cost of such disposal shall be deemed to have been included in the price.

#### Backfill

Backfill shall contain no ashes, rubbish combustible or decomposable material, nor any other material, which the Engineer-in-Charge deems unsuitable for this purpose.

All material used as backfill / fill under structures or concrete slab or around structures or trenches and pits shall be placed in layers not exceeding 300 mm and compacted to a minimum of 95% of the maximum laboratory dry density as per IS: 2720 (Part 8) and as directed by the Engineer-in-Charge. Backfilling of trenches shall not commence till the respective piping and electrical cables/conduits have been approved by the Engineer-in-Charge.

#### Compaction Control of Fill Material

The Contractor shall provide all the testing equipment, facilities and personnel required for the work. The number and periodicity of tests required to be conducted at the Site of fill shall be determined by the Engineer. The Contractor shall submit to the Engineer-in-Charge prior to commencement of work a detailed execution plan indicating the method of compaction and the compaction tests he proposes to conduct. All compacting and testing equipment and method of compaction proposed by the Contractor shall be subject to the prior approval of the Engineer.

Control shall be exercised on each layer by taking at least one measurement of density for each 1000 square meters of compacted area or closer as required to yield the minimum number of test results for evaluating a day's work on statistical basis. The determination of density shall be in accordance with IS: 2720 (Part 28). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 6 as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurements shall be increased to 10. The acceptance criteria shall be subject to the condition that the mean density is not less than the specified density plus:  $[1.65 - 1.65 / (\text{No. of Samples})^{0.5}]$  times the standard deviation.

However, for earthwork in shoulders (earthen) and in the sub grade, at least one density measurements shall be taken for every 500 Sq.m for the compacted area provided further that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

Earthworks and all components thereof should satisfy the following tests and codes:

S.No	I.S. No.	Description
1	IS 632	Gamma - BHC (Lindane) emulsifiable concentrates
2	IS 1200 (Part 1)	Method of measurement of Earth work
3	IS 1200 (Part 27)	Method of measurement of Earth work (by Mechanical Appliances)
4	IS 4081	Safety code for Blasting and related drilling operation
5	IS 4988 (Part 4)	Excavators
6	IS 6313 (Part 2)	Anti Termite measures in buildings (pre-construction)
7	IS 6313 (Part 3)	Anti Termite measures in buildings (post-construction)
8	IS 6940	Methods of test for pesticides and their formulations
9	IS 8944	Chloropyrifos emulsifiable concentrates
10	IS 8963	Chloropyrifos - Technical specifications

11	IS 12138	Earth moving equipments
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## 6. CONCRETE WORK

4.0 The concrete can be designed in grades denoting by volumetric proportion of the constituents' characteristic compressive strength. The concrete by volumetric proportion or nominal mix concrete of the constituents as well as Design Mix denoting compressive strength as detailed in this section.

### 4.1. Materials.

Water, cement, lime, fine aggregate or sand, surkhi, cinder and fly ash shall be as specified in Section 0.

#### Coarse aggregate

4.1.2.1. General - Aggregate most of which is retained on 4.75 mm IS Sieve and contains only as much fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Coarse aggregate shall be specified as stone aggregate, gravel or brick aggregate and it shall be obtained from approved / authorised sources

a) Stone aggregate -It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean. It shall be free from veins, adherent coating, and injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided. It shall conform to IS: 383 unless otherwise specified.

b) Gravel - It shall consists of naturally occurring (uncrushed, crushed or broken ) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, and loam adherent coating, alkali vegetable, matter and other deleterious substances. Pit gravel shall be washed if it contains soil materials adhering to it. These shall soil materials soil materials adhering to it. These shall conform to IS: 383 unless otherwise specified.

c) Brick aggregate - Brick aggregate shall be obtained by breaking well burnt or over burnt dense bricks / brick bats. They shall be homogenous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil vegetable matter and other deleterious substances. Such aggregate should not contain more than one percent of sulphate and should not absorb more than 10% of their own mass of water, when used in cement concrete and 20% when used in lime concrete. It shall conform to IS: 383 unless otherwise specified.

d) Lightweight aggregates such as sintered fly ash aggregate may also be used provided the engineer is satisfied with the data on the proportion of concrete made with them.

4.1.2.2. Deleterious material - Course aggregate shall not contain any deleterious material, such as pyrites, coal, lignite, shale or similar laminates material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of



the concrete. Coarse aggregate to be used for reinforced cement concrete shall not contain any material liable to

the steel reinforcement. Aggregates which are chemically reactive with alkali of cement shall not be used. The maximum quantity of deleterious material shall not more than five per cent of the weight of coarse aggregate when determined in accordance with IS: 2386 part II.

#### 4.1.2.3. Size and grading

(i) Stone aggregate and gravel - It shall be either graded or single sized as specified. Normal size and grading shall be as under --

(a) Nominal sizes of graded stone aggregate or gravel shall be 40, 20, 16, or 12.5 mm as specified. For any one of the nominal sizes, the proportion of other sizes shall be in accordance with Table 1.

Table 1 -Graded stone aggregate or gravel

IS Designation	Sieve	Percentage passing (by weight) for nominal size of			
		40 mm	20 mm	16 mm	12.5 mm
75 mm		100	-	-	-
37.5 mm		95 to 100	100	-	-
19 mm		-	95 to 100	100	100
16 mm		-	-	90 to 100	-
11.2 mm		-	-	-	90 to 100
9.5 mm		10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm		0 to 5	0 to 10	0 to 10	0 to 10
2.36 mm		-	-	-	-

Concrete work

(b). Normal sizes of single sized stone aggregate or gravel shall be 63, 40, 20, 16, 12.5 or 10 mm as specified. For any one of the nominal sizes the proportion of other sizes shall be in accordance with Table 2.

Table 2 -Single sized (ungraded) stone aggregate or gravel

IS Sieve Designation	Percentage passing (by weight) for nominal size of					
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
75 mm	100	-	-	-	-	-
63 mm	85-100	100	-	-	-	-

37.5 mm	0-30	85-100	100	-	-	-
19 mm	0-5	-20	85-100	100	-	-
16 mm	-	-	-	-85-100	100	-
11.2 mm	-	-	-	-	85-100	100
9.5	-	0-5	0-20	0-30	0-45	85-
100						
4.75 mm	-	-	0-5	0-5	0-10	0-20
2.36 mm	-	-	-	-	-	0-5

c). When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sizes aggregate of different sizes in the proportion to be determined by field tests to obtain graded aggregate of specified nominal size. For the required nominal size, the proportion of other sizes in mixed aggregate shall be in accordance with Table 1. Recommended proportions by volume for mixing of different sizes of single size (ungraded) aggregate to obtain the required nominal size of graded aggregate are given in Table 3.

Table 3 -Single sized (ungraded) stone aggregate or gravel

Cement Concrete	Nominal size of graded aggregate required	Parts of single size aggregate of size				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
1: 6:12	63	9	-	3	-	-
1: 6: 12	40	-	9	3	-	-
1: 5: 10	63	7 ½	-	2 ½	-	-
1: 5: 10	40	-	7 ½	2 ½	-	-
1: 4: 8	63	6	-	2	-	-
1: 4: 8	40	-	6	2	-	-
1: 3: 6	63	4 ½	-	1 ½	-	-
1: 3: 6	40	-	4 ½	1 ½	-	-
1: 3:6	20	-	-	4 ½	-	-
1: 2: 4	40	-	2 ½	1	-	½
1: 2: 4	20	-	-	3	-	1

1: 2: 4	12.5	-	-	-	3	-
1: 1 ½ : 3	20	-	-	2	-	1

Note-(i) The proportions indicated in Table 3 above are by volume when considered necessary, these proportions may be varied marginally by engineer after making sieve analysis of aggregate brought to site for obtaining required graded aggregate. No adjustments in rate shall be made for any variation in the proportions so ordered by the engineer. If single size coarse aggregates are not premixed at site to obtain the graded coarse aggregate required for mix, the volume of single size aggregates required for the mix shall be suitably increased to account for reduction in total volume at the site of mixing.

(ii) Brick aggregate - Nominal size of brick aggregate shall be 40 mm and its grading shall be as specified in the Table 4 when tested for sieve.

Table 4 -Brick aggregate

IS Sieve Designation(by weight)	Percentage passing
75 mm	100
37.5 mm	95-100
19.0 mm	45-100
4.75	0-5

Note -Coarse aggregate for cement concrete shall generally conform to para 4.2.1 of IS: 456 and fine aggregate shall conform to IS: 383.

4.1.2.4. Stacking - Aggregate shall be stacked on a hard, dry and level patch of ground. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

4.1.2.5. Testing - Coarse aggregate shall be tested for the following (as per IS: 2386 )

Determination of particle size and shape

Estimation of organic impurities (as per IS: 2386-Part II )

Surface moisture

Determination of 10% fine value

Measurements - The aggregates shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks in respect of aggregates of nominal size 40 mm and above. No deduction from the gross measurements of the stacks is to be made in respect of aggregates nominal size below 40 mm.

Admixtures - When required, admixtures of approved quality shall be mixed with concrete, as specified. The admixtures shall conform to IS: 9103.

#### 4.2. SPECIFICATIONS FOR CEMENT CONCRETE

4.2.0. This shall be prepared by mixing graded stone or brick aggregate of nominal size as specified with fine aggregate and cement in specified proportions with required quantity of water. The grading and quality of aggregates shall be such as to give minimum compressive strength of 140 kg/cm<sup>2</sup> and 210 kg / cm<sup>2</sup> at 7 days and 28 days respectively in case of mix 1:2:4, (One cement - two Coarse sand - four stone aggregate).

One sample consisting of 6 cubes 15x15x15 cm shall be taken for every 15 cubic meter or part thereof cement concrete 1:2:4. The cube tests shall not be carried out in case the quantity of cement concrete placed on any day is less than 15 cubic meter unless otherwise specific. For other details, refer section on R.C.C. work.

4.2.1. Proportioning - It shall be done by volume. Boxes of suitable size shall be used for measuring sand and aggregate. The internal dimensions of the boxes shall be generally 35 X 25 X40 cm deep or as otherwise approved by the engineer. The unit of measurement of cement shall be a bag of 50 kg. and this shall be taken as 0.035 cubic meter. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowances for bulk age shall be made as given for mortar.

4.2.2. Preparation - This shall be prepared by mixing coarse aggregate, fine aggregate and cement in specified proportions with required quantity of water. Nominal size and quality of aggregate shall be as specified.

Except where brick aggregate is used in cement concrete, minimum compressive strength on works test for different concrete mixes shall be as specified for various grades prepared by volume basis, in Table 5 below. The work test shall be carried out for every 15 cum of a day's concreting unless otherwise specified.

Table 5

Concrete mix	Min compressive strength on 15 cm cube in Kg / cm <sup>2</sup>	
	7 days strength	28 days strength
1:1:2	210	315
1:1½ :3		265
1:2:4	140	175

4.2.2.1. Mixing - Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS: 1791 having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical break down of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the engineer in writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a watertight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove, dirt, dust and other foreign materials. For guidance, the mixing time may be 1½ to 2 minutes, for hydrophobic cement it may be taken as 2½ to 3 minutes.

4.2.2.2. Power loader - Mixer will be fitted with a power loader complying with the following requirements.

a). The hopper shall be of adequate capacity to receive and discharge the maximum nominal batch of unmixed materials without spillage under normal operating conditions on a level site.

Note - In such a case the volume of the maximum nominal batch of mixed material is 50% greater than the nominal mixed batch capacity.

b). The minimum inside width of the feeding edge of the hopper shall be as specified below in Table 6.

Table 6

Nominal size of mixer (T, NT or R), litre	Minimum inside width of hopper feeding edge in mm
140	1.0
200	1.1
280	1.2
375	1.4
500	1.5
1000	2.0

..... T = tilting; NT = non-tilting; R = Reverse

The design of the loader shall be such that it allows the loading hopper to be elevated to such a height that the center line of the chute plate of the hopper when in discharge

position, is at an angle of not less than 50° to the horizontal. A mechanical device to aid discharge of the contents as quickly as possible from the hopper to the drum may also be provided. Even when a mechanical device is provided, it is recommended that the angle of center line of the chute plate of the hopper when in discharge position, should be as large as practicable, preferably not less than 40° to horizontal.

When the means of raising and lowering the loading hopper includes flexible wire ropes winding on to a drum or drums, the method of fastening the wire to rope to the drums shall be such as to avoid, as far as possible any tendency to cut the strands of the ropes and the fastening should preferably be positioned clear of the barrel of the drum for example, outside the drums flange. When the loading hopper is lowered to its normal loading position, there should be at least one and half drums of rope on the drum.

Clutch brake and hydraulic control lever shall be designed so as to prevent displacement by liberation or by accidental contact with any person.

The clutch and brake control arrangements shall also be so designed that the operator can control the falling speed of the loader.

Safety device shall be provided to secure the hopper in raised position when not in use

4.2.2.3. Mixing efficiency - The mixer shall be tested under normal working conditions in accordance with the method specified in IS - 4643 with a view to check its ability to mix the ingredients to obtain concrete having uniformity within the prescribed limits. The uniformity of mixed concrete shall be evaluated by finding the percentage variation in quantity (mass in water) of cement, fine aggregate and coarse aggregate in a freshly mixed batch of concrete.

The percentage variation between the quantities of cement, fine aggregate and coarse aggregates (as found by weighing in water) in the two halves of a batch and average of the two halves of the batch shall not be more than the following limits -

Cement	8%
Fine aggregate	6%
Coarse aggregate	5%

4.2.2.4. Machine mixing - The mixer drum shall be flushed clean with water. Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement. Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for at least four turns of the drum. While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the engineer. After adding water, the mixing shall be continued until concrete of uniform colour,

uniformly distributed material and consistency is obtained. Mixing shall be done for at least two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed. The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed clean with water.

4.2.2.5 Hand mixing - When hand mixing has been specifically permitted in exceptional circumstances by the engineer in writing, subject to adding 10% extra cement, it shall be carried out on a smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by shoveling and turning till the coarse aggregate gets evenly distributed in the cement sand mixture. Three quarter of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be continued until concrete of uniform colour and consistency is obtained. The mixing platform shall be washed and cleaned at the end of the day.

4.2.3. Workability - The quantity of water to be used for each mix shall be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means specified. Generally, the quantity of water to be used for each mix of 50 Kgs cement shall not be more than 34 litres for 1:3:6 mix, 30 litres for 1:2:4 mix, 30 litres for 1:1½:3 mix and 25 litres for 1:1:2 mix. In case of vibrated concrete, the quantity of water may be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests as described in Annexure 4.A.1. The slump and workability for different kind of works shall be as per Table 7 below

Table 7

Placing conditions.	Degree of workability	Value of workability
Concreting of shallow Sections with vibration	Very low	0.75-0.80 Compacting factor.
Concreting of lightly reinforced section with vibration.	Low	Slump up to 25 mm, 10-5 Seconds, vee bee time 0.8-0.85 compacting factor.
Concreting of lightly reinforced	Medium	25-75 mm, slump for 20 mm aggregate.

Section without vibration or heavily reinforced sections with vibration.		
Concreting of heavily reinforced sections without vibration.	High	75-125 mm slump for 20 mm aggregate.

Note - Where considered necessary, the workability of the concrete may also be ascertained by compacting factor test and vee-bee consistometer method as specified in IS: 1199. For suggested ranges of value of workability of concrete by the above methods, reference may be made to IS: 456-2000.

4.2.4. Transportation - Concrete shall be transported from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability.

4.2.5. Placing - The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) and shall be thoroughly vibrated and compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains.

4.2.6. Compaction - Concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till a dense concrete is obtained. The mechanical vibrators shall conform to IS: 2505 specifications for concrete vibrators (immersion type). To prevent segregation, over vibration shall be avoided. The use of mechanical vibrator may be relaxed by the engineer at his discretion for certain items and permit hand compaction. Hand compaction shall be done with the help of tamping rods. Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the engineer in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

4.2.7. Construction joints - Connecting shall be carried out continuously up to construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the engineer. Number of such joints shall be kept minimum and shall be kept as straight as possible.

4.2.7.1. When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints, neat cement slurry, of workable consistency by using 2kgs of cement per sq m shall be



applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete

4.2.7.2. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement per sqm. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against corners and close spots; work, thereafter, shall proceed in the normal way.

#### 4.2.8. Concreting under special conditions

4.2.8.1 Work in extreme weather conditions - During hot and cold weather, the concreting shall be done as per the procedure set out in IS: 7861(Part-I) and IS: 7861(Part II) respectively. Concreting shall not be done when the temperature falls below 4.5° C. In cold weather, the concrete placed shall be protected against frost. During hot weather, it shall be ensured that the temperature of wet concrete does not exceed 38°C.

Under water concreting - Concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. The concrete shall contain at least 10% more cement than that required for the same mix placed in dry conditions, the quantity of extra cement varying with conditions of placing with prior written permission of the engineer. Such extra cement will be paid extra. The volume of coarse aggregate shall not be less than 1½ times nor more than twice the fine aggregate and slump not less than 100 mm nor more than 180 mm. Where found necessary to deposit any concrete under water, the method, equipment, materials and mix shall first be got approved by the engineer. Concrete shall be deposited continuously until it is brought to required height. While depositing, the top surface shall be kept as nearly level as possible and the formation of heaps shall be avoided. The concrete shall be deposited under water by one of the approved methods such as Tremie method, drop bottom bucket, bags, grouting etc. as per details given in IS: 456-2000. If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any waves or commotion tending to wash away cement or to disturb the fresh concrete in any way

4.2.9. Curing - When the concrete begins to harden i.e. two to three hours after compaction, the exposed surfaces shall be kept damp with moist gunny bags, sand or any other material approved by the engineer 24 hours after compaction, the exposed surface shall be kept continuously in damp or wet conditions by ponding or by covering with a layer of sacking, canvass, Hessian or similar absorbent materials and kept constantly wet for at least 7 days where ordinary Portland cement is used and 10 days, where Portland pozzolana

cement is used from the date of placing of concrete. For concrete work with other types of cement, curing period shall be as directed by the engineer.

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set

4.2.9.1 Freshly laid concrete shall be protected from rain by suitable covering.

4.2.9.2 Over the foundation concrete, the masonry work may be started after 48 hours of its compaction but the curing of exposed surfaces of cement concrete shall be continued along with the masonry work for at least 7 days. And where cement concrete is used as base concrete for flooring, the flooring may be commenced before the curing of period of base concrete is over but the curing of base concrete shall be continued along with top layer of flooring for a minimum period of 7 days.

4.2.10. Testing of concrete will be done as described in section on R.C.C

4.2.11. Form work - Form work shall be as specified in R.C.C section and shall be paid for separately unless otherwise specified.

4.2.12. Finishes - Plastering and special finishes other than those, obtained through form work shall be specified and paid for separately unless otherwise specified.

4.2.13. Measurements

4.2.13.1. Dimensions of length, breadth and thickness shall be measured correct to nearest cm. Except for the thickness of slab and partition which shall be measured to nearest 5 mm. Area shall be worked out to nearest 0.01 square meter and the cubic contents of consolidated concrete shall be worked out nearest 0.001 cubic meters. Any work done in excess over the specified dimension or as required by engineer is ignored.

4.2.13.2. Concrete work executed in the following conditions shall be measured separately

At or near the ground level

Work in liquid mud

c. Work in or under foul positions

4.2.13.3. Cast-in-situ concrete and or precast concrete work shall be measured in stages described in the item of work, such as -

At or near the ground level,

Up to specified floor level

Between two specified floor levels

Up to specified height above or depth below plinth level/ defined datum level  
Between two specified heights or depths with reference to plinth level / defined datum level

4.2.13.4. No deduction shall be made for the following -

- a. Ends of dissimilar materials for example beams, girders, rafters, purlins trusses corbels and steps up to 500sq. cm in cross sections.
- b. Opening up to 0.1sq meter (1000sq.cm).
- c. Volume occupied by pipes, conduits, sheathing etc. not exceeding 100sq cm each in cross sectional areas.
- d. Small voids such as shaded portions in Figure when these do not exceed 40sq cm each in cross section.

Note - In calculating area of opening, the thickness of any separate lintel or still shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

4.2.13.5. Cast-in-situ concrete shall be classified and measured as follows -

Foundation, footings, bases for columns

Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.

Shelves

Slabs

Chajjas including portions bearing on the wall

Lintels, beams and Bressemmers

Columns, piers abutments, pillars, post and struts

Stair case including stringer beams but excluding landings.

Balustrades, newels and sailing

Spiral staircase (including landing)

Arches

Domes, vaults

Shell roof, arch ribs and folded plates

Chimneys and shaft.

Breast walls, retaining, walls, return walls

Concrete filling to precast components

Kerbs, steps and the like

String or lacing courses, parapets, copings, bed block, anchor blocks, plain window sills and the like

Cornices and moulded windows sills.

Louvers, fins, fascia.

4.2.13.6. Precast cement concrete solid articles shall be measured separately and shall include muse of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position in cement mortar 1:2 (1 cement -2 coarse sand). Plain and moulded work shall be measured separately and the work shall be classified and measured as under -

Classification	Method of measurement
a. Wall panels In square meters stating the thickness	In square meters stating the thickness
b. String or lacing courses, coping, bed plats, plain windows sills, shelves, louvers, steps etc.	In cubic meters
c. Kerbs, edgings etc. In cubic meters	In cubic meters
d. Solid block work	In square meters stating the thickness or in cubic meters.
e. Hollow block work	In square meters stating the thickness or in cubic meters.
f. Light weight Partitions	In square meters stating the thickness or in cubic meters.

4.2.14. Rate - The rate is inclusive of the cost of labour and materials involved in all the operations described above.

### **ALUMINIUM WORK**

#### **Sl. No. IS Code Subject**

1. IS 733 : Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineering Purposes) -Specification
2. IS 737: Wrought Aluminium and Aluminium alloy sheet and strip for general engineering purposes -Specification
3. IS 1285: Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) - Specification
4. IS 1868: Anodic coating on Aluminium and its Alloys-Specification
5. IS 1948: Specification for Aluminium Doors, Windows and Ventilators

6. IS 3908: Specification for Aluminium equal leg angles
7. IS 3909: Specification for Aluminium unequal leg angles
8. IS 3965: Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.
9. IS 5523: Method of testing anodic coating on aluminium and its alloys.
10. IS 6012: Measurement of coating thickness by Eddy Current Method
11. IS 6315: Floor springs (Hydraulically regulated) for heavy doors- Specifications
12. IS 6477: Dimensions of extruded hollow section and tolerances
13. IS 12823: Wood products- Pre-laminated particle board –Specifications.
14. IS 14900: Transparent Float glass- Specifications

### **Aluminium Sections**

Aluminium sections used for fixed/openable windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in-Charge for technical, structural, functional and visual considerations. The aluminium extruded sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304.

The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and appearance of door and windows.

Aluminium glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings. The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminium work, with the approval of Engineer-in-Charge. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Engineer-in-Charge. If the sections are varied, the contractor shall obtain prior approval of Engineer-in-Charge and nothing extra shall be paid on this account.

### **Powder Coating**

**Material:** The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer-in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer-in-Charge or his authorized representative.

**Pre-treatment:** Each aluminium alloy extrusion or performed section shall be thoroughly cleaned by alkaline or acidic solutions under the conditions specified by chemical conversion coating supplier and then rinsed. A chemical conversion coating shall be applied by treatment with a solution containing essentially chromate ions or chromate and phosphate ions as the active components as applicable. The amount of

the conversion coating deposited depends on the type used by the conversion coating chemical supplier. The conversion coating shall be thoroughly rinsed either with the solution specified by the conversion coating chemical supplier or with de-mineralized water and then dried at the temperature for the time specified by the conversion coating chemical supplier. The contractor shall submit the detail specifications and application procedure for application of conversion coating for approval of Engineer-in-Charge. The metal surface after the conversion coating pretreatment and prior to the application of the coating shall be free from dust or powdery deposits

**Process:** The polyester powder shall be applied by electrostatic powder spray method. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The powder coating shall be applied as per the specification approved by Engineer-in-Charge.

**Thickness:** The thickness of the finished polyester powder coating measured by micron meter shall not be less than 50 micron nor more than 120 micron at any point.

**Performance Requirements for the Finish**

*Surface appearance:* The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours of different surfaces of same section.

*Adhesion:* When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

**Protection of Powder Coated / Anodizing Finish:** It is mandatory that all aluminium members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

**Measurement:** All the aluminium sections including snap beading fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment. (Weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

**Rate:** The rate shall include the cost of all the materials, labours involved in all the

operations as described in nomenclature of item and particular specification.

## **DOOR, WINDOW, VENTILATOR AND PARTITION FRAMES**

### **Frame Work**

First of all the shop drawings for each type of doors/windows/ventilators etc. shall be prepared by using suitable sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of glazed doors, windows, ventilators etc. The shop drawings shall also show the details of fittings and joints. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-Charge. Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual door/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site. The frames shall be truly rectangular and flat with regular shape corners fabricated to true right angles. The frames shall be fabricated out of section which have been cut to length, mitered and jointed mechanically using appropriate machines. Mitered joints shall be corner crimped or fixed with self tapping stainless steel screws using extruded aluminium cleats of required length and profile. All aluminium work shall provide for replacing damaged/broken glass panes without having to remove or damage any member of exterior finishing material.

### **Fixing of Frames**

The holes in concrete/masonry/wood/any other members for fixing anchor bolts/ fasteners/ screws shall be drilled with an appropriate electric drill. Windows/ doors/ ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed, counter sunk and matching size groove. of required size at spacing not more than 250 mm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. Engineer-in-Charge in his sole discretion may allow the units to be assembled in their final location if the situation so warrants. Snap beadings and EPDM gasket shall be fixed as per the detail shown in the shop drawings.

Where aluminum comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electrochemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The contractor shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

### **Measurements**

All the aluminium sections including snap beadings fixed in place shall be measured in

running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

**Rate**

The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification.

**FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES**

Door Frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up or resin transfer moulding process. The process shall consist of laying gel coat at 1000 gms./m<sup>2</sup> and laid over with layer of FRP Mat (CSM mat) gel coat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isobathic resin and fillers & additives) by weight. The edge shall be sealed with gel coat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat. FRP door shall be manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

**Tolerance**

Tolerance of size of frame to be + 2 mm and on size of rebate to be + 1 mm.

**Finish**

The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

**Fixing of Frames**

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untilled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from



the floor. The third anchor bolt shall be fixed in the centre. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

**Measurement**

The outer length of the vertical and horizontal members of door frame shall be measured in running meters including embedded length in floor corrected up to a cm.

**Rate**

The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately.

**FIBRE GLASS REINFORCED PLASTIC (F.R.P.) SHUTTERS**

F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge. Blocks of any seasoned hardwood of bulk density not less than 450 kg./m<sup>3</sup> at 12 percent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as AL drops, tower bolt, handle, sliding door bolt, mortise lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the center and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortise locks, tower bolts, AL drops, door closures, etc. The finished surface shall be buffed and polished with wax.

**Location of Fittings and Accessories**

The lock rail of door shutters shall be so placed that its centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminum.

**Sampling & Criteria for Conformity**

The test specimens shall not have been exposed to a temperature below 40°C for 24 hours immediately preceding the test and shall be free from all visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded. If any test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

**Sampling**

criteria for conformity shall be in accordance with IS 4020 (Part -I) Lot in any consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to form a lot. The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Table.

**TABLE****No. of Sample and Criteria for Conformity**

<i>Sl. No.</i>	<i>Sample size</i>	<i>Permissible No. of Defects</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>
26 to 50	8	1
51 to 100	13	1
101 to 150	20	1
151 to 300	32	1
301 to 500	50	2
501 and above	80	2

**Note:** For lot size 25 or less, number of samples to be taken for testing shall be as agreed to between the manufacturer & Engineer-in-Charge. *Number of Tests:* The samples selected as in column 2 of Table shall be as agreed to between the manufacturer & Engineer-in-Charge. *Criteria for Conformity:* The lot shall be considered conforming to the requirements if the number of samples failing to satisfy the requirements of characteristics does not exceed the permissible number mentioned in col. 3.

**Finish**

The surface of the molded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

**Tests**

The door shutters shall be subjected to the following tests in accordance with IS 4020(Part1to 16)

**Fixing of Shutter** Door shutter shall be side hung on three bolt hinges of size 100 mm, one at the center and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel

**Tolerance**

The tolerance on the width and the height of the door shall be + 5 mm and the tolerance on the nominal thickness of the door shall be + 2 mm.

**Measurement**

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

#### **Rate**

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter.

Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

### **FITTINGS AND FIXTURES**

#### **Scope of Work**

The work covered under these specifications consist of supplying different types of fittings and fixtures required for doors, windows, ventilators etc. The supply shall be in accordance with the specification, drawings / approved samples. Samples of various fittings and fixtures proposed to be incorporated in the work shall be submitted by the contractor for approval of the Engineer-in-charge before order for bulk supply is placed.

#### **General**

All fittings and fixtures shall conform to relevant IS code and made with approved materials as specified. These shall be well made reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be counter sunk to suit the heads of the specified screws. All riveted heads pertaining to hinge pins shall be well formed. Screws supplied for fittings shall be of the same metal and finish as the fittings. Samples of each fixture/ fitting shall be furnished by the contractor for approval of the Engineer-in-Charge. Order for procurement of fittings and fixtures in bulk shall be placed only after approval by the Engineer-in-Charge.

The fittings and fixtures to be incorporated in the work shall be strictly according to the approved sample. Fittings shall be fixed in proper position as shown in the drawing and as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with a screwdriver and not hammered in. Recess shall be cut to the exact size and depth for the counter sinking of hinges. The fittings and fixtures shall be fixed in a workman like manner and any damages done either to fittings and fixtures or to the shutter frames etc. should be rectified by the contractor at his own cost.

Fittings shall be of Stainless steel or as specified. The fittings shall be well made, smooth, and free from sharp edges and corners, flaws and other defects.

Stainless steel fittings shall be non-magnetic, rust & moisture proof, strong & sturdy. Pin of hinges shall also be of stainless steel.

#### **Measurement**

All the fittings with all the necessary accessories shall be measured in numbers and the rate shall include the cost of all materials, loading, unloading, transporting, cost of screws, bolts and other accessories complete, fixing charges etc complete .

**Rate**

The rate shall include the cost & conveyance of all materials as above, and labour involved in all the operations including, installation, lead, lift etc complete as directed by Engineer in Charge.

**DISMANTLING AND DEMOLITION****General**

The term dismantling implies carefully taking up or down and removing without damage.

This shall consist of dismantling one or more parts of the building as specified or shown on the drawings.

The term Demolition implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on drawings.

**Precautions**

Necessary propping, shoring and /or underpinning shall be provided for the safety of the adjoining work or property, which is to be left in tact, before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property.

Wherever required, temporary enclosures or partitions/barricades shall also be provided.

Necessary precautions shall be taken to keep the dust- nuisance down as and when necessary.

Dismantling shall be commenced in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roofs, masonry etc., shall be carefully dismantled first. The dismantled articles shall be passed by hand where necessary and lowered to the ground and not thrown. The materials then be properly stacked as directed by the Engineer-in-charge. Methodology of dismantling shall be got approved in toto by Engineer-in-charge prior to take up work at site.

All materials obtained from dismantling or demolition shall be the property of Client unless otherwise specified and shall be kept in safe custody until handed over to the Engineer-in-charge.

Any serviceable material, obtained during dismantling or demolition shall be separated out and stacked properly as indicated by the Engineer-in-charge within a lead of 150m, or as specified in the item. All under serviceable materials, rubbish etc., shall be disposed off as directed by the Engineer-in-charge.

**Treatment**

All the dismantled area shall be rendered clean off all debris, dust etc. The sides of jambs, sills, soffits etc., of the openings if any, after taking out doors and window chowkhats, unless and otherwise to be treated, shall be plastered in C.M 1:3 with neeru finish to render true sides, corners, edges etc. Reinforcement shall be cut either by hacksaw or gas cutting as approved by Engineer-in-charge. All services shall be disconnected prior to taking up

job.

### **Rates**

The rate shall include cost of all such operations mentioned above including necessary labour, materials, transport, scaffolding, stacking the serviceable materials, disposing the unserviceable materials within the lead specified, all as directed by the Engineer-in-charge.

## **STEEL WORK**

### **TUBULAR / HOLLOW SECTION FOR TRUSSES & FRAMES**

#### **Structural Steel Tube**

These shall be of:

1. Hot finished welded (HFW) type, or
2. Hot finished seamless (HFS) type, or
3. Electric resistance or induction butt welded (ERW), YST 310  
Conforming to the requirement of IS 4923. Tubes shall be designed by their nominal bore. These shall be light, medium or heavy as specified depending upon the wall thickness. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut clean and square with axis of tube, unless otherwise specified.

#### **Minimum Thickness of Metals**

Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm and for construction not exposed to weather it shall be not less than 3.2 mm where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

#### **Fabrication**

The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are, maintained. The tubular steel work shall be painted with one coat of approved steel primer after fabrication. All fabrication and welding is to be done in an approved workshop. The joint details shall be generally as per S.P-38 of B.I.S publication.

#### **Straightening**

All material before being assembled shall be straightened, if necessary, unless required to be of curvilinear form and shall be free from twist.

#### **Bolting**

Washers shall be specially shaped where necessary, or other means, used to give the nuts and the heads of bolts a satisfactory bearing.

In all cases, where the full area of the bolts is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together and washers of appropriate thickness shall be provided to allow the nuts to be completely tightened.

#### **Welding**

Where welding is adopted, it shall be as per IS 816.

### **Caps and Bases for Columns**

The ends of all the tubes, for columns transmitting loads through the ends, should be true and square to the axis of the tubes and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

### **Sealing of Tubes**

When the end of a tube is not automatically sealed by virtue of its connection by welding to another member the end shall be properly and completely sealed. Before sealing, the inside of the tubes should be dry and free from loose scale.

### **Flattened Ends**

In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded, riveted or bolted connections provide that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

### **Hoisting and Erection**

Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workman. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-charge. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

### **Measurements**

The work as fixed in place shall be measured in running metres correct to a centimeter on their weights calculated on the basis of standard tables correct to the nearest kilogram unless otherwise specified. Weight of cleats, brackets, packing pieces bolts nuts, washers distance pieces separators diaphragms gussets (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

### **Rate**

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

### **Providing and fixing inserts in concrete works**

Inserts are required to be fixed/embedded as indicated in construction drawings and/or as directed by Engineer-in-charge in foundations, columns and other miscellaneous concrete works. These inserts comprise plates, angles, pipe sleeves, anchor bolt assemblies, etc.

The rate quoted by the Tenderer shall hold good for accurately fixing the inserts at the correct levels/alignment and shall include for the cost of any temporary or permanent supports/anchors such as bars including cutting, bending, welding, etc. as required.

Steel templates shall be used by Contractor to locate and very accurately position bolts, group of bolts, inserts, embedded parts, etc. at his cost. Such templates shall be

previously approved by the Engineer. Templates shall invariably be supported such that the same is not disturbed due to vibration, movement of labourers, materials, shuttering work, reinforcement, etc. while concreting. The Contractor will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at the locations of inserts as directed by the Engineer at no extra cost to OWNER. If the Engineer so directs, the inserts will have to be welded to reinforcement to keep them in place. Contractor shall be responsible for the accuracy of dimensions, levels, alignments and centre lines of the inserts in accordance with the drawings and for maintenance of the same until the erection of equipment/structure or final acceptance by Owner.

Contractor shall ensure proper protection of all bolts, inserts, etc. from weather and other damages by greasing or other approved means such as applying white lead putty and wrapping them with gunny bags or canvas or by other means as directed by Engineer to avoid damage due to movement of his labourers, material, equipment, etc. No extra claim from the Contractor on this account shall be entertained. Contractor shall be solely responsible for all the damages caused to bolts, inserts, etc. due to his negligence and in case damages do occur, they shall be rectified to the satisfaction of Engineer at the Contractor's cost.

#### **Steel Work In Built Up Sections (Riveted and Bolted)**

The steel work in built up section (Riveted and bolted) such as trusses, framed work etc. is specified in this clause.

#### **Laying Out**

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the Engineer-in-Charge. Steel tape shall be used for measurements.

#### **Fabrication**

Fabrication shall generally be done as specified in IS 800. In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details or rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-charge. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints. Wooden or metal sheet templates shall be made to correspond to each member, and position of rivet holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions. The base of steel

columns and the positions of anchor bolts shall be carefully set out at the required location. The steel section shall be straight or to be straightened or flattened by pressure unless required to be of curvilinear form and shall free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No tow pieces shall be welded or joined to make up for the required length of member.

**Making Holes:** Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

#### **Rivet Holes**

The diameter for rivets and black bolts holes shall be taken as the nominal diameter of a rivet/ black bolts plus 1.5 mm for rivets/ bolts of nominal diameter less than or equal to 25mm" and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts. Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process.

Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

**Assembly :** Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall be fixed (or placed) tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover flange plates, shall have their ends flush with the tops of angles unless otherwise required. The web plate when spliced, shall have clearance of not more than 5mm. The erection clearance of cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, seating designed suitably shall be provided.

Column splices and butt joints of struts and compression members *requiring* contact for tress transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not



unduly reduced in thickness by machining. The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

**Riveting:** Rivets shall be used, where slip under load has to be avoided. Preliminaries before Riveting's:- Members to be riveted shall have all parts firmly placed and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

#### Process of Riveting

The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the Engineer-in-charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than 10mm may be driven cold. Rivets shall be finished neat with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly. All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (Specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar where so specified, other tests shall be carried out to ensure the soundness of rivets. All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

**Bolting :** The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly. Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nut, spring

washers as directed by the Engineer-in-charge.

### **Erection**

Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-charge in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

The work of erection may be done in suitable units as may be directed by the Engineer-in-Charge. Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over-turning or collapse by suitable means. During execution, the steel members shall be securely bolted or otherwise fastened when necessary temporarily braced to provide for all loads including those due to erection equipment's and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.

Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible. The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For larger spans the truss shall be provided with proper bearing as per design.

Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3(1 cement: 3 coarse sand) or as specified.

**Bedding of Column, Stanchions etc.:-** Bedding shall not be carried out until the steel work has been finally levelled, plumbed and connected together. The stanchion shall be

supported on steel wedges and adjusted to make the column plumb. For multistoried buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made upto 25 mm which shall be pressure grouted with cement grouts. With small columns, if permitted by the Engineer-in-charge, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

### **Painting**

Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified

### **Measurements**

The work as fixed in position shall be measured in running metres correct to a millimeter and their weight calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower than permissible variation shall not be acceptable.

Unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivet heads. Unless otherwise specified and addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m<sup>2</sup>. The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m<sup>2</sup> for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

### **Rate**

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

### **STEEL WORK IN BUILT UP SECTION (WELDED)**

The steel work in built up sections (welded) such as in trusses, form work etc. is specified in this clause.

### **Laying out**

It shall be as specified.

**Fabrication**

Straightening, shaping to form, cutting and assembling, shall be as per 10.3.2 as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

**Welding :** Welding shall generally be done by electric arc process as per IS 816 and IS 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only be resorted to using oxyacetylene flame with specific approval of the Engineer-in-charge. Gas welding shall not be permitted for structural steel work Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses. The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813. As far as possible every efforts shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

**Precautions:** All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

Operation, Workmanship and process of Welding is described in Appendix B, Inspection and testing of welds shall be as per IS 822.

**Assembly:** Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

**Erection:** The specification shall be as described except that while erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the

temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed. 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

**Painting :** Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified.

**Measurements:** The mode of measurements shall be the same as specified except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

### **Rate**

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

### **Providing and fixing in position grill, railing, steel ladder, etc.**

This work shall be carried out as per the detailed drawings. The MS sections shall be of approved quality. The welding shall be perfect and the junctions shall be ground properly. The frames shall be provided with hold fasts and the same shall be grouted with CC blocks in brick work. It shall be painted with two coats of zinc chromate primer and two coats of synthetic enamel paint of approved make and colour.

### **Providing & Fixing MS holding down bolts**

The MS holding down bolts of specified dia, length and shape shall be provided as per the drawings in line & level. These shall be fixed to RCC work or brick work by grouting it with concrete. The bolt shall be provided with nuts and washers. The grease shall be applied to the threaded portion with the help of templates. If the bolts need some adjustment it shall be provided with a wooden piece 75x75 mm or 50 mm dia GI pipe around bolt shall be provided at the time of concreting and shall be removed after initial set.

### **STAINLESS STEEL WORK**

The Stainless steel railing pipes, hardware's & accessories of specified grade to be supplied and installed at site as per the above mentioned specifications as per BOQ , drawings and approved by the Engineer-in-Charge.

#### Material Properties:

The material properties of stainless steel pipes and accessories should be conforming to SS 316 grade.

#### Stainless Steel Works

The stainless steel pipes shall be procured from approved manufacture and of approved grade. The quality of stainless steel sheet and pipe shall be approved by Client/Consultant before proceeding with execution any item of work.

#### Hand Rail

The pipe used for handrail shall be of 14 gauge thick. The welded links are to be ground and organ buffed to get the original finish of the surface of the material welded. The joints or junctions where two pieces are joined/welded to be precisely cut and then welded.

#### Surface Finish

Surface finish of all the stainless steel materials will be satin finish free from all marks and blemishes.

#### Execution

The execution shall be carried out at site respectively as per the BOQ and drawings.

#### Accessories

Fixing will be done by stainless steel bolts and joining shall be with SS connectors of approved type, size and make as per direction of Engineer-in-charge and welding to be done by using organ welding rods and the surface being duly finished and cleaned by  $K_2$  passivation, which is nitric acid plus fluoric acid solution treatment by which the chances of corrosion will be eliminated and any burn out makes on the metal will also be eliminated.

#### Final Cleaning:-

Protective coating and warning markings shall remain undisturbed until final acceptance. Immediately prior to final inspection, temporary protective covering or coating shall be removed and surfaces shall be washed with a suitable thinner and left in a finished condition having approved uniform appearance and free from all marks and blemishes.

#### Fabrication & Tolerances

Unless otherwise shown on the drawing, the fabricating tolerances shall generally be as follows:

**Straightness:** Compression members shall not deviate from straightness by more than 1/1000 of the axial length between points, which are to be laterally supported.

Completed members shall be free from twist bends and open joints. Sharp links or bends shall be cause for rejection of material.

**Length:** of 1mm is permissible in the overall length of members with parts of the structure, shall have a variation for the detailed length not greater than 2mm for members 10 meters or less in length and not greater than 3mm for members over 10 meters in length.

**Inspection:-**

The Agency should arrange for factory inspection of all stainless steel material and glass to ascertain the quality of material i.e. stainless steel fixtures / accessories and glass as per manufacturer's standard / BIS / ASTM standard as per specification to the satisfaction of Engineer in charge.

#### **Measurement**

The work as fixed in place shall be measured in running metres correct to a centimeter on their weights calculated on the basis of standard tables correct to the nearest kilogram unless otherwise specified & Rates shall be inclusive of all stainless steel pipes and fittings required vertically or horizontally per running meter of composite section of railing including all stainless steel components complete as per the BOQ as required. Glass railing shall be measured in running meter.

#### **Rate**

The rate shall include the cost of all materials like,Stainless Steel pipes, Stainless steel fitting & accessories, other fixing material ,T & P, scaffolding and labour involved in all the operations

described above including fixing/installation, lead & lift etc. as applicable.

### **CERAMIC TILES IN FLOORING, SKIRTING AND DADO**

The ceramic tiles in flooring and dado shall be of first class quality as specified in the item specification and shall be approved by the Engineer. The tiles shall be of standard size without warp and with straight edges, true and even in shape and size and of uniform colour. The tiles surface shall be of fine grained texture, dense and homogeneous. The thickness of the tile shall be as per the item specification. The tiles shall be submerged in water till the bubbles cease.

They should be laid on a base of 12 mm thick mortar bed (cement or lime 1:3 sand) and cement (3 kg/sq.m) paste. They shall be laid truly vertical on walls and truly horizontal on floors or to slopes as directed. The joint shall be very thin, uniform and perfectly straight. The tiles in dado shall be finished in such a way that, only the tile thickness projects over the finished plaster or as specified otherwise. Where full tiles are not possible, the same should be cut or sawn to the required size and their edge rubbed to ensure straight and true joints. After the tiles are laid extra cement grout shall be removed. The joints shall be cleaned with wire brush and then the joint shall be floated with white or grey cement as approved by the Engineer. The tiles shall be cleaned after the work is complete.

#### **Measurement**

Measurements shall be taken correct to a cm in length and breadth and correct to 0.5 cm in thickness.

#### **Rate**

The rate shall include the cost and conveyance of all materials and labour involved in all the operations described above including the cost of material with wastage if any, cost of adhesive, cost of jointing with epoxy grout, rubbing, lead, lift etc. as applicable.

### **MANHOLE COVERS & FRAMES**

#### Manhole Covers

The covers and frames shall conform to IS 1726 for cast Iron and IS 12592 for pre-cast concrete covers and shall be of the following grades and types. Grades Grade Type/shape of



cover Designation Light Duty LD - 2.5 Rectangular, Square, Circular Medium Duty MD - 10 Rectangular, Circular and Square (for pre-cast concrete manhole covers) Heavy Duty HD - 20 Circular-Square, Rectangular, (Scraper Manhole) Extra Heavy Duty EHD - 35 Circular, Square, Rectangular, (Scraper Manhole)

### **Cast Iron Manhole Covers and Frames**

- (i) Manhole covers and frame shall be manufactured from appropriate grade of grey cast iron not inferior than FG150 grade of IS 210.
- (ii) They shall be cleanly cast and shall be free from air and sand holes, cold shuts and warping.
- (iii) Covers shall have on its operative top a raised chequered design to provide for an adequate no-slip grip. The rise of chequers shall be not less than 4mm.
- (iv) Key holes, keys and lifting devices shall be provided in the manhole covers to facilitate their placement in the frames and their operative maintenance.
- (v) Manhole covers and frames shall be coated with materials having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.
- (vi) Size and shape and performance requirement of manhole covers and frames shall conform to IS 1726.
- (vii) Each manhole covers and frame shall have cast on them the following information:
  - (a) Manufacturer's name or trade-mark
  - (b) Grade designation
  - (c) Date of manufacturer
  - (d) The words SWD or 'Sewer' to denote 'storm water drain' or 'sewer' respectively
  - (e) Identification marks as required by Engineer-in-Charge.
- (viii) The cover shall be gas tight and water tight.
- (ix) The sizes of covers specified shall be taken as the clear internal dimensions of the frame.
- (x) The approximate weight of the various type of manhole covers and frames shall be as per IS 1726.
- (xi) The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

#### **Measurements:**

The manhole covers shall be enumerated under relevant items.

#### **Rates:**

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

### **MOISTURE RESISTANT/FIRE RESISTANT 6 MM THICK FIBER CEMENT BOARD**

**Nominal Length and Width**

Flat fibre cement sheets shall be available in nominal lengths up to 3 000 mm and nominal widths up to 1240 mm.

**Min. Modulus of Rupture:** For 6mm & 9mm :13MPA

**Thickness:** Flat fibre cement sheets shall be 6, 8, 9mm.

**Tolerances on Dimensions:** Tolerances on nominal dimensions shall be as follows:

(a) On length and width (indicated by d)

$d < 1000 \text{ mm} : \pm 5\text{mm}$

$1000 \text{ mm} < d < 1600 \text{ mm} : \pm 0.5 \text{ percent}$

$d > 1600 \text{ mm} : \pm 8\text{mm}$

These tolerances do not apply to oversize sheets.

(b) On thickness, e :

$e < 6\text{mm} : \pm 0.6\text{mm}$

$e > 6\text{mm} : \pm 10\text{percent}$

For sheets without texture on the exposed face, the maximum difference between extreme values of the thickness measurements within one sheet shall not exceed 15 percent of the maximum measured value.

**Tolerances on Shape**

**Straightness of edges:** The tolerance on the straightness of edges shall be 3 mm/m for the relevant dimension (length or width) when measured in accordance with the method given

**Squareness of edges:** The tolerance on the squareness of sheets shall be 4 mm/m when measured in accordance with the method given.

**Acceptance Tests**

The objective of an acceptance test is to establish whether a batch of products conforms to a specification. The tests shall be performed on samples drawn either from continuous production or from a consignment (see also 8). The acceptance test shall be carried out at the manufacturer's works on sheets and test specimens cut from sheets as delivered. The following acceptance tests shall be carried out:

(a) Dimensional and geometrical characteristics (compulsory) ,

(b) Bending strength (compulsory) , and

(c) Apparent density (compulsory).

**Method for testing:** As per IS 14862 2000

**Fixing**

Fixing the moisture resistant/ fire resistant 6mm thick fibre cement board (High Pressure Steam cured) with necessary accessories & GI self drilling/ tapping screws etc., of required size (Screws shall be of counter sunk rib head of 1.60mm to 4 mm thick of 8 to 10 gauge of length varying from 25 to 45 mm), and filling the groove (i.e. 2-3mm gap between boards), taping and jointing of the first layer 6mm and 9mm thick fiber cement boards with epoxy based sealing compound or with silicon sealant. Second layer is fixed over it in a

staggered pattern, with suitable arrangement as per approval of Engineer-in-charge.

**Measurement:**

The length and breadth of fibre cement board shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

**Rate:**

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangement i.e. drilling, nut & bolts, filling groove etc.

**REPAIRS TO PLASTER**

The work includes cutting the patch and preparing the wall surface. Patches of 2.50 square metres and less in area shall be measured under item of 'Repairs to Plaster' under this sub-head. Plastering in patches over 2.5 square metres in area shall be paid for at the rate as applicable to new work under sub head 'Finishing' in CPWD specifications 2019.

**Scaffolding**

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder or jhoola these will be permitted in place of scaffolding.

**Cutting**

The mortar of the patch, where the existing plaster has cracked, crumbled or sounds hollow when gently tapped on the surface, shall be removed. The patch shall be cut out to a square or rectangular shape at position marked on the wall as directed by the Engineer-in-Charge or his authorized representative. The edges shall be slightly under cut to provide a neat joint.

**Preparation of Surface**

The masonry joints which become exposed after removal of old plaster shall be raked out to a minimum depth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking shall be carried out uniformly with a raking tool and not with a basuli, and loose mortar dusted off.

The surface shall then be thoroughly washed with water, and kept wet till plastering is commenced. In case of concrete surfaces, the same shall be thoroughly scrubbed with wire brushes after the plaster had been cut out and pock marked as described in 13.1.2 of CPWD specifications 2019. The surface shall be washed and cleaned and kept wet till plastering is commenced.

**Application of Plaster**

Mortar of specified mix with the specified sand shall be used. The method of application shall be as described for single coat plaster work of the specified mix and under Chapter 13 of CPWD specifications 2019. The surface shall be finished even and flush and matching with the old surrounding plaster. All roundings necessary at junctions of walls, ceilings etc. shall be carried out in a tidy manner as specified in sub-head 13.0 of CPWD specifications 2019.

All dismantled mortar & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.

#### **Protective Measure**

Doors, windows, floors, articles of furniture etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages, if any, to furniture or fittings and fixtures shall be recoverable from the contractor.

#### **Curing**

Curing shall be done as per plaster work with special reference to the particular type of plaster mix as described under sub-head 'finishing'.

#### **Finishing**

After the plaster is thoroughly cured and dried the surface shall be white washed or colour washed to suit the existing finishing as required unless specified.

#### **Measurements**

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Patches below 0.05 square metre in area shall not be measured for payment. Pre- measurements of the patches to be plastered shall be recorded after the old plaster has been cut and wall surface prepared.

#### **Rate**

The rate includes the cost of all the materials and labour involved in all the operations described above including lead as described in the item for disposal of old dismantled plaster /material.

### **4.5 SPECIFICATIONS FOR READY MIXED CONCRETE**

4.5.1 Ready Mixed Concrete - Concrete delivered at site or into the purchaser's vehicle in a plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden.

4.5.1.1 Agitation-The process of continuing the mixing of concrete at a reduced speed during transportation to prevent segregation.

4.5.1.2 Agitator-Truck mounted equipment designed to agitate concrete during transportation to the site of delivery.

4.5.1.3 Truck Mixer-A mixer generally mounted on a self-propelled chassis, capable of mixing the ingredients of concrete and of agitating the mixed concrete during transportation.

#### **4.5.2 Types**

For the purpose of this standard, the ready-mixed concrete shall be one of the two types, according to the method of production and delivery as specified in 4.5.3.1 and 4.5.3.2.

4.5.2.1 Centrally-mixed concrete – Concrete produced by completely mixing cement, aggregates, admixtures, if any and water at a stationary central mixing plant and delivered in containers fitted with agitating devices, except that when so agreed to between the purchaser and the manufacturer, the concrete may be transported without being agitated.

4.5.2.2 Truck-mixed concrete - Concrete produced by placing cement, aggregates and admixtures, if any, other than those to be added with mixing water, in a truck mixer at the batching plant, the addition of water and admixtures to be added along with mixing water, and the mixing being carried out entirely in the truck mixer either during the journey or on arrival at the site of delivery. No water shall be added to the aggregate and cement until the mixing of concrete commences.

#### 4.5.3. Materials

4.5.3.1 Cement - The cement used shall be ordinary Portland cement or low heat Portland cement conforming to IS: 269-1989 or 8112-1989 or 1226:1987 or Portland slag cement conforming to IS: 455-1989 or 'Portland-pozzolana cement conforming to IS: 1489-1991 or rapid hardening Portland cement conforming to IS: 8041-1976 as may be specified by the purchaser at the time of placing the order. If the type is not specified, ordinary Portland cement shall be used.

Fly ash when used for partial replacement of cement, shall conform to the requirements of IS:3812 -1981

4.5.3.2. Aggregates - Unless otherwise agreed to between the purchaser and the manufacturer, the aggregates shall conform to IS: 383-1970. Fly ash when used as fine aggregate shall conform to the requirements of IS: 3812-1981.

4.5.3.3. Water used for concrete shall conform to the requirements of IS: 456-2000.

4.5.3.4, Admixtures – Admixtures shall only be used when so agreed to between the purchaser and the manufacturer. The admixtures shall conform to the requirements of IS: 456-2000, and their nature, quantities and methods of use shall also be specified. Fly ash when used as an admixture for concrete shall conform to IS: 3812-1981.

4.5.3.5, Measurement and storage of materials – Measurement and storage of materials shall be done in accordance with the requirements of IS: 456-2000.

#### 4.5.4 Basis of supply

4.5.4.1 Depending upon the agreement between the purchaser and the manufacturer, the ready-mixed concrete shall be manufactured and supplied on either of the following basis:

a) Specified strength based on 28-day compressive strength of 15-cm cubes tested in accordance with IS: 456-2000.

b) Specified mix proportion.

Note - Under special circumstances and subject to the agreement between the purchaser and the supplier, strength of concrete in (a) above may be based on 28-day or 7-day flexural strength of concrete instead of compressive strength of 15-cm cube tested in accordance with IS: 456-2000.

When the concrete is manufactured and supplied on the basis of specified strength, the responsibility for the design of mix shall be that of the manufacturer and the concrete shall conform to the requirements.

When the concrete is manufactured and supplied on the basis of specified mix proportion, the responsibility for the design of the mix shall be that of the purchaser and the concrete shall conform to the requirements.

#### 4.5.4.2 Measurement of Ready-mixed concrete

The basis of purchase shall be the cubic meter of plastic concrete as delivered to the purchaser.

The volume of plastic concrete in a given batch shall be determined from the total mass of the batch divided by the actual mass per  $\text{m}^3$  of concrete. The total mass of the batch shall be calculated either as the sum of the masses of all materials, including water, entering the batch or as the net mass of concrete in the batch as delivered. If the purchaser wishes to verify the total mass, of the batch, this shall be obtained from the gross and tare masses of the vehicle on a stamped weigh bridge. The mass per  $\text{m}^3$  shall be determined in accordance with the method given in IS:1199-1959.

#### 4.5.5 General requirements

4.5.5.1. In addition to the requirements specified in this standard and subject to such modifications as may be agreed to between the purchaser and the manufacturer at the time of placing order, the ready-mixed concrete shall generally comply with the requirements of IS:456-2000.

Unless otherwise agreed to between the purchaser and the supplier, the minimum quantity of cement and the details regarding proportioning and works control shall be in accordance with IS:456-2000.

When a truck mixer agitator is used for mixing or transportation of concrete, no water from the truck-water system or from elsewhere shall be added after the initial introduction of the mixing water for the batch, except when on arrival at the site of work, the slump of the concrete is less than that specified; such additional water to bring the slump within required limits shall be injected into the mixer under such pressure and direction of flow that the requirements for uniformity specified in Appendix. A are met.

Unless otherwise agreed to between the purchaser and the supplier, when a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of work

and discharge shall be complete within 1½ hour (when the prevailing atmospheric temperature is above 20° C) and within 2 hours (when the prevailing atmospheric temperature is at or below 20° C) of adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the aggregate, whichever is earlier.

4.5.5.2 Temperature - The temperature of the concrete at the place and time of delivery shall be not less than 5° C. Unless otherwise required by the purchaser, no concrete shall be delivered, when the site temperature is less than 2.5° C and the thermometer reading is falling.

The temperature of the concrete shall not exceed 5° C above the prevailing shade temperature, when the shade temperature is over 20° C. The temperature of concrete mass on delivery shall not exceed 40° C.

4.5.5.3. Sampling and testing - Adequate facilities shall be provided by the manufacturer for the purchaser to inspect the materials used, the process of manufacture and the methods of delivery of concrete. He shall also adequate facilities for the purchaser to take samples of the materials used.

Unless otherwise agreed to between the purchaser and the supplier, the sampling and testing of concrete shall be done in accordance with the relevant requirements of IS: 456-2000, IS:1199-1959 and IS: 516-1959

Consistency or workability - The tests for consistency or workability shall be carried out in accordance with requirements of IS: 1199-1959 or by such other method as may be agreed to between the purchaser and the manufacturer.

4.5.5.4. Strength test - The compressive strength, and flexural strength tests shall be carried out in accordance with the requirements of IS: 516-1959 and the acceptance criteria for concrete whether supplied on the basis of specified strength or on the basis of mix proportion, shall conform to the requirements mentioned below.

Compressive strength - The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:

- a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of Table.
- b) Any individual test result complies with the appropriate limits in col.3 of Table.

Flexural strength - When both the following conditions are met, the concrete complies with the specified flexural strength.

- a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm<sup>2</sup>.

b) The strength determined from any test result is not less than the specified characteristic strength less  $0.3 \text{ N/mm}^2$ .

4.5.5.5. Quantity of concrete represented by strength test results - The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in col.2 of Table 9 or in item (b) of 16.2 only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to  $60\text{m}^3$ .

If the concrete is deemed not to comply, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

Concrete of each grade shall be assessed separately.

Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the engineer-in-charge.

Table 9 Characteristic compressive strength compliance requirement

Specified Grade	Mean of Group of 4 Non-Overlapping Consecutive Test Results in $\text{N/mm}^2$ .	Individual Test Results in $\text{N/mm}^2$ .
(1)	(2)	(3)
M15	$+0.825 \times$ established standard deviation (rounded off to nearest $0.5 \text{ N/mm}^2$ ).	$\geq f_{ck}$ $\text{N/mm}^2$ .
M 20 or above	$+ 3 \text{ N/mm}^2$ , whichever is greater $+ 0.825 \times$ established standard deviation (rounded off to nearest $0.5 \text{ N/mm}^2$ ) or $+4 \text{ N/mm}^2$ , whichever is greater	$\geq f_{ck}$ $\text{N/mm}^2$ .
Note:- In the absence of established value of standard deviation, the value given in Table 8 of IS:456-2000 may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.		

4.5.5.6 Cost of testing – Unless otherwise agreed to between the purchaser and the manufacturer, the cost of the tests carried out in accordance with the requirements of this specification shall be borne as follows:



a) By the manufacturer if the results show that the concrete does not comply with the requirements of this standard.

b) By the purchaser if the results show that the concrete complies with the requirements of this standard.

4.5.5.7 Manufacturer's records and certificates – The manufacturer shall keep batch records of the quantities by mass of all the solid materials, of the total amount of water used in mixing and of the results of all tests. If required by the purchaser, the manufacturer shall furnish certificates, at agreed intervals, giving this information.

4.5.6. Concrete manufactured and supplied on the basis of specified strength

4.5.6.1 The purchaser shall supply the following information for guidance of the manufacturer :

a) The type of cement to be used;

b) The maximum size and type of the aggregate;

c) The type of admixtures to be used;

d) The minimum acceptable compressive strength of flexural strength or both, determined from samples of plastic concrete taken at the place and time of delivery, in accordance with requirements of IS:456-2000.

e) The slump or compacting factor or both, or other requirements for consistency or workability at the place and time of delivery of the concrete;

f) The ages at which the test cubes or beams are to be tested, and the frequency and the number of tests to be made; and

g) Any other requirements.

4.5.6.2 Tolerances – Unless otherwise agreed to between the purchaser and the manufacturer, the concrete shall be deemed to comply with the requirement of these standard, if the results of tests where applicable, lie within the tolerances specified.

4.5.6.3. Consistency of workability – The slump (average of two tests) shall not differ from the specified value by  $\pm 10$  mm for a specified slump of 75mm or less and  $\pm 25$ mm when the specified slump is greater than  $\pm 75$ mm. The compacting factor average of two tests shall be within 0.03 of the value specified. If any other method of determining consistency is to be used, a suitable tolerance shall be agreed to between the purchaser and the manufacturer. The test for consistency or workability shall be completed within 15 minutes of the time of receipt of the ready-mixed concrete at the site.

4.5.6.4. Aggregates – When tested in accordance with IS: 2386(Part I)-1963, the quantity of aggregate larger than the maximum size specified by the purchaser shall not exceed 5

percent of the quantity of coarse aggregate and all such excess shall pass through sieve (conforming to IS: 460 (Part 1-3)-1985 of the next higher size.

4.5.7. Concrete manufactured and supplied on the basis of mix proportion

4.5.7.1 The purchaser shall supply the following information for guidance of the manufacturer:

- a) The type of the cement to be used;
- b) The sizes and types of the aggregate;
- c) The type of admixtures to be used;
- d) The proportions of the mix including the maximum water cement ration at the place and time of delivery of the concrete;
- e) The minimum mixing time after addition of the water; and
- f) Any other requirements.

Tolerances – Unless otherwise agreed to between the purchaser and the manufacturer, the concrete shall be deemed to comply with the requirements of this standard, if the result of tests where applicable, lie within the tolerance specified.

Cement content – The cement content, as shown by the samples taken, shall be not less than 95 percent of that specified.

Ratio of coarse to fine aggregates – The ratio of coarse to fine aggregates, as indicated by the sample taken, shall neither exceed nor fall below the ration specified by the purchaser by more than 10 percent.

Water/ cement ratio -  $\pm 5$  percent of the specified value.

Consistency or workability – The slump shall not differ from the amount specified by  $\pm 10$ mm for a specified slump of 75 mm or less and  $\pm 25$ mm when the specified a slump is greater than 75mm. The compacting factor shall be within  $\pm 0.03$  of the value specified. If any other method of determining consistency is used, a suitable tolerance shall be agreed to between the purchaser and the supplier.

## **APPENDIX A**

Concrete uniformity requirement

A-1 Tests

A-1.1 The variation within a batch as provided in Table 10 shall determined for each property listed as the difference between the highest value and the lowest value obtained from the different portions of the same batch. For this specification the comparison shall be between two samples, representing the first and last portions of the batch being tested.

Test results conforming to the limits of five of the six tests listed in Table I shall indicate uniform concrete within the limits of this specification. Analysis of concrete samples shall be made in accordance with the relevant requirements of IS: 1159-1959.

#### A.2. Coarse aggregate content

A-2.1 Coarse aggregate content shall be determined using the following equation:

$$p = \frac{c}{b} \times 100$$

Where

P= Percentage of coarse aggregate by mass in concrete;

c= saturated surface dry mass in kg of aggregate retained on 4.75 mm IS Sieve, resulting from washing all material finer than this sieve from the fresh concrete; and

b= mass of sample, in kg of fresh concrete in unit mass container.

Table 10 Requirements for uniformity of concrete

Sl. No.	Test	Requirement expressed as maximum permissible difference in results of tests or samples representing the first and last portions or concrete batch
1	2	3
i)	Mass per cubic meter calculated to an air-free basis	16 kg/m <sup>3</sup>
ii)	Air-content, percent by volume of concrete	1.0
iii)	Slump:	
	If average slump is 10cm or less	2.5 cm
	If average slump is 10 to 15 cm	3.8 cm
iv)	Coarse aggregate content, percent (portion by mass of each sample retained on 4.75-mm IS Sieve)	6.0
v)	Unit mass of air-free mortar, percent based on average for all comparative samples tested	1.6

VI)	Average compressive strength at 7 days for each comparative test specimens, percent	7.5
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A-3. Unit mass of air free mortar

$$M = \frac{b - c}{V = \left\{ \frac{V \times A}{100} + \frac{c}{1000G} \right\}}$$

A-3.1 Unit mass of air free mortar shall be calculated as follows:

Where

M= Unit mass of air free mortar in Kg/m<sup>3</sup>

b= mass of concrete sample in unit mass container in kg,

c= saturated-surface-dry mass of aggregate in kg retained on 4.75mm IS Sieve,

V= Volume of unit mass container in m<sup>3</sup>

A= air content of concrete in percent measured in accordance with the relevant requirements of IS:1199-1959\*, and

G = specific gravity of coarse aggregate.

#### 4.6 SPECIFICATIONS FOR REINFORCED CEMENT CONCRETE WORK

General - Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by engineer according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.

Form work ( Centering and shuttering )

Reinforcement

Concreting - 1) Cast-in-situ 2) Precast

##### 4.6.1 Materials

4.6.1.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of mortars and section 04-concrete work as applicable.

##### 4.6.1.2 Steel for reinforcement

The steel used for reinforcement shall be any of the following types -

Mild steel sand medium tensile bars conforming to IS: 432 (part I)

Hard drawn steel wire conforming to IS: 432 (part II)

High strength deformed steel bars conforming to IS: 1786

Hard drawn steel wire fabric conforming to IS: 1566

Structural steel section conforming to IS: 2062-1999

Types and grades - Reinforcement supplied in accordance with this standard shall be classified into the following types -

Mild steel bars - It shall be supplied in the following two grades

- i) Mild steel bars grade I designated as Fe 410-S
- ii) Mild steel bars grade II designated as Fe 410-O.
- b) Medium tensile steel bars, grade II designated as Fe-540-W-HT.

Mild steel and medium tensile steel - Physical requirement are given in Table 11.

Table 11

Sl No	Type and nominal size Of bars	Ultimate tensile stress N/mm <sup>2</sup> minimum	Yield stress N/mm <sup>2</sup> minimum	Elongation Percent
1	Mild steel grade I For bars up to and including 20 mm	410	250	23
	For bars over 20 mm up to and Including 50 mm	410	240	23
2	Mild steel grade I For bars up to and including 20 mm	370	225	23
	For bars over 20 mm up to and Including 50 mm	370	215	23
3	Medium tensile steel For bars up to & including 16 mm	540	350	20
	For bars over 16 mm, up to and including 32 mm	540	340	20
	For bars over 32 mm, up to and including 50 mm	510	330	20

Elongation percent on gauge length  $5.65 \sqrt{so}$  where so is the cross section area of the test piece.

Note-1. Grade (II) Mild steel bars are not recommended for the use in structures located in the earthquake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.

2. Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS: 2751.

Nominal mass / weight - The tolerance on mass/weight for round and square bars shall be the percentage given in Table.12 of the mass/weight calculated on the basis that the masses of the bar/wire of nominal diameter and of density 0.785 kg / cm<sup>3</sup> or 0.00785 kg / mm<sup>3</sup>.

Table 12 (Tolerance on nominal mass)

Nominal size In mm	Tolerance on the nominal mass percent		
	Batch	Individual Sample +	Individual sample for coil(-x-)
a) up to and including 10	± 7	± 8	± 8
over 10, up to and including 16	+5	-6	+6
c) over 16	± 3	-4	± 4

+ for individual sample plus tolerance in not specified

(x) for coil batch tolerance is not applicable

Tolerance shall be determined in accordance with method given in IS 1786-1985

Tests - Following type of lab test shall be carried out

Tensile test - This shall be done as per IS: 1608

Bend test - This shall be done as per IS: 1599

Re-test - This shall be done as per IS: 1786

Rebend test -This shall be done as per IS: 1786

Should any one of the test pieces first selected fail to pass any of the tests specified above, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the materials represented by the test samples shall be deemed to comply with the requirement of the particular test. Should the test piece from either of these additional samples fail, the material represented by the test samples shall be considered as not having complied with standard. High strength deformed

bars & wires shall conform to IS: 1786. The physical properties for all sizes of steel bars are mentioned below in Table 13.

Table 13

Sl. No	Property	Grade		
		Fe 415	Fe 500	Fe 550
1	0.2% proof Stress/Yield stress, in. N/mm <sup>2</sup>	415	500	550
	Elongation, percent min. on gauge Length 5.65 A, Where A is the X-sectional Area of the test piece	14.5	12	8
3	Tensile strength	10 % more than actual 0.2 % proof stress but not less than 465 N/mm <sup>2</sup>	8 % more than actual 0.2 % proof stress but not less than 545 N/mm <sup>2</sup>	6 % more than actual 0.2 % proof stress but not less than 585 N/mm <sup>2</sup>

Tests - Selection and preparation of test sample. All the tests pieces shall be selected by the engineer or his authorised representative either-

From cutting of bars or

If he so desires, from any after it has been cut to the required or specified size and the test piece taken from any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the engineer or his authorised representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deductions in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile test - This shall be done as per IS: 1599.

Re-test - This shall be done as per IS: 1786.

4.6.1.3 Stacking and storage - Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause to minimum wastage in cutting from standard length.

#### 4.6.2 SPECIFICATIONS FOR FORMWORK (CENTRING & SHUTTERING)

4.6.2.1 - Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

4.6.2.2 - Design & tolerance in construction - Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerances given below.

a)	Deviation from specified dimensions of cross section of columns and beams		+ 12 mm
b)	Deviation from dimensions of footings		+ 12 mm
	i)	Dimension in plan	+ 50 mm
	ii)	Eccentrically in plan	0.02 times the width of the footings in the direction of deviation but not more than 50 mm
	iii)	Thickness	+ 0.05 times the specified thickness.

(Note – Tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels.)

4.6.2.3. General requirement - It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, Screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Care shall be taken to see that no piece is keyed into the concrete. See also Annexure 4-A.7

#### 4.6.2.4. Material for form work

Propping and centering - All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

Centering / Staging - Staging should be as designed with required extension pieces as approved by engineer to ensure proper slopes, as per design for slabs /beams etc. and as per levels as shown in drawings. All the staging to be either tubular steel structure with



adequate bracings as approved or made of built up structural sections made from rolled structural steel sections

a). In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.

b). Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

Shuttering - Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the engineer shall be provided in the joints.

Steel shuttering used for concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

Runner joints RS, MS Channel or any other suitable section of the required size shall be used as runners.

Assembly of beam head over props, Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.

Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 meters, the prop may be provided in multi-stages. Typical arrangements of form work for 'Beams, columns and walls, and forms secured by wall ties are shown in Figure 1 to 8: and typical detail of multistage shuttering is given in Fig. 9.

Camber - Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per meter (1 to 250) or as directed by the engineer, so as to offset the subsequent deflection. For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the engineer.

Walls - The forms faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. A typical wall form with the components identified is given in Fig.1, 2, & 3. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs.

Removal of form work (stripping time) - In normal circumstance and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods -

a) Walls ,columns and faces of all structural members 24 to 48 hours as many be decided by the engineer

b) Slab

i) Spanning up to 4.50 M 7 days

ii) Spanning over 4.50 M 14 days

c) Beams and arches

i) Spanning up to 6 M 14 days

ii) Spanning over 6 M & up to 9 m 21 days

iii) Spanning over 9 M 28 days

Note 1 -For the other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. If Portland pozzolana or low heat cement has been used for concrete, the stripping time will be 10/7 of the period stated above.

Note 2 - The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead of the slabs, beam or arch as the case may be together with any live load likely to occur during curing of further construction.

Note 3 - For rapid hardening cement, 3/7 of above periods will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

Note 4 - In case cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

Note 5 - Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

Note 6 - Work damaged through premature or careless removal of forms shall be reconstructed.

#### 4.6.2.5. Surface treatment

Oiling the surface - Shuttering gives much longer service life in the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections. Typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3-4 uses and also in case when shuttering has been stored for a long time, it should be recoated with mould oil before the next use. The design of form work shall conform to sound engineering practices and relevant IS codes.

4.6.2.6. Inspection of form work - The completed form work shall be inspected and approved by the engineer before reinforcement bars are placed in position. Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discolouration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by engineer.

Shuttering surface before concreting should be free from any defect / deposits and fully cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

4.6.2.7. Erection of form work (centering and shuttering) - Following points shall be borne in mind while checking during erection.

Any member which is to remain in position after the general dismantling is done, should be clearly marked.

Material used should be checked to ensure that, wrong items / rejects are not used.

If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.

i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.

Sole plates shall be properly seated on their bearing pads or sleepers.

The bearing plates of steel props shall not be distorted.

The steel parts on the bearing members shall have adequate bearing areas.

d) Safety measures to prevent impact of traffic; scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

e) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing device and bracing shall be tightened.

f) The stacked materials shall be placed as catered for, in the design.

g) When adjustable steel props are used, they should -

i). Be undamaged and not visibly bent.

ii). Have the steel pins provided by the manufacturers for use.

iii). Be restrained laterally near each end.

- iv). Have means for centralizing beams placed in the fork heads.
- h) Screw adjustment of adjustable props shall not be over extended.
- i) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening of props occur. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened / clamped down after adjustment to prevent their shifting.
- j) No member shall be eccentric upon vertical member.
- k) The number of nuts and bolts shall be adequate.
- l) All provisions of the design and / or drawings shall be complied with.
- m) Cantilever supports shall be adequate.
- n) Props shall be directly under one another in multistage constructions as far as possible.
- o) Guy ropes or stays shall be tensioned properly.
- p) There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.
- q) Required camber shall be provided over long spans.
- r) Supports shall be adequate, and in plumb within the specified tolerances.

#### 4.6.2.8 Measurements

4.6.2.8.1. General - The form work shall include the following;

- a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.
- b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.
- c) Bolts, wire ties, clamps, spreaders, nails or any other items to hold the sheathing together.
- d) Working scaffolds ladders, gangways, and similar items.
- e) Filling to form stop chamfered edges of splayed external angles not exceeding 20 mm wide to beams, columns and the like.
- f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before concrete.
- g) Dressing with oil to prevent adhesion and
- h) Raking or circular cutting.

4.6.2.8.2. Classification of measurements - Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following -

- a). Foundations, footings, bases of columns etc. and for mass concrete and precast shelves,
- b). Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
- c). Suspended floors, roofs, landings, shelves and their supports and balconies.
- d). Lintels, beams, girders, Bressummers and cantilevers.
- e). Columns, pillars, posts and struts.
- f). Stairs (excluding landing) except Spiral staircase.
- g). Spiral staircase (including landing).
- h). Arches.
- i). Domes, vaults, shells roofs, arch ribs and folded plates.
- j). Chimneys and shafts.
- k). Well steining.
- l). Vertical and horizontal fins individually nor forming box, louvers and bands.
- m). Waffle or ribbed slabs.
- n). Edges of slabs and breaks in floors and walls (to be measured in running meters where below 200 mm in width or thickness).
- o). Cornices and mouldings.
- p). Small surfaces, such as cantilevers ends, brackets and end of steps, caps and boxes to pilasters and columns and like.
- q). Chula hoods, weather shades, Chajjas, corbels etc. including edges and
- r). Elevated water reservoirs.

4.6.2.8.3 Centering, and shuttering where exceeding 3.5 meter height in one floor shall be measured and paid for separately.

4.6.2.8.4 Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

4.6.2.8.5. No deductions from the shuttering due to the openings / obstructions shall be made if the area of such openings / obstructions does not exceed 0.1 square meters. Nothing extra shall be paid for forming such openings.

4.6.2.8.7 Rate - The rate of the form work includes the cost of labour and materials required for all the operations described above.

#### 4.6.3. SPECIFICATIONS FOR REINFORCEMENTS IN CONCRETE

4.6.3.1. General requirements - Steel conforming to para 4.6.1.2. for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coatings which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall used for removing the rust.

(1). Assembly of reinforcement - Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by engineer. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Over lapping of bars, where necessary shall be done as directed by the engineer. The overlapping bars shall

not touch each other and these shall be kept apart with concrete between them by 25 mm or  $1 \frac{1}{4}$  times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. Of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps / splices shall be staggered as per directions of the engineer. But in no case the overlapping shall be more than 50% of cross sectional area at one section.

(2). Bonds and hooks forming end anchorages - Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice for bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.

a) U-Type hook - In case of mild steel plain bars standard U-type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter of the bar

Note-In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawing.

b) Bends - Bend forming anchorage to a M.S. plain bar shall be bent with an internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

(3). Anchoring bars in tension - Deformed bars may be used without end anchorages provided, development length requirement is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per clause 25.2.1 of IS: 456-2000.

(4). Anchoring bars in compression - The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in of IS: 456-2000. The projected length of hooks, bends and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

(5). Binders, stirrups, links and the like - In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times the nominal size of bar.

(6). Welding of bars - Whenever facility for electric arc welding is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the engineer. Welding shall be as per IS: 2751 for mild steel bars and for cold worked bars.

4.6.3.2 Placing in position - Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the engineer. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Track welding in crossing bars shall also be permitted in lieu of bending with steel wire if approved by engineer.

The bars shall be kept in correct position by the following methods -

- a) In case of beam and slab construction precast cover blocks of cement mortar 1:2 about 4x4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.
- b) In case of cantilevered and doubly reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 meter or at shorter spacing to avoid sagging.
- c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with block of cement mortar 1:2 of required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.
- d) In case of R.C.C. structure such arches, domes, shells, storage tanks etc. a combination of cover blocks, spaces and templates shall be used as directed by engineer.

Tolerance on placing of reinforcement - Unless otherwise specified by the engineer, reinforcement shall be placed within the following tolerances -

Tolerance in spacing

		Tolerance in spacing
a)	For effective depth 200 mm or less	$\pm 10$
b)	For effective depth More than 200 mm	$\pm 15$

The cover shall in no case be reduced by more than one third of specified cover or 5 mm which ever is less. Bending at construction joints - Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bars diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bars is not damaged.

4.6.3.3. Measurements - Reinforcement including authorised spacer bars and laps shall be measured in length of different diameters, as actually (not more than as specified in the drawings.) used in the work nearest to a centimeter and their weight calculated on the basis

of standard weight given in Table 14 below. Wastage and unauthorized overlaps shall be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate reinforcement.

Wherever tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the engineer and measured separately and paid for.

Table 14 Cross-sectional area and mass of steel bar

Nominal size mm	Cross sectional area sq.mm	Mass per meter run kg
6	28.3	0.222
7	38.5	0.302
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
18	254.6	2.00
20	314.3	2.47
22	380.3	2.98
25	491.1	3.85
28	616.0	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.85
45	1591.1	12.50
50	1964.3	15.42

Note - These are as per clause 5.2 of IS 1786.

4.6.3.4. Rate - The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, as required of directed including tack welding on crossing of bars in lieu of binding with wires.



#### 4.6.4 SPECIFICATIONS FOR CONCRETING

The concrete shall be done as specified. The proportion by volume of ingredients shall be as specified.

4.6.4.1 Consistency - The concrete which will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar shall be used. The consistency shall depend on whether the concrete is vibrated or hand tamped. It shall be determined by slump test as n[prescribed in chapter " concrete under para 4.2.3 workability"

Where considered necessary, the workability of the concrete may also be ascertained by compacting factor test and VEE BEE consistometer method specified in IS: 1199. For suggested ranges of values of workability of concrete by the above two methods, reference may be made to IS: 456.

##### 4.6.4.2 Placing of concrete

Concreting shall be commenced only after engineer has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shaving, saw dust, pieces of wood, or other foreign material and surfaces shall be treated as prescribed.

In case of concreting of slabs and beams, wooden plank or cat walks of chequered MS plates or bamboo chlies or any other suitable material supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

In case of columns and walls, it is desirable to place concrete without construction joints. The progress of concreting in the vertical direction shall be restricted to one meter per hour.

The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings concrete shall be placed through chutes or as directed by the engineer. In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete in not more than 1.5 meters at a time.

During cold weather, concreting shall not be done when the temperature falls below 4.5° c. the concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.

During hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38°C. no concrete shall be laid within half of the closing time of the day, unless permitted by the engineer.

It is necessary that the time taken between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with

4.6.4.3 Compaction - Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations. The engineer may however relax this conditions at his discretion for certain items, depending on the thickness of the members and feasibility of vibrating the same and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the form. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation, such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being compacted at the time of placing.

Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibrators. In case both internal and external vibrators are being used, the internal vibrator shall be first withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. within 30 minutes of addition of water to the dry mixture.

4.6.4.4 Construction joints - Concreting shall be carried out continuously up to the construction joints, the position and details of which shall be as shown in structural drawing or as indicated in Fig. 26 or as directed by engineer. Number of such joints shall be kept to minimum. The joints shall be kept at places where the shear force is the minimum. These shall be straight and shall be at right angles to the direction of main reinforcement.

In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head. The portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.

When stopping the concrete on a vertical plane in slabs and beams, an approved stop-board (see Fig.26C) shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop-board. Inclined or feather

joints shall not be permitted. Any concrete flowing through the joints of stop-board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square meter shall then be applied on the roughened surface before fresh concrete is laid.

4.6.4.5 Expansion joints - Expansion joints shall be provided as shown in the structural drawings or as indicated in Fig. 10 to 25 or as directed by engineer, for the purpose of general guidance. However it is recommended that structures exceeding 45 m in length shall be divided by one or more expansion joints. The filling of these joints with bitumen filler, bitumen felt or any such material and provision of copper plate, etc. shall be paid for separately in running meter. The measurement shall be taken up to two places of decimal stating the depth and width of joint.

4.6.4.6 Curing - After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying by covering with moist gunny bags, sand, canvass Hessian or any other material approved by the engineer. After 24 hours of laying of concrete, the surface shall be cured of ponding with water for a minimum period of 7 days from the date of placing of concrete.

4.6.4.7 Finishing - In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set.

Immediately on removal of forms, the R.C.C work shall be examined by the engineer, before any defects are made good.

The work that has sagged or contains honey combing to an extent detrimental to structural safety or architectural concept shall be rejected as given for visual inspection test.

Surface defects of a minor nature may be accepted. On acceptance of such a work by the engineer, the same shall be rectified as follows -

1) Surface defects which require repair when forms are removed, usually consist of bulges due to movement of forms, ridges at form joints, honey combed areas, damage resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey-combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferable slightly undercut to provide a key at the edge of the path.

2) Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of fine sand and then filled with mortar similar to that used in the

concrete. The mortar is placed in layers not more than 10 mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.

3) Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.

4) Holes left by bolts are filled with mortar carefully packed into places in small amounts. The mortar is mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.

5) Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motor cars.

6) Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.

7) The same amount of care to cure the material in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound in these cases will be most convenient.

c). The exposed surface of R.C.C work shall be plastered with cement mortar 1 -3 (1 cement - 3 fine sand) of thickness not exceeding 6 mm to give smooth and even surface true to line and form. Any RCC surface which remains permanently exposed to view in the completed structure shall be considered exposed surface for the purpose of this specification.

Where such exposed surface exceeding 0.5 sq.m in each location is not plastered with cement mortar 1:3 (1 cement to 3 fine sand) 6 mm thick, necessary deduction shall be made for plastering not done.

d). The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give bond between concrete and plaster.

e). The surface of RCC slab on which the cement concrete of mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done without disturbing the concrete.

4.6.4.8 Strength of concrete - The compressive strength on work tests for different mixes shall be as given in Table 15 below -

Table 15

Concrete mix (Nominal mix on volume basis)	Compressive strength in (kg/sq cm)	
	7 days	28 days
1:1:2	210	315
1:1 ½ : 3	175	265
1:2:4	140	210

#### 4.6.4.9 Testing of concrete

(1). Regular mandatory tests on the consistency and workability of the fresh concrete shall be done to achieve the specified compressive strength of concrete. These will be of two types

Mandatory Lab. Test

Mandatory Field Test

(3). Results of Mandatory Field Test will prevail over Mandatory Lab. Test.

a) Work Test-Mandatory Lab. Test shall be carried out as prescribed.

b) Mandatory Field Test (Hammer Test), shall be carried out as prescribe in Annexure 4.A.2

(4). Additional test - Additional test, if required, shall be carried out as prescribed in Annexure 4.A.7

(5). Slump test - This test shall be carried out as prescribed in Annexure 4.A.1

(6). Visual inspection test - The concrete will be inspected after removal of the form work as described. The question of carrying out mandatory test or other tests described in Annexure 4-A.2 and 4-A.4 will arise only after satisfactory report of visual inspection.

The concrete is liable to be rejected, if,

(i) It is porous or honeycombed.-

(ii) Its placing has been interrupted without providing a proper construction joint;

(iii) The reinforcement has been displaced beyond tolerance specified; or construction tolerance has not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the engineer at the risk and cost of the contractor.

#### 4.6.4.10 Standard of acceptance

(1). Mandatory lab test - For concrete sample and tested as prescribed in Annexure 4- A.2 the following requirement shall apply.

Out of six sample cubes, three cubes shall be tested at 7 days and remaining three cubes at 28 days, if found necessary.

(2). 7days' tests

(a). Sampling - The average of the strength of three specimens shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than  $\pm 15\%$  of the average. Difference between the maximum and minimum strength should not exceed 30% of average strength of three specimen. If the difference between maximum and minimum strength exceeds 30% of the average strength, then 28 days' test shall have to be carried out.

(a). Strength - If the actual average strength of sample accepted in para 'sampling' above is equal to or higher than specified strength up to 15% then strength of the concrete shall be considered in order. In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days' test shall have to be carried out to determine the compressive strength of concrete cubes.

(3). 28 days' test

(a) The average of the strength of three specimen be accepted as the compressive strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

(b) If the actual average strength of accepted sample exceeds specified strength by more than 30%, the engineer, if he so desires may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.

(c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of specified strength, the concrete may be accepted at reduced rate at the discretion of engineer.

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the engineer shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however, the engineer so desires, he may order additional tests (see Annexure 4-A.4) to be carried out to ascertain if the structure can

be retained. All the charges in connection with these additional tests shall be borne by the contractor.

(4). Acceptance criteria of mandatory field test

(A) Preparation of standard test cubes for calibration of rebound hammer at site

(a) In the beginning the standard test cubes of specified mix shall be prepared by field units before undertaking any concrete work in each project.

(b) At least 18 standard cubes necessary for formation of one specimen of specified mix, shall be cast by site staff well in advance. From these 18 cubes any 3 cubes may be selected at random to be tested for crushing strength of 7 days. The crushing strength obtained should satisfy the specified strength for the mix as per specification or agreement. If the strength is satisfactory then the remaining cubes will form the standard samples for calibration of rebound hammer. In case of failure, the site staff should totally reject the samples and remove them also and then make another set of samples by fresh mixing or alternatively, out of the remaining 15 cubes 3 cubes will be tested on 28 days. If the 28 days' tests are found satisfactory then remaining 12 cubes will form the standard sample for calibration at 28 days' strength otherwise all samples shall be rejected and whole procedure repeated to form a fresh specimen. All the results shall be recorded in a register.

(c) No concreting will be allowed unless the standard specimen cubes are obtained.

The criteria for acceptance and calibration of hammer will be 28 days' strength. the 7 days' strength is only to facilitate the work to start.

(d) No work (for the concrete cast between 8th day) shall be allowed to be paid unless 28 days' cube strength is obtained. For the concrete cast between 8th and 28th day, the decision to make the payment may be taken by the engineer on the basis of existing criteria. Concrete work will be rejected if 28 days' strength falls short as per acceptance criteria. No further work will be allowed till the acceptable standard cubes are obtained.

(e) Frequency - It will be once in each quarter or as per the direction and discretion of engineer. Whenever the acceptance criteria is changed or concrete mix or type of cement is changed or engineer feels it necessary for recorded reasons with the approval of the authority according technical sanction, fresh specimen shall be prepared.

(B) Calibration of hammer

(a) Simultaneously, same three cubes to be tested on 28 days as referred in para A (b) above shall be used to correlate the compressive strength of their concrete with rebound number as per procedure described in para 5.2 of the IS: 13311 (Part 2) "Indian standard for non-destructive testing of concrete Method of test by rebound hammer which is given below in para B (b). the average of values of the rebound number (minimum readings)

obtained in respect of same three cubes passing on 28 days' work test shall form the datum reference for remaining cubes for the strength of cubes.

(b) The concrete cubes specimens are held in a compression testing machine under a fixed load, measurements of rebound hammer taken and then compressive strength determined as per IS: 516. The fixed load required is of the order of  $7N / mm^2$  when the impact energy of the hammer is about 2.2 NM.

If the specimens are wet cured, they should be removed from wet storage & kept in the laboratory atmosphere for about 24 hours before testing. Only the vertical faces of the cubes as cast should be tested for rebound number. At least nine readings should be taken on each of the three vertical faces accessible in the compression testing machine when using rebound hammers. The points of impact on the specimen must not be nearer than 20 mm from each other. The same points must not be impacted more than once.

(c) The rebound number of hammer will be determined on each of the remaining (18-3-3=12) cubes. Whenever the rebound number of hammer of any individual cube varies by more than  $\pm 25\%$  from the datum readings referred to in para B(a) above, that cube will be excluded and will not be considered for standard specimen cubes for calibration. It must be ensured that at least 8 cubes out of 12 that is 66.6% are within the permissible range of variation of rebound number i.e.  $\pm 25\%$  or otherwise whole procedure shall have to be repeated and fresh specimen prepared.

These 8 cubes will form one standard sample in the beginning before commencement of work and shall be kept carefully for the visiting officers who will calibrate their hammers on these cubes.

(d) This calibration will be done by field staff with their hammer and then chart of calibration giving the details of the average readings, date & month of casting, mix of the concrete etc. shall be prepared and signed by engineer and will be duly preserved for future reference as and when required.

(C) Preservation of cubes at site - Standard sample cubes cast shall be carefully preserved at site under the safe custody of AE or his representative for making them available together with the charts, to the any other senior departmental officers, during their inspection of the work.

(D) Testing at site - (D-2) Testing will be done generally by non-destructive methods like rebound hammers etc. Each field Division / Sub Division / Unit will purchase rebound hammers and keep them in working order at work site. Testing will be done only by hammers, which are dully calibrated.

(D-3) The relative strength of actual field work will be tested with reference to strength of these standard cubes and calibration charts of a hammer for determining the rebound



number on the field work. The hammer will be used as per manufacturer's guidelines at various locations chosen at random. The number of location / reading on each wall, beam or column etc. shall not be less than 12. All the readings should be within the  $\pm 25\%$  range of values prescribed in calibration chart normally. However, reading indicating good strength will be when it is at par with calibrated value between 100% & 125% and very good if more than 125%. Any value between 100% & 75% of calibrated value shall be considered satisfactory. Values from 75% to 50% shall be considered for fragment at rates reduced on prorata basis. The concrete indicating rebound number less than 50% of calibrated value shall be rejected and not paid for.

(E) Acceptance of field tests and strength - If the relative strength of actual field work is found satisfactory considering the calibration charts with reference to the standard cube test kept at site, the representative work will be considered satisfactory. If the work is considered below satisfactory, the same will be dealt as stated in para D-3 above.

(F) 7 days' Strength in rare cases only - Normally cube crushing strength on 28 days' test shall form the basis of acceptance. However in rare cases of time bound projects / urgent repairs 7 days' cube test strength criteria may be adopted on similar lines using 7 days' standard test cubes and calibration graphs / curves /charts for 7 days' in lieu of 28 days' and testing work done at 7 days'.

(G) Precautions

(G-1) The testing shall be done generally as per the guidelines of manufacturer of the apparatus and strictly in accordance with the procedure laid down in clause 6 of IS: 13311 (part 2) Indian Standard for Non-Destructive Testing of concrete-Method of Test by Rebound Hammer.

(G-2) The rebound hammers are influenced by number of factors like type of cement aggregate, surface conditions, moisture content, age of concrete etc. Hence care shall be taken to compare the cement, aggregate etc. and tested under the similar surface conditions having more or less same moisture content and age. However effect of age can be ignored for concrete between 3 days & 3 months old.

4.6.4.11 Measurement

4.6.4.11.1. Dimensions shall be measured nearest to a cm except for the thickness of slab which shall be measured correct to 0.5 cm.

4.6.4.11.2. The areas shall be worked out nearest to 0.01 sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic meters.

4.6.4.11.3. Reinforced cement concrete whether cast-in-situ or present shall be classified and measured separately as follows.

(a) Raft, footing, bases of columns etc. and mass concrete. (b) walls (any thickness) including attached pilasters, buttresses, plinth and string course, fillets etc. (c) suspended floors, roofs, landings and balconies. (d) Shelves (e) Chajjas (f) Lintel, beams and Bressummers. (g) Columns, pillars, piers, abutments, posts and struts. (h) Stair-cases including waist or waist less slab but excluding landing except in (l) below. (j) Spiral stair-case (including landing). (k) Arches, arch ribs, domes and vaults. (l) Chimneys and shafts. (m) Well steining. (n) Vertical and horizontal fins individually or forming box, louvers and fascias. (o) Kerbs, steps and the like. (p) String course, bands, coping, bed plates, anchor blocks, plain window sills and the like. (q) Moldings as in cornices window sills etc.

Shell, dome and folded plates. (r) Extra for shuttering in circular work in plan.

4.6.4.11.4 No deduction shall be made for the following -

(a) Ends of dissimilar materials (e.g. joists, beams post girders, rafters, purlin trusses, corbels steps etc.) up to 500 sq cm in cross-section

(b) Opening up to 0.1sq.m.

Note-In calculating area of openings up to 0.1sq.m the size of opening shall include the thickness of any separate lintels or sills. No extra labour for forming such opening or voids shall be paid for.

(c) The volume occupied by reinforcement.

(d) The volume occupied by water pipes, conducts etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

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

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

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

(c) The columns measurement shall be taken through.

(d) Chajjas along with its bearing on wall shall be measured in cubic meter nearest to two places of decimal. When Chajjas is combined with Lintel, slab or beam, the projecting portion shall be measured as Chajjas, built in bearing shall be measured as per item of Lintel, slab or beam in which chhajja bears.

(e) Where the band and Lintels are of the same height and the band serves as Lintel, the portion of the band to be measured as lintel shall be for clear length of opening plus twice the over all depth of band.

4.6.4.12. Tolerances - Subject to the condition that structural safety is not impaired and architectural concept does not hamper, the tolerances in dimensions of R.C.C members shall be as specified in the drawing by the designer. Whenever these are not specified, the permissible tolerance shall be decided by the engineer after consultations with the Designer, if necessary.

When tolerances in dimensions are permitted, following procedure for measurements shall apply.

(a). If the actual dimensions of R.C.C members do not exceed or decrease the design dimensions of the members plus or minus tolerance limit specified above, the design dimensions shall be taken for the purpose of measurements.

(b). If the actual dimensions exceed the design dimensions by more than the tolerance limit, the design dimensions only shall be measured for the purpose of payment.

(c). If the actual dimensions decrease more than the tolerance limit specified, the actual dimensions of the RCC members shall be taken for the purpose of measurement and payment.

(d). For acceptance of RCC members whose dimensions are not exactly as per design dimension of engineer shall be final. For the purpose of payment, however, the clarification as given in para a, b & c above shall apply

#### 4.6.4.13 Rate

The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering.

On the basis of mandatory lab tests, in case of actual average compressive strength being less than specified strength but upto 70% of specified strength, the rate payable shall be in the same proportion as actual average compressive strength bears to the specified compressive strength.

#### Example

1. Average compressive strength in 80% of specified strength. Rate payable shall be 80% of agreement rate.

2. In case average compressive strength in less than 70% of the specified strength, the work represented by the sample shall be rejected.

3. However, on the basis of mandatory field test, where they prevail, the rates of the work represented by samples showing actual compressive strength less than specified strength

shall be worked out as per para above. In addition, engineer may order for additional tests (see Annexure 4-A.4) to be carried out at the cost of contractor to ascertain if the portion of structure where in concrete represented by the samples has been used, can be retained on the basis of these test. Engineer may take further remedial measures as necessary to retain the structure at the risk and cost of the contractor.

Where throating or plaster drip or molding is not required to be provided in RCC Chajjas, deduction for not providing throating or plaster drip or molding shall be made from the item of R.C.C. In Chajjas. The measurement for deduction item shall be measured in running meters direct to a cm of the edge of chhajja.

No extra payment for richer mix which projects into any meter from another member during concreting of junctions of beams and columns etc. will be made except to the extent structurally considered necessary and when so indicated in the structural drawing. The payments for work done under items of different mixes shall be limited strictly to what is indicated in the structural drawings.

#### 4.6.8. SPECIFICATIONS FOR DESIGN MIX CONCRETE.

Definition - Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete.

It will be designed based on the principles given in IS 456-2000 and 23 "Hand book for design mix concrete".

In order to ensure that not more than the specification proportion of test results is likely to fall below the characteristic strength, the concrete mix has to be designed for higher average compressive strength for a specified grade of concrete is defined as target mean strength.

##### 4.6.8.1. Materials

Cement - One of the following types of cement as specified shall be used -

1. Ordinary Portland Cement 33 grade conforming to IS: 269.
2. Ordinary Portland Cement 43 grade conforming to IS: 8112.
3. Ordinary Portland Cement 53 grade conforming to IS: 2269.
4. Rapid hardening Portland Cement Conforming to IS: 8041.
5. Blast Furnace slag cement conforming to IS: 455.

However for severe conditions of sulphate content in sub soil water, special literature on use of sulphate resisting cement may be referred to.

Coarse aggregate - This shall be specified in para 4.1.2 and subparas.

Fine aggregate - This shall be grading zone I, II, or III as specified under para 3.1.4 and subparas.

Water - It shall conform to the requirement as laid down in IS: 456 para and para 4.6.1.1. of this section.

Grades of concrete - The compressive strength of various grades of designation concrete shall be as given in table 16 below -

Table 16

Grades designation	Compressive strength on 15 cm cubes min at 7 days (N/mm <sup>2</sup> )	Specified characteristic compressive strength at 28 days (N/mm <sup>2</sup> )
M 15	10.0	15
M 20	13.5	20
M 25	17.0	25
M 30	20.0	30
M 35	23.5	35

Note - In the designation of a concrete mix letter M refer the mix and the number to the specified characteristic compressive strength of 15 cm-cubes at 28 days expressed in N/mm<sup>2</sup>.

4.6.8.2 Scope - The procedure described below for design mix is for concrete up to grade M-35 which are generally used for reinforced concrete structure. Minimum grade of concrete for design mix will be M-20 normally. However in cases of projects having some parts of M-15 also in addition to M-20 to M-35 grade, then design mix concrete will cover M-15 grade as an exception only.

4.6.8.3 Data for mix design - The following basic data are required to be specified for design of concrete mix.

Characteristic compressive strength of concrete at 28 days.

Degree of workability desired.

Limitation on water cement ratio and minimum cement content to ensure adequate durability.

Type of maximum size of aggregate to be used.

Standard deviation of compressive strength of concrete.

Minimum cement content required in Reinforced cement concrete to ensure durability under specified conditions of exposure, will be in accordance with IS: 456. However it shall not be less than 300 Kgs /m<sup>3</sup> of concrete for 33 grade cement.

(a). Standard Deviation of concrete for each grade shall depend upon the degree of quality control expected to be exercised at site. As per IS: 10262 the values of standard deviation for various grades of concrete for different degree of control shall be specified in Table. 17.

**Table 17**

Grade of concrete	Standard Deviation for different degree of control in N/mm <sup>2</sup>		
	Very good	Good	Fair
M-15	2.5	3.5	4.5
M-20	3.6	4.6	5.6
M-25	4.3	4.3	6.3
M-30	5.0	6.0	7.0
M-35	5.7	6.7	7.7

Degree of quality control expected under different site conditions are described in Table18

**Table 18**

Degree of Control	Condition of production of concrete
Very good	Fresh cement from single source and regular test, weigh batching of all materials, aggregates grading and moisture content, control of water added, frequent supervision, regular workability and strength tests and field laboratory facilities,
Good	Carefully stored cement and periodic test, weigh batching of all materials, controlled water, graded aggregate supplied, occasional grading and moisture tests, periodic check of workability and strength, intermittent supervision and experienced workers.
Fair	Proper storage of cement, volume batching of all aggregates allowing for bulking of sand, weigh batching of cement, water content controlled by inspection of mix and occasional supervision and tests

4.6.8.4. Target strength for mix design - The target mean strength for a specified grade concrete depends upon the quality control (expressed by standard deviation) and accepted

proportion of results of the strength tests below the characteristic strength ( $f_{ck}$ ) and is given by relation,

$$T_{ck} = f_{ck} + t \cdot s$$

$T_{ck}$  – target mean compressive strength at 28 days

$f_{ck}$  – characteristic compressive strength at 28 days

$s$  – standard Deviation

$t$  – a statistical figure depending upon the accepted proportion of low test results and number of tests.

Note - According to IS: 456 & IS: 1343 the characteristic strength is defined as that value below which not more than 5% (1 in 20) results are expected to fall. In such case value of  $t$  will be 1.65 and equation will reduce to  $T_{ck} = f_{ck} + 1.65 s$ .

Selection of proportions - Since different cement, aggregate, of different maximum size, grading surface texture shape, produce concrete of different compressive strength for the same free water cement ratio, the relationship between strength and free water cement ratio corresponding to 28 days' strength of cement of various grades is given in Fig.1 of IS: 10262 and is reproduced below in chart 1.

28 days strength of cement tested according IS: 4031-1968

A = 31.9 – 36.8 N/mm<sup>2</sup> (325-375 kg /cm<sup>2</sup>)

B = 36.8 – 41.7 N/mm<sup>2</sup> (375-425 kg /cm<sup>2</sup>)

C = 41.7 – 46.6 N /mm<sup>2</sup> (425-475 kg /cm<sup>2</sup>)

D = 46.6 – 51.5 N /mm<sup>2</sup> (475-525 kg /cm<sup>2</sup>)

E = 51.5 – 56.4 N/mm<sup>2</sup> (525-575 kg/cm<sup>2</sup>)

F = 56.4 - 61.3 N /mm<sup>2</sup> (575-625 kg /cm<sup>2</sup>)

Chart 1- Relationship between free water cement ratio and concrete strength for different cement strengths.

(a) The free water cement ratio selected from Chart 1 above should be checked against the limiting water cement ratio for requirement of durability as given in IS: 456 and the lower of the two values is to be adopted.

(b) Estimate of air control - The amount of entrapped air for normal mix (non air entrained) concrete as per IS: 10262 are given in Table 19.

Table 19.

Nominal	maximum	Entrapped air as percentage of
---------	---------	--------------------------------

size of aggregate	volume of concrete
10 mm	3.0
20 mm	2.0
40 mm	1.0

(c) Selection of water content and fine to total aggregate ratio - Based on experience, empirical relationship have been established between quantity of water per unit volume of concrete and ratio of fine aggregate to total aggregate by absolute volume for desired workability. The estimated values for concrete up to M35 grade are given in Table 20.

Table 20.

Nominal maximum size of aggregate in mm	Water content in kgs per cubic meter of concrete	Sand as % age of total aggregate by absolute volume
10	208	40
20	186	35
40	165	30

A) The values given in Table 19. are based on the following conditions -

Crushed coarse aggregate conforming to IS: 383 and para 4.1.2 of this specification

Fine aggregate consisting of natural sand conforming to grading zone II of IS: 383 water cement ratio (by mass) of 0.6 and

Workability corresponding to compacting factor of 0.8.

B) For other conditions of workability, water cement ratio, grading of fine aggregate and for round aggregate, certain adjustment in quantities of mixing water and fine to total aggregate ratio as given in Table 19 are to be made as per IS: 10262. These are explained in Table 21 below -

Table 21.

Change of conditions stipulated for	Adjustment required in	
	Water content	Percentage of fines to total aggregate
For sand conforming to grading Zone I & III of IS -383	0	+1.5% for Zone I -1.5% for Zone III



Increase or decrease in the value of compacting factor by 0.1 For increase For decrease	+3.0 % -3.0%	0
For each 0.05 increase or decrease in free water-cement ratio For increase For decrease	0 0	+1.0 % -1.0 %
For rounded aggregates	-15 kg / mm <sup>3</sup>	-7

C) Comparison of consistency measurement by various methods-

Workability description	Slump mm	Compacting factor
Extremely dry	--	--
Very stiff	--	0.70
Stiff	0-25	0.75
Stiff plastic	25-50	0.85
Plastic	75-100	0.90
Flowing	150-175	0.95

Calculation of aggregate content - With the quantities of water and cement per unit volume of concrete and ratio of fine to total aggregate content per unit volume of concrete to be calculated from the following equations -

$$V = \left\{ w + \frac{C}{S_c} + \frac{1}{p} \times \frac{fa}{S_{fa}} \right\} \times \frac{1}{1000}$$

$$V = \left\{ w + \frac{C}{S_c} + \frac{1}{1-p} \times \frac{fa}{S_{ca}} \right\} \times \frac{1}{1000}$$

= absolute volume of fresh concrete which is equal to gross volume (m<sup>3</sup>), minus the volume of entrapped air.

W = mass of water (kg) per m<sup>3</sup> of concrete

C = mass cement (kg) per m<sup>3</sup> of concrete

P = ratio of fine aggregate to total aggregate by absolute volume

$S_c$  = specific gravity of cement

$F_a, C_a$  = aggregate (kg) per  $m^3$  of concrete respectively (total masses of fine aggregate and coarse aggregate )

$S_{fa}, S_{ca}$  = Specific gravities of saturated surface dry fine aggregate and coarse aggregate respectively.

Calculation of batch masses - The masses of various ingredients for concrete for design mix of a particular batch size may be calculate as described above.

4.6.8.5 Production of controlled concrete - The calculated mix proportion shall be checked by means of trial batches. Quantities of materials worked out as described above shall be termed as trial mix no.1. The quantities of materials for each trial mix shall be sufficient for at least three 150 mm size cube concrete specimens and concrete required to carry out workability test according to IS: 1199.

Workability of Trial Mix No.1 shall be measured. The mix shall be carefully observed for freedom from segregation and bleeding and its finishing properties. If the measured workability of Trial Mix No.1 is different from the stipulated value, the water content shall be adjusted according to Table 22 corresponding to the required changes in compacting factor. With this adjustment in water content, the mix proportions shall be recalculated keeping the free water-cement ratio at the preselected value which will comprise Trial Mix No.2. In addition, two more Trial Mixes No 3 and 4 shall be made with the water content same as Trial Mix No.2 and varying the free water cement ratio by (+) 10 per cent and (-) 10 per cent of the preselected value. For these two additional trial mixes No.3 and 4, the mix proportions are to be recalculated for the altered condition of free water-cement ratio with suitable adjustments in accordance with Table 22.

Fresh trial mixes are to be made for different types and brands of cement, alternative source of aggregates, maximum size and grading of aggregates.

4.6.8.6. Batching - In proportioning concrete, the quantity of both cement and aggregate should be determined by mass. Cement shall be used on the basis of mass and should be weighed separately from the aggregate. Water should be either measured by volume in calibrated tanks or weighed. Any solid admixture that may be added may be measured by mass. Liquid and paste admixture by volume or mass. Batching plant where used should conform to IS: 4925. All measuring equipment should be maintained in a clean serviceable condition and their accuracy periodically checked.

Except where it can be shown to the satisfaction of engineer that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate should controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate

stock piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by engineer to ensure that the specified grading is maintained.

It is important to maintain the water-cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregate shall be made as frequently as possible, the frequency for a given job being determined by the engineer according to weather conditions. The amount of the water to be added shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregates, IS: 2386 (part 3) may be referred to. The allow for the variation in mass of aggregate due to variation in their moisture content, suitable adjustments in the masses of aggregates shall also be made. In the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in the Table 22.

Table 22 (Surface water carried by aggregate) (Clause 4.6.8.4)

Aggregate	Approximate quantity of surface water	
	Percent by mass	Litres/m <sup>3</sup>
Very wet sand	7.5	20
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel to crushed rock	1.25-2.5	20-40

4.6.8.7. Mixing - Concrete shall be mixed in mechanical mixer. The should mixer comply with IS -1791. It shall be fitted with hopper. The mixing shall be continuous until there is uniform distribution of the material and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete should be remixed. The mixing time shall be not less than 2 minutes.

4.6.8.8. Laying - It shall be done as specified under para 4.2.4 of this specification.

4.6.8.9. Curing - It shall be done as specified under para 4.3.4 of this specification

4.6.8.10. Approval of design mix - The preliminary test for approval of design mix shall consists of three sets of separate tests and each set of test shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. Of the six specimens of each set, three shall be tested at seven days and remaining three at 28 days. The preliminary tests at seven days are intended only to indicate the strength to be attained at 28 days.

4.6.8.11. Work strength test - Work strength test shall be conducted in accordance with IS - 516 on random sampling. Each test shall be conducted on ten specimens, five of which shall be tested at 7 days and remaining five at 28 days. Not less than one work test consisting of testing of test on 10 cubes shall be carried out for every 30 cubic meter of concrete or less as per the lot size as specified below -

Lot size - Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following -

No individual lot shall be more than 30 m<sup>3</sup> in volume.

At least one cube forming an item of the sample representing the lot shall be taken from the concrete of same grade and mix proportions cast in any day.

Different grades or mixes of concrete shall be divided into separate lots.

Concrete of a lot shall be used in the same identifiable unit of the structure.

#### 4.6.8.12. Standard of acceptance

The average strength of group of cubes cast for each day shall not be less than the specified work cube strength. 20 per cent of cubes cast for each day may have values less than the specified strength provided that the lowest value is not less than 85% of the specified strength.

Concrete strength less than specified may as a special case be accepted in a member with the approval of engineer provided that the maximum stress in the member under the maximum design live load does not exceed the permissible safe stress appropriate to the lower strength of the concrete.

Concrete which does not meet the strength requirements as specified but has a strength greater than that of the lowest value of 85% may, at the discretion of the designer, be accepted as being structurally adequate without further testing.

Concrete of each grade shall be assessed separately.

Concrete shall be assessed daily for compliance.

Concrete is liable to be rejected if it is porous or honey combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the engineer.

4.6.8.13. An example illustration the mix design for concrete mix M 20 grade is given below

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## Design stipulation

a	Characteristic compressive strength required in the field at 28 days	20N/mm <sup>2</sup>
b	Maximum sizes of aggregate	20 MM (angular crushed)
c	Degree of workability	0.9 compacting factor (slump 75 mm)
d	Degree of quality control	Good
e	Type of exposure	Mild

## Test data of material

a	Cement used - ordinary Portland cement satisfying the requirements of IS: 269-1989	
b	Specific gravity of cement	3.15
c	Specific gravity of	
i)	Coarse aggregate	2.60
ii)	Fine aggregate (natural sand)	2.60
d	Water absorption of	
i)	Coarse aggregate	0.5 percent
ii)	Fine aggregate (natural sand)	1.0 percent
e	Free surface moisture of	
i)	Coarse aggregate	Nil (absorbed moisture also nil)
ii)	Fine aggregate (natural sand)	2.0 percent

## Sieve analysis

## a) Coarse aggregate

IS sieve Size mm	Analysis of coarse aggregate fraction (Percent passing)		Percentage of different fraction		
			I	II	Combined
20	100	100	60%	40%	100%
10	0	71.2	60%	40%	100%
4.75		9.4	0	28.5%	28.5%
2.63		0		3.7%	3.7%

The grading of combined fraction I and II in the ratio of 60 and 40 conform to Table 10 described above.

b) Fine aggregate

IS sieve sizes	Fine aggregate (percent passing)
100	-
2.36 mm	100
1.18 mm	93
600 micron	60
300 micron	12
150 micron	2

The sand conforms to grading zone III.

Target mean strength - As described earlier for degree of quality control 'good' the value of standard deviation is 4.6, therefore with a tolerance factor of 1.65 the value of target mean strength for specified characteristic cube strength =  $20 + 1.65 \times 4.6 = 27.6 \text{ N/mm}^2$ .

Selection of water cement ratio - From chart 1, the free water cement ratio required for target mean strength of  $27.6 \text{ N/mm}^2$  is 0.50. This is lower than the maximum value of 0.65 prescribed for mild exposure.

Selection of water and sand content - From Table 8 for 20 mm nominal maximum size aggregate and sand conforming to grading zone II water content as per cum concrete is 186 kg and sand content percentage of total aggregate by absolute volume is equal to 35%. For change in value of water cement ratio compacting factor, and sand belonging to zone III the following adjustment is required.

Change in condition	Adjustment required in	
	Water content	Percentage in total aggregate
For decrease in water cement Ratio by (0.6-0.5) i.e.0.10	0	-2
For increase in compacting Factor by (0.9-0.8) i.e. 0.10	+3	0

For the conforming Grading zone III	0	-1.5
Total	3	-3.5

Therefore, the required water content =  $186 + 186/100 \times 3 = 186 + 3.58 = 191.6 \text{ kg / m}^3$

And required sand content =  $35 - 3.5 = 31.5$  percent

Determination of Cement Content

Water-Cement ratio = 0.5

Water = 191.6 kgs

Cement =  $191.6 / 0.5 = 383 \text{ kg / m}^3$

Thus cement content is adequate for mild exposure condition as per IS: 456-2000 as described in table below.

Determination of coarse and fine aggregate content

From Table 18 for specified maximum size of aggregate of 20 mm, the amount of entrapped air in wet concrete is 2 per cent. Taking this into account and applying equations given above.

$$0.98 \text{ m}^3 = 191.6 + 383/3.15 + 1/0.315 \cdot f_a / 2.60 \times 1/1000$$

and

$$0.98 \text{ m}^3 = 191.6 + 383/3.15 + 1/0.315 \cdot C_a / 2.60 \times 1/1000$$

or  $f_a = 546 \text{ kg / m}^3$  and  $C_a = 1187 \text{ kg / m}^3$

The mix proportion now works out -

Water	Cement	Fine aggregate	Coarse aggregate
191.6	383 kg	546 kg	1187 kg
or 0.5	1	1.42	3.0

For 50 kg cement, the quantity of materials are worked out as below -

a)	Cement	= 50 kg.
b)	Sand	= 71 kg
c)	Coarse aggregate	154.5 kg.
	Fraction I - 92.7	
	Fraction II - 61.8	

d)	Water	
1	For water cement ratio of 0.5 quantity	= 25.0 kg.
2	Extra quantity of water to be added for absorption in coarse aggregate at 0.5% by mass	= $154.5 / 100 \times 0.5 = 0.77$ kg.
3	Quantity of water to be deducted for free moisture in sand at 2% by mass	= $(-) 171.0 / 100 \times 2 = (-) 1.42$ kg.

Therefore actual quantity of water =  $25.00 + 0.77 - 1.42 = 24.35$  kg

Actual quantity of sand required after allowing for mass of free moisture

$$= 71.0 + 1.42 = 72.42 \text{ kg}$$

Actual quantity of Coarse aggregate

$$\text{Fraction I} = 92.7 - (0.6 \times 0.77) = 92.24$$

$$\text{Fraction II} = 61.8 - (0.4 \times 0.77) = 61.49$$

Therefore the actual quantities of different constituent required for mix are -

Water = 24.35 kg

Cement = 50 kg

Sand = 72.42 kg

Coarse aggregate    Fraction I = 92.42 kg    Fraction II = 61.49 kg

Measurements shall be done in accordance with paras above.

Tolerances - Paras above shall apply.

Rate - Paras above shall apply with the exception regarding limitations for actual average compressive strength being less than specified strength which shall be governed by para above for acceptance and prorata rates worked out accordingly.

#### **Annexure 4-A.1**

#### **SLUMP TEST**

Apparatus - Mould shall consist of a metal frustum of cone having the following internal dimensions -

Bottom diameter .....20 cm

Top diameter .....10 cm

Height .....30 cm



The mould shall be of a metal other than brass and aluminum of at least 1.6 mm (or 16 BG) thickness. The top and bottom shall be open and at right angles to the axis of the cone. The mould shall have a smooth internal surface. It shall be provided with suitable foot pieces and handles to facilitate lifting it from the moulded concrete test specimen in a vertical direction as required by the test. A mould provided with a suitable guide attachment may be used.

Tamping rod shall be of steel or other suitable material 16 mm in diameter 60 mm long and rounded at one end.

Procedure - The internal surface of the mould shall be thoroughly cleaned and free from superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth horizontal, rigid and non-absorbent surface viz. leveled metal plate. The operator shall hold the mould firmly in place while it is being filled with test specimen of concrete. The mould shall be filled in four layers, each approximately one quarter of height of

mould. Each layer shall be tamped with twenty-five strokes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the underlying layer. The bottom layer shall be tamped through out its depth, after the top layer has been rodded, the concrete shall be struck off level with trowel or the tamping rod, so that the mould be exactly filled. Any mortar, which shall leak out between the mould and the base plate, shall be cleaned away. The mould shall be removed from the concrete immediately after filling by raising it slowly and carefully in a vertical direction. The molded concrete shall then be allowed to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of specimen.

The above operations shall be carried out at a place free from vibration or shock, and within a period of two minutes after sampling.

Result - The slump shall be recorded in terms of millimeters of subsidence of the specimen during the test. Any slump specimen which collapses or shears off laterally gives incorrect result. If this occurs, the test shall be repeated with another sample.

The slump test shall not be used for very dry mixes as the results obtained are not accurate.

#### **Annexure 4-A.2**

##### WORK TEST FOR CONCRETE – MANDATORY LAB TEST

A-O One sample (consisting of six cubes 15x15x15 cm shall be taken for every 20 cum or part thereof at concrete work ignoring any part less than 5 cum or as often as considered necessary by the engineer. The test of concrete cubes shall be carried out in accordance

with the procedure as described below. A register of cubes shall be maintained at the site of work in Annexure 4-A.8. The casting of cubes and all other incidental charges, such as curing, carriage to the testing laboratory shall be borne by the contractors. The testing fee for the cubes, if any, shall be borne by the department.

#### A-1 Test procedure

A-1.1 Mould - The mould shall be of size 15 cm x 15 cm x 15 cm for the maximum nominal size of aggregate not exceeding 40 mm. For concrete with aggregate size more than 40 mm, size of mould shall be specified by the engineer keeping in view the fact that the length of size of mould should be about four times the size of aggregate

The moulds for test specimens shall be made of non-absorbent material and shall be substantially strong enough to hold their form during the moulding of test specimens. They shall not vary from the standard dimensions by more than one per cent. The moulds shall be so constructed that there is no leakage of water from the test specimen during moulding. All the cube moulds for particular site should, prior to use, be checked for accuracy in dimensions and geometric form and such test should at least be made once a year.

Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly without leakage. Glass plates not less than 6.5-mm thick or plain metal not less than 12 mm thick shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when molded.

Note - Satisfactory moulds can be made from machine or steel castings, rolled metal plates or galvanized iron.

A-1.2 Sample of concrete - Samples of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge or as directed by engineer. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of concrete. The sampling operation should spread over evenly to the entire discharging operation. The samples thus obtained shall be transported to the place of molding of the specimen. To counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for further reference. In case of paving concrete, samples shall be taken from the batch immediately after deposition of the sub grade. At least five samples shall be taken from different portion of the pile and these samples shall be spread as evenly as possible through out the day. When wide changes occur during concreting, additional samples shall be taken if so desired by the engineer.

A-1.3 Preparation of test specimens - The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. The samples of concrete obtained

as described under the test specimen shall be immediately molded by one of the following methods as indicated below.

When the job concrete is compacted by manual methods, the test specimen shall be molded by placing the fresh concrete in the mould in three layers, each approximately one-third of the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 35 times with 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in uniform manner over the cross section of the mould and shall penetrate into underlying layer. The bottom layer shall be rodded throughout its depth. After the top layer has been struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined plate. The whole process of molding shall be carried out in such a manner as to preclude the change of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or over flow from the top of mould,

When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly molded by hand rodding as described above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrator may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall be of appropriate size and shall penetrate only the layer to be compacted. In compacting the first layer, the mould shall be filled to the extent that there will be no mortar loss during vibration. After vibrating the second layer enough concrete shall be added to bring level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified above. The whole process of molding shall be carried out in such a manner as to preclude the alteration of water cement ratio of the concrete by loss of water, either by leakage from the bottom or over flow from the top of the mould.

A-1.4 Curing and storage of test specimen - In order to ensure reasonably uniform temperature and moisture conditions during the first 24 hours for curing the specimen and to protect them from damage, moulds shall be covered with wet straw or gunny sacking and placed in a storage box so constructed and kept on the work site that its air temperature when containing concrete specimens shall remain 22° C to 33° C. Other suitable means which provide such a temperate and moisture conditions may be used.

Note - It is suggested that the storage box be made of 25 mm dressed tongued and grooved timber, well braced with battens to avoid warping. The box should be well painted inside and should be provided with a hinged cover and padlock.

The test specimen shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within 24° C to 30° C until the time of test. If storage in water is desired, saturated lime solution shall be used.

A-1.5. Testing - The specimens shall be tested in accordance with procedure as described below -

The tests shall be made at an age of concrete corresponding to that for which the strengths are specified.

Compression tests shall be made immediately upon removal of the concrete test specimen from the curing room i.e. the test specimen shall be loaded in damp condition. The dimensions of the test specimens shall be measured in mm accurate to 0.5 mm.

The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

The load shall be applied axially without shock at the rate of approximately 140 kg. sq cm per minute. The total load indicated by the testing machine at failure of test specimen shall be recorded and the unit compressive strength is calculated in kg per sq cm using the area computed from the measured dimensions of the test specimen. The type of failure and appearance of the concrete shall be noted.

Annexure 4-A.3.

#### REBOUND HAMMER TEST. (MANDATORY FIELD TEST)

If a rebound hammer is regularly used by trained personnel in accordance with procedure described in IS: 13311 (part II) and a continuously maintained individual charts are kept showing a large number of readings and the relation between the readings and strength of concrete cubes made from the same batch of concrete, such charts may be used in conjunction with hammer readings to obtain an approximate indication of the strength of concrete in a structure or element. If calibration charts are available from manufacturers, it can be used. When making rebound hammer tests each result should be the average of at least 12 readings. Readings should not be taken within 20 mm of the edge of concrete members and it may be necessary to distinguish between readings taken on a troweled

face and those on a molded face, when making the test on a precast units, special care should be taken to bed them firmly against the impact of the hammer.

#### Annexure 4-A.4

#### ADDITIONAL TESTS FOR CONCRETE

C-0 In case the concrete fails when tested as per the method prescribed in Annexure 4-A.5, one or more of the following check tests may be carried out at the discretion of engineer to satisfy the strength of the concrete laid. All testing expenditure shall be borne by the contractor. The number of additional tests to be carried out shall be determined by the engineer. He shall be the final authority for interpreting the results of additional tests and shall decide upon the acceptance or otherwise. His decision in this regard shall be final and binding. For the purpose of payment, the Hammering test results only shall be the criteria. Some of the tests are outlined below -

C-1 Cutting cores - This method involves drilling and testing cores from the concrete for determination of compressive strength. In suitable circumstances the compressive strength of the concrete in the structure may be assessed by drilling cores from the concrete and testing. The procedure used shall comply with the requirements of IS: 1199 and IS: 516.

The points from which cores shall be taken shall be representative of the whole concrete and at least three cores shall be obtained and tested. If the average of the strength of all cores cut from the structure is less than the specified strength, the concrete represented by the cores shall be liable to rejection and shall be rejected if a static load test (C-4) either cannot be carried out or is not permitted by the engineer.

C-2 Ultrasonic test - If an ultrasonic apparatus is regularly used by trained personnel in accordance with IS: 13311 (part I) and continuously maintained individual charts are kept showing a large number of readings and the relation between number of readings and the relation between the reading and strength of cubes made from the same batch of concrete, such charts may be used to obtain approximate indications of the strength of concrete in the structures. In cases of suspected lack of compaction or low cubes strength the results obtained from the ultrasonic test results on adjacent acceptable sections of the structures may be used for the purpose of assessing the strength of concrete in the suspected portion.

C-3 Load Tests on Individual Precast Units - The load tests described in this clause are intended as check on the quality of the units and should not be used as substitute for normal design procedures. Where members require special testing, such special testing procedures shall be in accordance with the specification. Test loads shall be applied and removed incrementally.

C-3.1. Non-destructive tests - The unit shall be supported at its designed points of support and loaded for five minutes with a load equal to the sum of the characteristic dead load plus

one and a quarter time the characteristic imposed load. The deflection is then recorded. The maximum deflection after application of the load shall be in accordance with the requirements defined by the engineer. The recovery is measured five minutes after the removal of the load and the load then reimposed. The percentage recovery after the second loading shall be not less than that after the first loading nor less than 90% of the deflection recorded during the second loading.

At no time during the tests, shall be unit show any sign of weakness of faulty construction as defined by the engineer in the light of reasonable interpretation of relevant data.

C-3.2. Destructive tests - The units is loaded while supported at its design point of support an must not fail at its design load for collapse, within 15 minutes of time when the test load becomes operative. A Defection exceeding  $1/40$  of the test span is regarded as failure of the unit.

C-3.3. Special tests - For very large units or units not readily amenable to the above test e.g. columns, the precast parts of composite beams and members designed foe continuity or fixity, and the testing arrangement shall be agreed upon before such units are cast.

C-4. Load tests of structures or parts of structures - The tests described in this clause are intended as check where there is a doubt regarding structural strength. Test loads are to be applied and removed incrementally.

C-4.1. Age at tests - The test is to be carried as soon as possible after the expiry of 28 days from the time of placing of the concrete. When the test is for a reason other than the quality of concrete in the structure being in doubt, the test may be carried out earlier, provided that the concrete has already reached is specified characteristic strength.

C-4.2. Test load - The tests loads to be applied for the limit states of deflection and local damage are the appropriate design loads i.e. the characteristic dead and superimposed loads. When the limit state of collapse is being considered the test load shall be equal to the sum of characteristic dead load plus one and a quarter times the characteristic imposed load and shall be maintained for a period of 24 hours. In any of the test temporary supports of sufficient strength to take the whole load shall be placed in position underneath but not in contact with the member being tested. Sufficient precautions must be taken to safeguard persons in the vicinity of the structure.

C-4.3. Measurements during tests - Measurements of deflection and crack width shall be taken immediately after application of the load and, in the case of 24h loaded period, after removal of the load and after 24h recovery period. Sufficient measurements shall be taken to enable side effects to be taken into account. Temperature and weather conditions shall be recorded during the tests.

C-4.0. Assessment of results - In assessing the strength of a structure or a part of the structure following a load test, the possible effects of variation in temperature and humidity during the period of the test shall be considered.

The following requirements shall be met -

The maximum width of any crack measured immediately on application of the test load for local damage, is to be not more than 2/3 of the value of the appropriate limit state requirement.

For members spanning between two supports the deflection measured immediately on application of the test load for deflection is to be not more than 1/500 of the effective span. Limits shall be agreed upon before testing cantilevered portions of structures.

If maximum deflection in mm shown during 24 h under load is less than  $40 L^2 / DD$  where L is effective span in m and D is overall depth of construction in mm, it is not necessary for the recovery to be measured and the requirements (d) does not apply, and

If within 24 hours of the removal of test load for collapse as calculated in clause (a) a reinforced concrete structure does not show a recovery of at least 75 per cent of the maximum deflection shown during the 24 h under load, the loading should be repeated. The structure should be considered to have failed to pass the test if the recovery after second loading is not at least 75 per cent of the maximum deflection shown during the second loading.

Annexure 4-A.5

#### FORMWORK AND SCAFFOLDING

1. Concrete is the most widely used construction material today because of its durability, mouldability and other characteristic. Concrete in its plastic stage has no form and therefore, needs to be molded to the required shape. Formwork includes the mould in contact with the wet concrete and all the necessary supports, hardware and bracing. The hardware supports and bracings are generally referred to as centering or false work. Scaffolding is the structure made to provide access to the point of working.

2. In the early days, formwork was generally rigged up by carpenter with available timber and nails as best as possible, using rule of thumb approach. Along with the growth in the development of concrete construction, formwork techniques have also developed side by side. With the technological advancement and introduction of new materials such as plywood, steel, aluminium, polypropylene, fibre reinforced plastics etc more rational approach is being made in the design of formwork.

3. Formwork - The basic objectives of the formwork designer should be to achieve the following:

4. Safety: to build substantially so that formwork is capable of supporting all dead and live loads, without collapse or danger to workmen and to the concrete structure.
5. Quality: To design and build forms accurately so that the desired size, shape and finish of the concrete is attained.
6. Economy: To build efficiently saving time and money for the contractor and owner.
7. Safety must find the first place in the design, construction, erection and stripping of formwork and centering systems.
8. Design consideration - To achieve the above basic objectives of formwork design the following should be considered.
  - a) Correct assessment of loads that come over forms with due consideration to pressures that arise from wet concrete.
  - b) Selection of proper forming material considering its strength, durability and cost.
  - c) Selection of proper supporting systems, either of wood, steel or aluminium. Proprietary supporting systems that are standardised and proved by tests should be adopted with advantage.
  - d) Provision for proper ties/anchors for the forms and bracing for support.
  - e) Provision of proper and safe working/access platforms for labour and equipment.
  - f) Proper scheduling, stripping and refixing of shores.

It is important to realize that centering design requires the same skill and attention to details as the design of permanent structure of like type.

9. Loads on forms - The loads on vertical forms are to be assessed from consideration of:
  - a. Density of concrete, b. Slump of concrete, c. Rate of pour, d. Method of discharge, e. Concrete temperature, f. Vibration, g. Height of discharge, h. Dimensions of section cast, i. Reinforcement details, j. Stiffness of forms
10. Form material and type - The choice of the form material mainly depends on the availability and cost of the material. Form materials include timber, plywood, hardboard, plastic fiber board, corrugated boxes, steel, aluminium, plaster of Paris etc., Thin metal sheets, neoprene craft paper, hardboard, fibre board and gypsum are generally used as forms liners attached to inside face to improve or alter the surface texture of concrete. Timber, plywood and steel are the main materials used in our country.
11. Timber - Traditional material for formwork has been timber due to its easy availability, relatively low cost and ease for shaping. The disadvantages of timber are warping, twisting, deterioration under stress of heat and contact with wet concrete. It is common practice to support formwork for slab in buildings with timber ballies cut to approximate sizes with



wedges used underneath them for final adjustments. These make weak points and are seldom prevented from displacement. Timber ballies are generally not straight and do not transmit load axially.

12. Plywood - The advantages of plywood are large panels for economical construction and removal, choice of thickness, physical properties, good finish and economy from repeated uses.

13. Steel - Steel has been an important material for fabrication of standard as well as special purpose forms, accessories and hardware. Steel is also extensively used for making horizontal and vertical shores. Because of the known characteristics of steel, design calculations for the system can be precisely made. Steel formwork system also facilitates to maintain accurate alignment, level and dimension with excellent surface finish.

Readymade forms are modular panel systems and accessories that can be adopted to build formwork for various sizes and shapes. Tailor made or special purpose made forms is fabricated to order and include tunnel forms, bridge girder shutters, dam shutters etc.

14. Climbing formwork - Most commonly used formwork system is the Climbing Forms. This system basically consists of form panels assembled with or without walers and supported by vertical strong back members (generally called soldiers) of various designs. The Climbing Form System for large and deep concrete pours may incorporate special features such as, working platforms, adjustable push-pull struts for aligning the formwork and also roller mechanism for shifting the form assembly to allow tying reinforcement and fixing other inserts, in case of thin walls. Various types of anchorage's are used to fix or support the Climbing Form Assembly to the previous concrete lift complete floor height in case of shear walls in buildings, deep pours in piers, abutments of bridges and duct walls are typical examples where such systems are used and generally handled by cranes. For smaller structures and shallow pours, lighter soldiers are used and the Form assembly is usually dismantled in small sections and refixed from pour to pour manually, with external access scaffolding.

15. Slip forms - Slip form construction also known, as sliding forms of construction is similar to extrusion process. The rate of movement of forms is regulated so that when forms leave the concrete it is strong enough to retain its shape while supporting its own weight. Vertical slip form is used for bins, silos, bridge piers etc. where as horizontal slip form is used for canal lining, tunnel invert etc. Recent developments in slip form techniques enable construction of tapered structures like chimneys, cooling towers etc where simultaneously with moving of forms, vertically, mechanical/hydraulic jacks also adjust the forms circumferentially to the required sizes as the slide progresses.

16. Suspended forms - This is a climbing system of formwork used for construction of chimneys, silos etc. the forms for outside of the structure is suspended from a concreting

platform which in turn is suspended from a central scaffold tower by means of chain pulley block. The formwork system incorporates a radial shift mechanism for adjusting the outer form to the required diameter. The inside forms are usually the climbing types.

17. Travelling or moving forms - Travelling or moving forms are usually made of steel and are generally resorted for construction of long stretches of similar section such as tunnel linings, sewers, galleries, culverts etc. Substantial saving in time and labour is possible by using travelling forms. Travelling forms are tailors made form fabricated/assembled to shape and supported by framework or gantry structure which is fitted with wheels for movement either manually or by electric or hydraulic motors. Hinges or other stripping devices are provided in the shutter itself for collapsing the formwork by means of jacks or turnbuckles. In telescopic type the form is so designed that with one mobile gantry several units of formwork can be handled by telescoping one section of formwork through the other.

18. Aluminum forms - Certain aluminium alloys are used for making forms, which are similar to steel forms. They are lightweight and reduce handling costs.

19. Concrete hardware's - Formwork systems generally incorporate a variety of hardware's such as ties and anchors for resisting lateral pressure exerted by green concrete. Form ties are tensile units consisting of an internal tension member and an external holding device. The ties can be continuous single unit or internal disconnecting type. Form anchors are devices embedded in previously poured concrete and are used for securing formwork for the subsequent lifts.

20. Formwork supports or centering - Various types of formwork supports have been developed in steel. They have been specially designed to cut labour cost in erection and stripping and to make them versatile by incorporating an adjustability feature in most cases. Generally formwork supports are either single leg type or multilegged type such as a frame or a tripod or a trestle. The single leg type is called a prop or a shore and is generally tubular and telescopic type. It incorporates adjusting features through a collar or nut to provide infinite adjustment in height. The props are usually used for supporting formwork upto heights of about 5 M. Beyond this height, they may be used in tiers in which case they are properly tied and braced to form a rigid structure. Bracings can be provided by means of tubes and clamps.

Among the multilegged support systems the common ones are of prefabricated tubular frames in a variety of shapes and modular sizes which can be assembled one over other to get the required heights and also spaced at suitable intervals depending on the loads to be carried. The forms are usually braced together by means of ledgers and cross braces to form a rigid structure. For finer adjustments in height, there are special accessories like screw jack either at top or bottom or both.

Like vertical formwork supports or shores there are also many types of horizontal formwork supports available. These are usually latticed or boxed beams which also telescope one into the other and cater for a range of spans. These horizontal supports rest either on beam forms or other shores at ends. The need for intermediate supports is eliminated and free access and working space is obtained during construction.

An important development in the formwork system particularly for flat slab and multistoried construction is the drop head system. Drop head is fitted on top of the prop or supports which continue to support the slab while the remaining form for the decking could be struck for reuse, thereby affecting a great economy in the formwork costs. With this system only an extra set of shores would be required to get faster cycle of slab construction.

Various scaffolding systems may also be adopted and used to act as centering especially when the heights of supports involved is large such as in the case of high industrial buildings, motorway decks, high shell or barrel roof hangers etc.

21. Scaffolding - Practically in all stages of construction, scaffolds are required to provide temporary platforms at various levels to carry out all these works which can not be conveniently and easily carried out either from ground level or any other floor of the building or with the use of a ladder.

22. Timber scaffold - Timber has been used for building scaffold from time immemorial and continues to be used even today. The most common type of scaffolding used in India even today is bally or bamboo scaffold. Barring a few cases where bally or bamboo scaffolding is neatly erected, properly braced and well tied to the building, invariably such scaffolds are in crooked and awkward shapes presenting a dreadful sight particularly on tall building where a stronger and safer scaffolding is called for. The draft revision of IS 3696 suggests limiting bamboo and timber scaffold up to maximum of 18 M. height.

23. Metal scaffold - By and large metal scaffolds are made of steel tubes. Many countries have formulated standard specifications and codes of practice for metal scaffolding. IS: 2750 for steel scaffolding and IS: 4014 parts 1 and 2 for steel tubular scaffolding are relevant Indian Standards.

Metal scaffolds are broadly two types viz. Tubes and fitting type and prefabricated unit frame type.

Tubes and fittings type consists of plain tubes, which are, used for making uprights, transoms, ledger and putlog. Various type of clamps viz. Right angle or double coupler, swivel coupler, putlog coupler, joint pins etc are available for connecting tubes.

Many designs of prefabricated unit type of scaffold have been developed by proprietary concerns and are now being extensively used in most of the construction sites through out the world. Units have been designed incorporating the following basic features.

- i) Prefabrication of adjustable components with few or no loose parts.
- ii) Simple and fool-proof devices as far as practical to ensure maximum safety.
- iii) Speed and ease in erection and dismantling at site by unskilled workers.
- iv) Known characteristics of each component enabling complete calculation of loading to ensure use of minimum materials.
- v) High degree of versatility and durability enables hundreds of uses for a wide range of applications.

Some of the prefabricated types of scaffoldings available are as follows:

24. Unit frame or three pieces frame - This consists of two verticals and one horizontal member with specially designed end fittings and when three are assembled together it forms a H frame. The end fittings on the horizontal also incorporate a fixing device for the longitudinal ledger. The unit frames can be erected one above the other and are spaced at suitable intervals depending on the duty of the scaffolding. The manufacturers provide complete data on loading capacities. The advantage of this type of three piece frame is that the units can be spaced at any required intervals and also the platforms can be had at any required levels and hence scaffold of this type may be truly called as all purpose type.

25. Welded frame type - These scaffold frames are made as welded units consisting of two uprights and one or more cross members to form a rectangular or H frame. Such frames can be erected one over the other to the required height. Lengthwise such frames are connected either by scissors type cross braces or ledgers. In this system the length of the ledger or cross braces decides the longitudinal spacing of the frame. Accessories such as base plate, adjustable stirrup head etc are also supplied to complete the system. The frames are made of tubes in different grades viz. Light duty or heavy duty as required.

26. Wedge lock or collar grip type - Wedge lock type scaffold consists of verticals, ledgers, transoms and diagonals. The uprights have housing welded on them at regular intervals. The transoms, ledgers and diagonals have specially designed wedge lock assemblies fitted at ends, which engage in the housing on the uprights. This type of scaffolding can be erected very fast and does not require any special tool except a small hammer to drive the wedges in. Necessary accessories are also supplied to complete the system. This is extensively used for building scaffold towers inside chimneys, silos etc and also in ship building.

29. Scaffold boards - Scaffold boards for platform are generally in timber, particularly in pinewood because of its lightweight and strength. Apart from timber boards, Steel planks are also available. They are generally made with thin M.S. Sheet with pressed or cold-formed flanges and provided with anti-skid surface treatment. It may be noted that steel planks would not be suitable for platform in extreme tropical climate and also where oil/grease or such other slippery materials are likely to fall on platforms.

30. Safety requirements - Codes of practice specify the construction details of scaffolding and also give guidelines for bracketing and tying of scaffolds for stability. Single pole scaffolds shall be braced longitudinally and the double pole scaffold shall be braced both longitudinally and transversally, so that the scaffolds form a rigid and stable structure. The scaffold shall be effectively tied to a building or adjacent structure to prevent movement of the scaffold either towards or away from the building or structure. In extreme wind conditions, it may be necessary to provide additional ties, guys or other suitable supports as decided by the engineer.

31. Scaffolding systems.

1. Metallic scaffolding is mainly of steel although aluminum is also finding increasing use as a raw material. Steel scaffolding generally includes the following.

2. Tubes & fittings. This is the commonest type of metallic scaffold first used in 1908 by a British company. This system is versatile but cumbersome and time-consuming to use since it involves a lot of joints and several loose components, which necessitate safety precautions during erection. It is recommended only for limited applications such as access scaffold for not a very tall building and for old structures/connections.

3. Welded frame-Type-Fabricated - Steel frames and cross braces systems frames are placed at regular intervals one over the other and inter-connected by cross braces for rigidity and stability. This is sturdier and safer, easy to erect and dismantle, and is suited for most staging and scaffolding jobs. But the system has some limitations in use due to the fixed size of components. It is ideal for access scaffold, heavy staging of industrial buildings, bridges, flyovers, aqueducts, etc.

4. All-purpose units / Wedge-lock type scaffolds: These scaffolds are fairly versatile but require more time to erect and dismantle compared to the welded frame type of scaffold. They are suited for access scaffolding and slab staging of industrial structures. All-purpose units consist of two vertical and one horizontal unit which are interconnected by ordinary 40 mm. NB M.S. tubes called ledgers.

5. CUPLOK systems - This is among the most versatile modular scaffolding arrangements in the world. Its unique node point connection makes it a fast assembly scaffolding. The absence of loose parts and a unique cup action allows four horizontal units to be fixed or released in a single operation by means of only a hammer. Careful selection of raw materials for various components such as higher grade YST-240 tube, malleable cast iron top cups, deep drawn steel of bottom cups and drop-forged ledger blades makes it a sturdy and yet light scaffolding system. It is ideally suited for all access scaffolds and slab staging for any type of construction. The prime feature of CUPLOK is that since its vertical member has cup joints at every 500 mm. One has to just change the location of the horizontal units (thereby reducing or increasing l/r ratio) for different loading conditions without changing

the size or thickness of the vertical tubes. Modular scaffolding systems have been effectively used for boiler maintenance, chimneystacks, access, flyovers, silos as well as offshore structures/ship building and repairs. These systems prove economical as they cut down erection time significantly.

6. Slab shuttering & support systems - From the days of timber shuttering & wooden props, slabs shuttering and centering have come a long way. The various slab shuttering systems are:

a) Conventional span-prop arrangements: Adjustability of the components makes the system versatile for normal slab shuttering.

b) Shuttering for heavier slab/deck slab - Specially designed shutters are made for jobs such as slab of industrial building, flyovers, bridges, etc.

c). Metriform unit – Decking arrangements: These consist of modular Metriform beams and panels while supporting the slab on drop-heads fitted over steel props or scaffolds. Slab shuttering can be removed in three days instead of the regular seven days thereby considerably increasing the rotation of shuttering materials. It is thus ideal for today's time-bound projects.

d) Shuttering for waffles troughs - Made out of moulded plastic materials to give architectural finish.

e) Flying form - This includes the crane-handled formwork of a complete floor slab of a building for speedy completion. All the slabs of the building should be identical in this case.

f) Support staging - Slab/beam staging is normally effected through adjustable steel props or any type of system scaffold depending on the height and load of the structure to be taken on support staging.

7. Wall / column shuttering - The construction of RCC walls/columns requires sturdy shuttering to take care of concrete pour pressures. The systems generally available are:

a) Conventional channel/heavy duty soldier - This consists of steel panels connected side by side with soldiers. Heavy duty soldiers are used for one-sided shuttering such as for RCC piers, retaining walls, etc. these are ideal for lift walls, shear walls, RCC piers, columns etc.

b) Heavy duty/ strong back arrangement - This is meant for a pour height of up to 5 m. using J-4 or Slimlite back-up soldiers. Shuttering can be of steel/ply with soldiers provided as back-ups, behind the shutters. It is ideal for fast concreting, with the help of pumps and can be crane-handled.

8. Special shuttering - Construction of special structures also requires suitable formwork. Some of the applications are:

a) Slip form of chimneys/silos: Hydraulically lifted complete shuttering by means of heavy duty jacks enables concreting of a tall chimney in hardly any time as more often the slipping (or concreting) is continuous once it starts.

b) Dam shuttering: Special heavy duty hinged soldiers along with heavy shutters are used to match the profile of a dam.

c) Canal lining: Mobile shutters are specially designed to move along the canal, for the concrete lining.

d) Bridge shuttering: Shutters for girders are specially designed to take care of concreting loads.

9. Conclusion - It is obvious that modern shuttering and scaffolding systems, which are continuously evolving, are among the most important aspects of construction and maintenance. Unfortunately, so far neither the industry nor the engineering institutions have really gone into the relevance and details of this equipment are which should be utilized for effecting proper and economical designs for particular applications. With the advent of professional scaffolding organisations and realisation of the need on the part of the industry for safer, faster and economical construction, one hopes for the development of this long-neglected but important area in the near future is going to be a reality.

Annexure-4-A.7

#### CONCRETE WORK --- LIST OF BUREAU OF INDIAN STANDARDS

SI No	IS No.	Subject
1	306-1983	Tin bronze ingots and castings (3rd revision) Reaffirmed 1993.
2	383-1970	Coarse and fine aggregate from Natural source for concrete (2nd revision) Reaffirmed 1990.
3	456-2000	Code of practice for plain and reinforced concrete (3rd revision) (Amendments 2) Reaffirmed 1991.
4	516-1959	Method of sampling and analysis of concrete. Reaffirmed 1991.
6	1200 (Part II) 1974	Method of measurement of building and civil engineering work Part 2 (concrete works). (3rd revision) (Amendments 2) Reaffirmed 1991.
7	1322-1993	Bitumen felt for water proofing and damp proofing (4th revision) (previously 13220-1982)
8	1791-1985	Batch type concrete mixers. (2nd revision) Reaffirmed 1990.

9	2386-1963	Method of test for aggregate for concrete work. Part 1 particle size and shape (Amendments 2) Reaffirmed 1990
		Part 2 Estimation of deleterious materials and organic impurities (Amendments 1) Reaffirmed 1990.
		Part 3 Specific gravity, density, voids, absorption and bulking - Reaffirmed 1990.I
		Part 4 Mechanical properties (Amendments 3) Reaffirmed 1990.
10	2505-1980	General requirements for concrete vibrators immersion type. Reaffirmed 1993.
11	2505-1985	General requirements for screed board concrete vibrators. (1st revision) Reaffirmed 1990.
12	2645-1975	Integral cement water proofing components (1st revision) (Amendments 1) Reaffirmed 1992.
13	2686-1977	Cinder as fine aggregate for use in lime concrete (1st revision) (Amendments 1) Reaffirmed 1992.
14	3068-1986	Broken burnt (clay) coarse aggregate for use in lime concrete. (2nd revision) Reaffirmed 1991.
15	3812-1981	Flyash for use as pozzolana and admixtures (1st revision) Reaffirmed 1992.
16	4643-1984	Section wrenches for fire bridge use (1st revision) Reaffirmed 1992.
17	4656-1968	Form vibrators for concrete. Reaffirmed 1991.
18	7861 (Part 1) 1981	Code of practice for extreme weather concreting (Part 1) recommended practice for hot weather concreting (Amendments 1) Reaffirmed 1990.
19	7861 (Part 2) 1975	Code of practice for cold weather concreting (Part 2) Recommended practice for cold weather concreting (Amendments 1) Reaffirmed 1992.
20	9103-1979	Admixture for concrete Reaffirmed 1990.

## 7. STEEL, IRON AND ALLUMINIUM WORKS

### 7.1 Materials

7.1.1. **Steel** - All finished steel shall be well and cleanly rolled to the dimensions and weight specified by Bureau of Indian Standards subject to permissible tolerances as per IS: 1852. A List of BI Standards applicable to this section is Annexure 7-A.1. The finished materials



shall be reasonably free from cracks, surface flaws laminations, rough and imperfect edges and all other harmful defects.

7.1.2. Steel sections, shall be free from excessive rust, scaling and pitting and shall be well protected. The decision of the engineer regarding rejecting any steel section on account of any of the above defects shall be final and binding.

7.1.3. Structural steel work shall conform to the following requirements. The following varieties of steel should be used for structural purposes

7.1.4. **S.T. 42S** - The standard quality steel designated as ST-42S, conforming to IS: 226 shall be used for all types of structure (riveted or bolted) including those subject to dynamic loading and where fatigue, wide fluctuation of stresses are involved, as for example crane gantry girders, road and rail bridges etc. It is also suitable for welded structures provided that the thickness of materials does not exceed 20 mm.

7.1.5. **S.T. 42W** - The fusion welding quality steel designated as S.T. 42W, conforming to IS: 2062 shall be used for structures subject to dynamic loading (Wind load is not to be considered as dynamic load for this purpose) where welding is employed for fabrication and where fatigue, wide fluctuation of, stresses reversal of stress and great restraint are involved as for example, crane gantry girders and road and rail bridges.

7.1.6. **S.T. 420** - The ordinary quality steel designated as S. T. 420 conforming IS: 1977 shall be used for structures not subjected to dynamic loading other than wind loads where welding is not employed or / and structures not situated in earth quake zones or / and design has not been based on plastic theory.

7.1.7. **S.T. 320** - The ordinary quality steel designated as S. T. 420 conforming to IS: 1977 shall be used for doors, window frames, window bars, grills, steel gates, hand railing, builders hardware, fencing post, tie bars etc.

7.1.8. Casting shall be cast from cast iron of grade FG 150 conforming to IS: 210-1978, Specification for grey iron castings. The castings shall be sound, clean and free from porosity, blow holes, hard spots, cold shuts (i.e. irregularities due to casting at too low a temperature), distortion and other harmful defects. They shall be well dressed and fettled, accurately moulded in accordance with the pattern/drawing and shall be of uniform thickness except where the design necessitates variation. Abrupt changes in the section of adjoining members shall be avoided as far as possible. Unless otherwise indicated edges of castings shall be rounded and internal angles finished with an angle fillet. No welding or repairs shall be carried out, unless otherwise indicated.

7.1.9. **Rivets** - Rivets shall be made from rivet bars of mild steel as per IS: 1148-1982. High tensile rivet bars shall conform to IS: 1149-1982.

7.1.10. **Bolts** - These are of two types namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for

turned bolts is adopted. They shall conform to IS: 1367 Technical supply conditions for threaded steel fasteners.

7.1.11. **Electrodes** - The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS: 814-1991.

## 7.2. Workmanship – General

7.2.1. Structural steel work riveted, bolted or welded shall be carried out described in IS: 800-1984, Code of practice for use of structural steel in general building construction.

7.2.2. **Straightening and bending** - All material shall be straight and if necessary, before being worked shall be straightened and flattened by pressure, unless required to be of curvilinear form and shall be free from twists. Straightening of steel by hammer blows is not permitted. All bending and cutting shall be carried out in cold condition, unless otherwise directed, in such manner as not to impair the strength of the metal.

7.2.3. **Cutting and machining** - Member shall be cut mechanically by saw or shear or by oxyacetylene flame. All sharp rough or broken edges and all edges of joints which are subjected to tensile or oscillating stresses shall be grounded. No electric metal arc cutting shall be allowed. All edges cut by oxyacetylene pores shall be cleaned of impurities and slag prior to assembly, cutting tolerance shall be as follows (a) For member connected at ends  $\pm 1$  mm. (b) Elsewhere  $\pm 3$  mm.

When compression members depend on contact surfaces for stress transmission, then ends of columns and bases together with gussets, angles and channels (after riveting / welding together) shall be accurately measured so that the parts connected butt over the entire surfaces of contact. Columns at bases or at caps or at butt joints need to be machined.

7.2.4. **Holes** - All holes shall be accurately marked and drilled. Holes through more than one thickness shall preferably be drilled together after the members are assembled and tightly clamped or bolted together. In such cases, if required, these parts shall be separated after drilling and burrs removed. For thickness of materials less than 16 mm the holes may be punched 3 mm less in diameter than the required size and may be reamed to the full diameter after assembly. Finished holes for rivets and black bolts shall be more than 1.5 mm (2.0 mm for rivets and bolts of diameter more than 25 mm) in diameter larger than the diameter of rivets and bolts passing through them. All matching holes for rivets shall be so prepared that a gauge 0.8 mm diameter less than the hole can pass freely through the members assembled for riveting. Holes other than those required for close tolerance may be punched full size through material not less than 12 mm thick.

All holes shall have their axis perpendicular to the surface bored through Holes through two or more members shall be truly concentric. No rivet or bolt hole shall be nearer the edge of the member than a distance equal to its own diameter. Holes shall not be formed by gas cutting process.

## 7.2.5. Assembly

7.2.5.1. **Laying out** - Steel structure shall be laid out on a level platform to full scale and to full size or in parts as shown on working drawings or as directed by engineer. Wooden templates 12 mm to 19 mm thick or metal sheet templates shall be made to correspond to each member and part; rivet holes shall be marked accurately on them and drilled. The templates shall be laid on the steel members and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting. The base of steel columns and the positions of anchor bolts shall be carefully set out. The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified cambers, if any, are provided. All box sections shall be sealed so as to prevent the access of moisture to the inside of the members.

Assembly shall be done by using assembly fixtures, jigs and stands which facilitate high quality assembly with proper safety. Misalignment and distortion of parts after assembly shall not be allowed; only thoroughly straightened parts free from burrs, grease, rust, etc. shall be allowed for assembly.

Temporary connection of parts during assembly shall be done in the following way:

- d) For welded structures joining shall be done by means of tack weld, fastening devices and fixtures.
- e) For riveted and bolted structures joining shall be done by adequate number of bolts. If tack welding is permitted, in such cases the same shall be removed after the work is over.
- f) For riveted structures in which holes are to be drilled after assembly, joining shall be done by appropriate fixtures.

Tack welding shall be done on the side and along the line of the weld. Tack weld dimension all be minimum, welding being carried out with similar electrodes as the final welding and the tacks shall completely fuse with the final weld metal. In case splicing is necessary, the individual members shall be spliced first before assembly and before final welding with other members.

For riveted structures, members shall be well tightened by assembly bolts in every third hole maximum distance between bolts shall not exceed 500 mm. To prevent stiffening drift pins shall be used 30 per cent of the assembly bolts. After tightening, the gap between members to be jointed shall be checked by 0.2 mm thick feeler gauge which should not go inside by more than 2 mm, looseness of bolts shall be checked by tapping with a test hammer.

#### 7.2.6. **Riveting**

Riveting shall be done by pneumatic riveting or hydraulic riveting equipment, riveting of diameter less than 10 mm may be fitted cold. In cold riveting the rivets are driven with the aid of powerful pneumatic or electrical clamps and the holes filled with sufficient tightness. However where such facilities are not available, hand riveting may be permitted by the engineer.

Members to be riveted shall be properly pinned, or bolted and rigidly held together while riveting. Rivets shall be heated uniformly throughout the length without burning or excess scaling and shall be of sufficient length to provide ahead of standard dimension. They shall, when driven, completely fill the holes and if countersunk, the countersinking shall be fully filled by the rivet. Any proudness of countersunk head shall be dressed off flush. All loose, burnt and badly formed or otherwise defective rivets shall be cut out and replaced before the structure is loaded. The heads of rivets shall be central to shanks and shall grip the assembled members firmly. In cutting out rivets care shall be taken so as not to injure the assembled members. Caulking or recupping shall not be permitted.

#### **7.2.7. Bolting**

Bolt heads and nuts shall be of such length as to project one clear thread beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Round washers shall be placed under the heads and nuts of permanent bolts. Maximum two washers for one nut and one for each bolt head shall be used. Both threads shall be outside the limits of joining members and unthreaded portion of bolt shall not be outside the washer.

Where there is risk of the nuts being removed or becoming loose due to vibration or reversal of stresses, these shall be secured from slackening by the use of lock-nuts or spring washers, as directed by the engineer. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil before use. Quality of lightening of bolts shall be inspected by tapping them with a hammer. The bolt shall not be shaken or shifted. The bolts shall be tightened starting from centre of the joint towards the edge.

#### **7.2.8. Welding**

Welding shall be done by metal arc process unless otherwise permitted by the engineer, in writing, in accordance with IS: 816-1969 Code of Practice for use of metal arc welding of general construction in mild steel, and IS: 9595-1980. Recommendation of Metal Arc Welding, regarding workmanship welding method, welding procedure with suitable electrodes and wire flux, combinations, quality of welds, correction of weld faults etc.

#### **7.2.9. Preparation of members for welding**

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axis, nodes etc.).

Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped or ground or filed over the length of the affected area, deep enough to remove faults completely. Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint. Generally no special edge preparation shall be required for members under 8 mm thick.

Edge preparation (beveling) denotes cutting of the same so as to result in V, X, K or U seam shapes as per IS: 9595-1980.

The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter, likely to get into the gaps between members to be welded.

Before assembly, the edges to be welded as well as adjacent areas extending for at least 20 mm shall be cleaned (Until metallic polish is achieved). When assembling members proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure. The elements shall be got checked and approved by the engineer before assembly wherever it is specified. The permissible tolerances for assembly of members preparatory to welding shall be as per IS: 9595. After assembly has been checked, temporary tack welding in position shall be done by electric welding; keeping in view finished dimensions of the structure. Preheating of members to be joined to be carried out as per standards wherever necessary.

#### 7.2.10. **Butt welds** (Fig. 1)

The form of joint, angle between fusion faces, gap between parts and the welding procedure shall be such that the welded joint shall comply with the design requirements. The ends of butt joints in plate shall be welded so as to provide full throat thickness. In the gas welded condition, the weld face shall be proud of the surface of the parent metal. Where a flush surface is required, the excess metal shall be dressed off. Where no dressing is to be carried out, the permissible weld profile shall be as specified in the relevant IS.

For butt weld, where these are to be welded for both sides, certain welding procedures allow this to be done without back going, but where complete penetration cannot be achieved, the back of the first run shall be gouged out to clean sound metal before welding is started on the gouged outside.

#### 7.2.11. **Fillet Welds** (Fig. 1)

A fillet weld as deposited shall be not less than the specified dimensions indicated as throat thickness and/or leg thickness taking into account penetration or partial penetration. For concave fillet welds the actual throat thickness shall be not less than 0.7 times the specified leg length. For convex fillet welds, the actual throat thickness shall be not less than 0.9 times the specified leg length.

#### 7.2.12. **Preparation of joint faces**

If preparation or cutting of material is necessary, this shall be done by shearing, chipping, grinding, machining, thermal cutting or thermal gouging. When shearing is used the effect of work hardening shall be taken care of to ensure that there is no cracking of the edges. Removal of 1 mm to 2 mm from a cut face normally eliminates the layer of hardness.

#### 7.2.13. **Fusion faces**

Fusion faces and adjacent surfaces shall be free from cracks, notches or other irregularities which might be the cause of defects or would interfere with the deposition of the weld. They shall also be free from heavy scale, moisture, oil, paint and any other substance which might affect the quality of weld or impede the progress of welding.

**7.2.14. Assembly for welding**

Jigs and manipulators should be used, where practicable, so that the welding can be carried out in the most suitable position. Jigs shall maintain the alignment with the minimum restraint so as to reduce the possibility of lock in stresses.

**7.2.15. Alignment of butt joint**

The root edges or root faces of butt joints shall not be out of alignment by more than 25 per cent of the thickness of the thinner material for material up to 12 mm thick or by more than 3 mm for thicker material. For certain applications closer tolerances may be necessary for proper alignment.

**7.2.16. Fit up of parts jointed by fillet welds**

The edges and surfaces to be jointed by fillet welds shall be in as close contact as possible since any gap increases the risk of cracking but in no case should the gap exceed 3 mm.

**7.2.17. Tack welds (Fig.1)**

Tack welds shall be not less than the throat thickness or leg lengths of the root run to be used in the joint. The length of the tack weld shall not be less than four times the thickness of the thicker part or 50 mm whichever is similar. If smaller tack welds are desired, these shall be so indicated.

Where the tack weld is incorporated in a welded joint, the shape of the tack shall be suitable for incorporation in the finished weld and it shall be free from cracks and other deposition faults.

**7.2.18. Protection from weather**

Surface to be welded shall be dry. When rain or snow is falling or during periods of high wind, necessary precautions shall be taken for outdoor welding arc. Warming shall be carried out at all ambient temperatures below 10 degree C.

**7.2.19. Inter-run cleaning**

Each run of weld bead and each layer of weld shall be thoroughly cleaned of slag, spatters, etc. before depositing subsequent bead or weld with particular reference to thorough cleaning of toes of the welds. Visible defects such as cracks, cavities and other deposition faults, if any, shall be removed to sound metal before depositing subsequent run or layer of weld.

**7.2.20. Welding procedure**

Welding shall be carried out only by fully trained and experienced welders as tested and approved by the engineer. Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS: 823-1964. The nature of test for performance qualification for welders shall commensurate with the quality of welding required on this work as judged by the engineer. The steel structures shall be automatically, semi automatically or manually welded. Welding shall be only after the checks have been carried out. Welding procedures and Tests for welders shall be conducted as per IS: 9595 and approved by the engineer. The welder shall mark with his identification mark on each

element welded by him. When welding is carried out in open air steps shall be taken to protect the places of welding against wind or rain. The electrodes wire and parts being weld on shall be dry. Before beginning the welding operation each joint shall be checked to assure that the parts to be welded are clean and root gaps provided as per IS: 9595. For continuing the welding of seams discontinued due to some reasons the end of the discontinued seam shall be melted in order to obtain a good continuity. Before resuming the welding operation the groove as well as the adjacent parts shall be well cleaned for a length of approximately 50 mm. For single butt welds (in V, ½ V or U) and double butt welds (in K, double U, etc.) the re-welding of the root butt is mandatory but only after the metal deposition on the root has been cleaned by back gouging or chipping. The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any method. For multilayer welding before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed. The order and method of welding shall be so that (a) no unacceptable deformation appears in the welded parts. (b) due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses. The defects in welds must be rectified according to IS: 9595-1980 and as per instruction of engineer.

#### 7.2.21. Approval and testing of welders

The contractor shall satisfy the engineer that the welder is suitable for the work upon which they will be employed.

#### 7.2.22. Weld inspection

The weld seems shall satisfy the following

b) Shall correspond to design shapes and dimensions.(b)Shall not have any defects such as cracks, incomplete penetration and fusion under cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible. During the welding operation and approval of finished elements inspections and tests shall be made as shown in Table 1 below

Table 1 Extent of inspection and testing

Sl .N o	Inspection of test	Coverage	Procedure	Evaluation and remedy of defects
1	Inspection of weld seam Appearance	All welds	Naked eye or lens	All faulty welds shall be rectified.
2	Checking of sizes	Atleast one for each weld seam	Ordinary measuring instruments (Rule template)	Should faulty weld be found, all welds shall be checked and all defects shall be rectified.

	Mechanical test for welding procedure, performance & electrodes.		As per IS: 9595	As per IS: 9595
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The mechanical characteristics of the welded joints shall be as in IS: 9595.

#### 7.2.23. Quality of welds and corrections

Welded joints shall be free from defects that would impair the service performance of the construction. All welds shall be free from incomplete penetration, incomplete fusion, slag inclusion, burns, un-welded craters, undercuts and cracks in the weld metal or in the heat affected zone, porosity etc. Unacceptable undercutting shall be made good by grinding. In case of shrinkage cracks, cracks in parent plate and crater, defective portions shall be removed down to sound metal and re-welded. Whenever corrections necessitate the deposition of additional weld metal, electrode of a size not exceeding 4 mm may be used. Rectification of welds by caulking shall not be permitted.

7.2.24. **Cleaning** - All welds shall be cleaned of slag and other deposits after completion; till the work is inspected and approved, painting shall not be done.

#### 7.2.25. Plaining of ends

Plaining of ends of members like Column ends shall be done by grinding where so specified. Plaining of but welded member shall be done after these have been assembled and the edges be removed with grinding machine or file.

The following tolerances shall be permitted on members that have been plained

- d) The length of member having both ends plained max  $\pm 2$  mm with respect to design.
- e) Level difference between plained surface = 0.3 mm.
- f) Deviation between plained surface and member axis = max  $1/5000$ .

#### 7.2.26. Safety and health

The contractor shall ensure that the safety requirements and health provisions laid down in IS: 818-1968 Code of Practice for safety and health requirements in electric and gas welding and cutting operations are complied with during welding operations. The contractors shall also provide equipment for eye and face protection during welding as laid down in IS: 1179-1967. Fire precautions shall be taken in accordance with IS: 3016-1982 Code of Practice for fire precautions in welding and cutting operations.

#### 7.2.27. Erection

Erection works shall be performed in accordance with the general construction schedule. A scheme shall be worked before the commencement of the erection which shall also contain rules for safety precautions as detailed in IS: 7205-1973. (Safety Code for erection of structural steel work).

Anchor bolts for fastening of steel structures shall be set in designed position and grouted along with foundations. Alternatively anchor bolts should be provided in the concrete



foundations with bolt boxes and anchor channels for the purpose of flexibility and grouted after final alignment and leveling of column. The gaps between the bearing surface of foundation and bottom of the structures to be erected shall be filled properly by cement grouting. Grouting shall be done after the verification and proper positioning of the structures but before encasing the structures with concrete if specified. Damaged structural members shall be examined and rectified or replaced as directed. The erected parts of the structure shall be stable during all the stages of erection; and structural elements to be erected shall be stable and strong to bear erection loads. Working on the already erected structures is permitted only after they are finally fixed. Erection of structures of each tier high structures shall be executed only after the relevant fastening of lower tier by the permanent or temporary fastening devices as per schedule of execution of work and certified for safety. The joint and mating surface including the mating planes, strips and filler or spacers shall be cleaned of dust, rust and water.

Erected structural members shall be firmly fastened by bolts and drifts, permanent or provisional tacking, crossing bars and so on before the erection crane hook is removed. The trusses shall be lifted only at nodes. The trusses above 12 m span shall not be slinged at the apex, as it will develop compression stresses in the bottom tie member. It shall be lifted by slinging at two mid points of rafters, which shall be temporarily braced by a wooden member of suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible. The end of truss which faces the prevailing winds shall be fixed with holding down bolts and the other end kept free to move. In case of small truss of span say up to 12 m the free end of the truss shall be laid on steel plate as per design and the holes for holding down bolts shall be made in the form of oblong slot so as to permit the free movement of the truss end. For large spans, the free end of the truss shall be provided with suitable rocker and roller bearing where indicated.

#### **7.2.28. Erection joints**

While erecting, holes to be riveted shall be fitted with temporary bolts and drifts of diameters equal to those of the holes. It is necessary to initial drifts for accurate matching of holes. Number of bolts and drifts shall not be less than 40 per cent of total number of holes. Forces applied to drifts shall be same as approved for rivets. Number of drifts shall be 10 per cent of number of holes.

The number, size and length of tack welds in erection joints bearing erection forces shall be as indicated. For the erection joints which do not bear the erection forces the length of tack welds shall be minimum 10 per cent of the designed weld length of the joints.

Welding, riveting and final fastening or permanent bolts shall be done only after the inspection of the structural elements for their positions. Head bolts and nuts shall perfectly be in touch with the surfaces of structures and washers.

#### **7.2.29. Tolerance allowed in erection**

**Building without crane** - The maximum Tolerance for line and level of steel structure shall be  $\pm 3.00$  mm on any part of the structure. The structure shall not be out of plumb more than 5.00 mm each 10 metre section in height and not more than 7.00 mm per 30 metre section. These tolerances shall apply to all parts of structure unless otherwise specified.

Tolerance allowed in erection of steel structure containing cranes shall be as per following Table.

Table

Component	Description		Tolerance allowed
Main columns And roof posts	a	Shifting of columns axis at foundation level with respect to building line:	$\pm 5.00$ mm
	i	In longitudinal direction	
	ii	In lateral direction	$\pm 5.00$ mm
	b	Deviation of both major column axis from vertical between foundation and other member connection levels:	
	i	For a column upto and including 10 m height	$\pm 5.00$ mm from true vertical.
	ii	For a column greater than 10 m but less than 40 m height	$\pm 5.00$ mm from True vertical for any 10 M length measured between connection levels but not more than $\pm 8.00$ mm for 30 m length.
	c	For adjacent pairs of columns across the width of the building prior to placing of truss.	$\pm 5.00$ on true span
	d	For any individual column deviation of any bearing or resting level from levels shown on drawings.	$\pm 5.00$ mm
	e	For adjacent pairs of columns either across the width of buildings or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	5.00 mm

Trusses	a	Deviation at centre of span or upper chord member from vertical plane running through centre of bottom chord.	1/500 of the span or 10 mm whichever is less.
	b	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is less.

### 7.3. Steel reinforcement

**Steel reinforcement for concrete** - Steel reinforcement shall be mild steel bars, deformed bars, steel wire fabrics and of grade / types as indicated.

Mild Steel Bars shall be of grade I or grade II indicated and conforming to IS: 432 (Part I)-1982 and (part II) (Annexure 7-A.7 & 7-A.8) Specification for mild steel and medium tensile steel bars. Alternatively mild steel shall be of grade Fe 410S conforming to IS: 226-1975 or of grade Fe 4100 conforming to IS: 1977-(1975) as indicated. The limitations, on the use of mild steel bars or of grade Fe 4100 as given under structural steel shall apply. Deformed Bars shall conform to IS: 1786-1979 Specifications for High strength deformed bars and wires for concrete reinforcement- enclosed as Annexure 7-A.9. Fabric reinforcement shall conform to IS: 1566-(1982) Specification for hard drawn steel wire fabrics for concrete reinforcement.

#### 7.3.5. Tolerance on size of reinforcement bars

The tolerance on diameter of the mild steel bars shall be  $\pm 0.5$  mm for bars up to and including 25 mm with a total margin of 1mm and  $\pm 0.75$  mm for bars above 25 mm dia with total margin of 1.5 mm. The tolerance on the diameter in the case of coiled round bars shall be  $\pm 0.5$  mm up to and including 12 mm diameter with a total margin of 1 mm. Measurement shall be taken at point sufficiently away from the ends ensuring exclusion of heavy ends.

#### 7.3.6. Tolerance on weight

The tolerance on weight of plain and deformed round shall be  $\pm 4$  per cent with a total margin of 8 per cent for bars up to and including 8 mm diameter and  $\pm 2.5$  percent for bars over 8 mm diameter with a total margin of 5 percent.

Tolerance on weight of fabric reinforcement shall be  $\pm 6$  per cent.

#### 7.3.7. Freedom from defects

All finished bars shall be well and cleanly rolled to the dimensions and weights specified; these shall be sound and free from cracks, surface flaws, laminations and rough, jagged and imperfect edges and other defects and shall be finished in a workman like manner.

Steel reinforcement shall be stored as to prevent distortion and corrosion. Any reinforcement that has deteriorated or corroded or is considered defective by the engineer shall not be used in the work. Bars of different classification, sizes and lengths shall be

stored separately to facilitate use in such sizes and lengths as to minimise wastage in cutting from the standard lengths.

#### 7.3.8. **Bends and hooks forming end anchorages**

Ends of plain round mild steel bars shall be bent to radius of not less than 2 diameters and the straight portion beyond the curve shall not be less than 4 diameters unless otherwise indicated. In the case of deformed bars, bends shall be made to radius of 4 times the diameter of the bar and straight portion beyond the curve shall not be less than 4 diameters, unless otherwise indicated. Ends of deformed bars are not bent to form hooks. In the case of binders, stirrups, links, etc., the straight portion beyond end of the curve at the end shall be not less than 8 times the nominal size of the bar

Bars specified to be formed to radii exceeding those given in Table X of IS 2502-1963 Code of practice for bending and fixing of bars for concreting, need not be bent but the required curvature may be obtained during the placing.

#### 7.3.9. **Bending of bars**

Bars shall be bent to shape cold except that bars larger than 25 mm in size may be bent hot at cherry red heat (not exceeding 850 degree C). Hot bar shall not be cooled by quenching. A bar which shows any sign of cracks at a bend shall be rejected.

Fig. 1 Welds and Rivets

#### 7.3.10. **Splicing**

Where bars required are longer than those carried in stock, splices shall be provided as far as possible, away from the section of maximum stress and be staggered. The use of short length bars shall not be permitted. IS: 456-1978 Code of practice for plain and reinforced concrete recommends

that splices in flexural members should not be at sections where the bending moment is more than 50 per cent of the moment of resistance ; and not more than half the bars shall be spliced at a section.

#### 7.3.11. **Lap splices**

Lap splices shall not be used for bars larger than 36 mm dia, larger diameter bars may be welded, in cases where welding is not practicable, lapping of bars larger than 36 mm dia may be permitted in which case additional spirals shall be provided around the lapped bars. Lap length shall be not less than 30 diameters for flexural tension and direct tension and not less than 24 diameters for compression. When bars of two different diameters are to be spliced the lap length shall be calculated on the basis of diameter of the smaller bar. End bearing splices shall be used only for the bars in compression. The ends of the bars shall be square out and concentric bearing ensured by suitable devices. When larger diameters have to be welded to avoid congestion rather than lapped for splicing, the method of welding shall be as directed. The location of staggered welds at heights or position shall be convenient for welding.

#### 7.3.12. **Spiral reinforcement**

Spirals shall be provided with one and a half extra turns at both top and bottom. Where necessary to splice the spiral it shall be done by a lap of one and a half turns or by shop welding.

#### **7.3.13. Placing and fixing of bars**

Reinforcements shall be placed in position as per detailed design drawing and shall be secured at that position. In case of delay occurring between fixing of reinforcement and concreting, the position of the reinforcement shall be checked prior to concreting. Bars crossing each other shall be secured by binding wire (annealed) of size not less than 0.9 mm, and conforming to IS: 280-1977. Specification for mild steel wire, in such a manner that they will not slip over each other at the time of fixing and concreting. Every compression bar shall be tied at least in two perpendicular directions.

#### **7.3.14. Cover blocks**

Cover blocks generally of cement mortar shall be used to ensure the required cover for the reinforcement. The mortar or concrete used for the cover blocks or rings shall be not leaner than the mortar or concrete in which they would be embedded.

#### **7.3.15. Spacers**

Where multiple rows of reinforcement are provided distances between successive rows shall be properly maintained while concreting by providing suitable spacer bars.

#### **7.3.16. Placing reinforcements**

All mill scale, loose or scaly rust, oil and grease or any coating that will destroy or reduce bond shall be thoroughly cleaned off the steel reinforcement with a stiff wire brush or other approved means before it is placed in forms. Steel reinforcement when placed in the forms shall be properly braced, supported, or otherwise held firmly in position so that placing and ramming / vibrating of concrete does not displace it. It shall be ensured that all the reinforcement can be properly placed. Congestion of steel shall be avoided at points where members intersect.

#### **7.3.17. Tolerance in placing of reinforcement**

Unless otherwise indicated, reinforcement shall be placed within following tolerance.

(a) For effective depth 200 mm or less  $\pm 10$  mm (b) For effective depth more than 200 mm or  $\pm 15$  mm

The cover shall in no case be reduced by more than 1/3 of specified cover or 5 mm whichever is less.

#### **7.3.18. Steel wire fabric reinforcement**

Hard drawn steel fabric shall conform to IS 1566-1982 – Specification for hard drawn steel wire fabric for concrete reinforcement, MESH size, weight, size of wire for square and oblong welded shall be indicated. The fabric shall be formed by spacing the main and the cross wire, which shall be fixed at the point of intersection by electric welding.

Since fabric is supplied in long rolls it is rarely necessary to have a joint of the main wires. In structural slab laps in regions, of maximum stress shall be avoided. When splicing of

welded wire fabric is to be carried out, lap splices of wires shall be made so that overlap measured between the extreme cross wires shall be not less than the spacing of cross wires plus 10 cm. For edge laps a lap of 5 cm shall be provided.

#### 7.3.19. **Welding of reinforcement**

Welding of bars where indicated or agreed to by the engineer, in writing, in lieu of lapping shall be done in accordance with IS: 2751-1979, Code of practice for welding of concrete construction. Welding in general shall be done as described for structural steel work.

Bars up to and including 20 mm dia shall be lap welded and those larger than 20 mm dia shall be butt welded. In case of lap welds, the length of lap shall be five times the dia or 100 mm whichever is greater. The throat thickness shall not be less than 3 mm for bars up to 16 mm dia and 5 mm for bars over 16 mm dia and up to 20 mm dia.

#### 7.3.20. **Butt welding**

Where it is not possible to rotate bars for welding in flat positions the axis of the bars shall be horizontal and the respective axis of welds shall be vertical. The edge preparation for inclined bars shall be such that welding is done only on sides. All the bars to be butt welded shall be aligned and set up in position with their axis in one straight line. This may be done in a jig or by means of a clamp or by using guides. Rotation of the bars shall be avoided, until they are adequately welded.

#### 7.3.21. **Lap welding**

Edge preparation is not necessary for lap welds.

#### 7.3.22. **Finish**

The profile of the welds shall be uniform, slightly convex and free from overlap at the toes of the welds. The weld face shall be uniform in appearance throughout its length. The welded joint shall be free from undercut. The joints in the weld run shall be as smooth as practicable and shall show no pronounced hump or crater in the weld surface. The surface of the weld shall be free from porosity, cavities and trapped slag.

### 7.4. **SPECIFICATIONS FOR STEEL WORK IN SINGLE SECTION FIXED INDEPENDENTLY WITH CONNECTING PLATE**

7.4.1. The steel work in single sections of R. S. joists, flats, Tees Angles fixed independently with or without connecting plate, is described in these clauses.

#### 7.4.2. **Fabrication**

The steel sections as specified shall be straightened and cut square to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

#### 7.4.3. **Painting**

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer i.e. red oxide zinc chrome primer conforming to IS: 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

#### **7.4.4. Erection**

Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc shall be used. The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the engineer.

#### **7.4.5. Measurements**

The work as fixed in place shall be measured in running metres correct to a millimeter and weights calculated on the basis of standard tables correct to the nearest kilogram.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm, gussets (taking overall square dimensions) fish plates, etc., shall be added to the weight of respective items. In riveted work, allowance is to be made for weight of rivet

heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures.

No deduction shall be made for rivet / or bolt holes (excluding holes for anchor or holding down bolts).

Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm.

The weight of steel sheets, plates and strips shall be taken from relevant Indian Standards based on 7.85 kg/m<sup>2</sup> for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### **7.4.6. Rate**

Rate includes the cost of labour and materials required for all the operations described above.

### **7.5. SPECIFICATIONS FOR STEEL WORK RIVETTED AND BOLTED BUILT UP SECTIONS.**

The steel work in built up sections (Riveted and bolted such as in trusses, framed work etc. is specified in this clause.

#### **7.5.2. Laying out**

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the engineer. Steel tape shall be used for measurements.

### 7.5.3. Fabrication

Fabrication shall generally be done as specified in IS: 800-1984.

In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details of rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the engineer. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints.

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

The steel section shall be straight or be straightened or flattened by pressure unless required to be of curvilinear form and shall be free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No two pieces shall be welded or joined to make up for the required length of member.

### 7.5.4. Making holes

Holes through more than one thickness of material for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

### 7.5.5. Rivet holes

The diameter for rivets and blank holes shall be taken as the nominal diameter of a rivet plus 1.5 mm for rivets of nominal diameter less than or equal to 25 mm and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be

formed by gas cutting process. Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.



#### 7.5.6. **Assembly**

Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall bear tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover plates, shall have their ends flush with the tops and angles unless otherwise required. The web plates when spliced shall have clearance of not more than 5 mm. The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary suitably designed seating shall be provided.

Column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining.

The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

#### 7.5.7. **Riveting**

Rivets shall be used, where the connection is such that slip under load has to be avoided.

#### 7.5.8. **Preliminaries before riveting**

Members to be riveted shall have all parts firmly drawn and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

#### 7.5.9. **Process of riveting**

The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the engineer. The rivets shall be heated red hot, care being taken to control the temperature of heating so as to not to burn the steel. Rivets of diameter less than 10 mm may be driven cold. Rivets shall be finished neat, with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly. All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recupping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (specially the machine head) shall be tapped. When so tested, the rivets shall not give

a hollow sound and a jar. Where so specified, other tests shall be carried out to ensure the soundness of rivets. All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

#### 7.5.10. Bolting

The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads, Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS: 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nuts, spring washers as directed by the engineer.

#### 7.5.11. Erection

Steel work shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the engineer in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used. The work may be erected in suitable units as may be directed by the engineer. Fabricated members shall be lifted at such points as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over –turning or collapse by suitable means. During execution, the steel work shall be securely bolted or otherwise fastened and when necessary temporarily braced to provide for all loads to be carried safely by the structure during erection including those due to erection equipment and its operations. The steel work shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done after proper alignment has been checked and confirmed.

Trusses shall be lifted only at nodes. The trusses above 10 mm in span not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member

of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans up to 10 m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For large spans the truss shall be provided with proper bearing as per design.

Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement 3 coarse sand) or as specified.

#### **7.5.12. Bedding of column, stanchions etc.**

Bedding shall not be carried out until the steel work has been finally leveled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoreyed buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made up to 25 mm shall then be pressure grouted with cement grouts.

With small columns, if permitted by the engineer, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

#### **7.5.13. Painting**

Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified.

#### **7.5.14. Measurements**

The work as fixed in place shall be measured in running metres correct to a millimetre and their weight calculated on the basis of standard tables correct to the nearest kilogram.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivet heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made of shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m<sup>2</sup>.

The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m<sup>2</sup> for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### 7.5.15. **Rate**

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

### 7.6. **SPECIFICATIONS FOR STEEL WORK IN WELDED BUILT UP SECTION**

The steel work in built up sections (welded) such as in trusses, framed work etc. is specified in this clause.

#### 7.6.2. **Laying out**

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the engineer. Steel tape shall be used for measurements.

#### 7.6.3. **Fabrication**

Straightening, shaping to form, cutting and assembling, shall be as per 7.5.3 as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

#### 7.6.4. **Welding**

Welding shall generally be done by electric arc process as per IS: 816 and IS: 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only be resorted to using oxyacetylene flame with specific approval of the engineer. Gas welding shall not be permitted for structural steel work. Gas welding requires heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperatures stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plane and shops drawings shall be according to IS: 813.

As far as possible every effort shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc., apart from the aspect of economy. The maximum dia of electrodes for welding any work shall be as per IS: 814 and appendix "B" of IS: 823. Joint surfaces which are to be together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

**7.6.5. Precautions** -All operations connected with welding and cutting equipment shall conform to the safety requirements given in IS: 818 for Safety Requirements and Health Provisions in electric and gas welding and cutting operations. Operation, Workmanship and Process of Welding shall be as described in this section. Inspection and testing of welds shall be as per IS: 822.

**7.6.6. Assembly**

Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. The temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to final weld in quality and shall be cleaned off before final weld is made.

**7.6.7. Erection**

The specifications shall be as described except that while erecting a welded structure adequate means shall be employed for temporary fastening of the members together and bracing the frame work until the joints are welded. Such means shall consist of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

**7.6.8. Painting**

Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified.

**7.6.9. Measurements**

The mode of measurements shall be the same as specified except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

**7.6.10. Rate**

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

**List of Bureau of Indian Standards (IS) \*\***

Sl. No	IS No.	Subject
1	63-1978	Whiting for paints and putty (2 <sup>nd</sup> revision) (Amendment 2) (Reaffirmed 1994)
2	198-1978	Varnish gold size (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 1991)
3	226-1975	Structural steel (standard quality) (5 <sup>th</sup> revision) superseded by IS 2062:1992.
4	277-2003	Specification for galvanized steel sheets (plain and corrugated) (5 <sup>th</sup> revision) (Amendments 2)
5	800-1984	Code of practice for use of structural steel in general in steel construction (2 <sup>nd</sup> revision) (Amendments 2) (Reaffirmed 1991)
6	806-1968	Code of practice for use of steel tubes in general building construction (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 1991)
7	812-1978	Glossary of terms relating to welding and cutting of metals (Reaffirmed 1991)
8	813-1986	Scheme of symbols for welding (revised) (Reaffirmed 1991)
9	814-2004	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel (5 <sup>th</sup> revision)
10	815-1974	Classification and coding of covered electrodes for metal arc welding of structural steels (2 <sup>nd</sup> revision) (Supersedes by IS 8141:1991).
11	816-1969	Code of practice for use of metal arc welding for general construction in mild steel (1 <sup>st</sup> revision) (Amendments 2) (Reaffirmed 1992)
12	817-1966	Code of practice for training and testing of metal arc welders (revised) (Reaffirmed 1991) Part I-1992, Part-II-1996
13	818-1968	Code of practice for safety and healthy requirements in electric and gas welding and cutting operations (1 <sup>st</sup> revision) (Reaffirmed 1991)
14	822-1970	Code of procedure for inspection of welds (Reaffirmed 1991)
15	823-1964	Code of procedure for manual for metal arc welding in mild steel (withdrawn)
16	1038-1983	Steel doors, windows and ventilators (3 <sup>rd</sup> revision) (Amendment 1) (Reaffirmed 1991)
17	1081-1960	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators (Amendment 1) (Reaffirmed 1991)
18	1148-1982	Hot rolled steel rivet bars (upto 40 mm diameters) for structural purposes (3 <sup>rd</sup> revision) (Reaffirmed 1992)
19	1161-1979	Steel tubes for structural purposes (3 <sup>rd</sup> revision) (Amendments 2)

		Reaffirmed 1998)
20	1182-1983	Recommended practice for radiographic examination of fusion welded butt joints in steel plates (2 <sup>nd</sup> revision) (Reaffirmed 1991)
21	1200-1993 (Part 8)	Method of measurements of building and civil engineering works Part 8 steel work and iron works (4 <sup>th</sup> revision) Part I,II & III 2002
22	1363-1992	Hexagonal head bolts, screws and nuts of product grade C 2002
	Part-1	(Hexagon head bolt) (size range M5 to M64) (3 <sup>rd</sup> revision) 2002
	Part-2	(Hexagon head screws) (size M5 to M64) (3 <sup>rd</sup> revision) 2002
	Part-3	(Hexagon nuts) (size range M5 to M64) (3 <sup>rd</sup> revision) 2002
23	1367-1980	(Part 1-19) Technical supply conditions for threaded steel fasteners (Part 1 to 19)
24	1599-1985	Method for bond test for steel products other than sheet, strip, wire and tube (2 <sup>nd</sup> revision) (superseding IS 1692 : 1974, IS 3260 : 1960, 815, 4598 : 1968) (Reaffirmed 1991)
25	1608-2005	Method of tensile testing for steel products (1 <sup>st</sup> revision) (Amendments 1) (Reaffirmed 1991)
26	1821-1987	Dimensions for clearance holes for bolts and screws (3 <sup>rd</sup> revision) (Reaffirmed 1992)
27	1852-1985	Rolling and cutting tolerances for hot rolled steel products (4 <sup>th</sup> revision) (Amendment 1) (Reaffirmed 1991)
28	1894-1972	Method for tensile testing of steel tubes (1 <sup>st</sup> Revision) (Reaffirmed 1991)
29	1977-1975	Structural steel (ordinary quality) (2 <sup>nd</sup> revision) (Amendments 4) (Reaffirmed 1996)
30	2062-1992	Steel for general structural purposes (4 <sup>th</sup> revision) (Supersedes IS 226:1975) (Amendment 1) 1999
31	2074-1992	Ready mixed paint, air drying red oxide-zinc chrome, priming (2 <sup>nd</sup> revision)
32	4351-1976	Specification for steel door frames (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 2003) 2003
33	4454-1981 (Part 1)	Steel wires for cold formed springs. Patented and cold drawn steel wires unalloyed (2 <sup>nd</sup> revision) (Reaffirmed 1992) Part I -2001, Part II -2001, Part II – 1975 & Part IV 2001
34	4736-1986	Hot-dip zinc coatings on mild steel tubes (1 <sup>st</sup> revision) (Amendment 1) (Reaffirmed 1992)
35	6248-1979	Metal rolling shutters and rolling grills (1 <sup>st</sup> revision) (Reaffirmed 1991)
36	7452-1990	Specifications for hot rolled steel sections for doors, windows and ventilators (2 <sup>nd</sup> revision).

## SPECIFICATIONS FOR STEEL FOR GENERAL STRUCTURAL PURPOSES

(Extract of IS: 2062-1999)

### 1. Scope

1.1. This Indian Standard covers the requirements of steel plates, strips, sections, flats, bars, etc, for use in structural work.

1.1.1. The steels are suitable for welded, bolted and riveted structures, and for general engineering purposes.

1.2. Where welding is employed for fabrication and guaranteed weld ability is required, welding procedure should be as specified in IS: 9595-1996 Metal arc welding of carbon and carbon manganese steels-Recommendations (first revision)

2. **References** - The following Indian Standards are necessary adjuncts to this standard:

IS.No.	Title
228	Methods of chemical analysis of steel
1599-1955	Method for bend test (second revision)
1608-1995	Mechanical testing of metals Tensile testing (second revision)
1757- 1988	Method for Charpy impact test (V notch) for metallic material (second revision)
1852-1985	Rolling and culling tolerances for hot-rolled steel products (third revision)
1956	Glossary of terms relating to iron and steel
3803 (Part1) - 1989	Steel - Conversion of elongation values: Part I Carbon and alloy steels (second revision)
8910-1978	General technical delivery requirements for steel and steel products
9595=1996	Metal arc welding of carbon and carbon manganese steels Recommendations (first revision)
10842-1984	Testing and evaluation procedure for Y groove crackability test

3. **Terminology** - For the purpose of this standard, the following definitions in addition to those given in the relevant parts of IS: 1956 shall apply.

3.1. **Micro-alloying elements** - Elements, such as niobium, vanadium and titanium, added singly or in combination to obtain higher strength levels combined with better form ability, weldability and toughness as compared with non-alloyed steel produced to equivalent strength levels.

3.2. **Weldability** - A metallic substance is considered to be weldable by a given process and for the given purpose, when metallic continuity to a stated degree can be obtained by



welding using a suitable procedure, so that the joints comply with the requirements specified in regard to both their local properties and their influence on the construction of which they form a part.

4. **Supply of material** - General requirements relating to supply of weldable structural steel shall conform to IS 8910.

5. **Grades** - There shall be three grades of steel as given in Tables 1 and 3.

Grade-A steel specified in this standard is intended for use in structures subject to normal conditions for non-critical applications. The use of Grade A steel is generally justified for these structural parts which are not prone to brittle fracture on account of its thickness, size and shape adopted and/or because of the fabrication and / or service conditions.

Grade-B steel specified in this standard is intended for use in structures subject to critical loading applications, where service temperatures do not fall below 0°C. Use of Grade B steel is generally specified for those structural parts which are prone to brittle fracture and/or are subjected to severe fluctuation of stresses.

Grade-C steel specified in this standard, is supplied with guaranteed low temperature impact properties. This grade is intended to be used in structures or structural parts, where the risk of brittle fracture requires consideration due to their design, size and/or service conditions. In cases where owing to increased thicknesses, loading conditions and general design of the structures, higher resistance to brittle fracture is required, use of steel of Grade C with a guarantee of impact properties at 0°C or -20°C or -40°C will be advisable.

The steel products conforming to the requirements of this specification can be rolled from the cast billet ingots, billets, blooms, slabs and continuously cast billets, blooms or slabs conforming to IS: 2830:1992 Carbon steel cast billet ingots, billets, blooms and slabs for re-rolling into steel for general structural purposes (second revision).

6. **Manufacture** - The processes used in making the steel and manufacturing hot rolled steel plates, strips, sections, flats, bars, etc, are left to the discretion of the manufacturer. If required, secondary refining may follow steel making.

7. Freedom from defects

7.1. All finished steel shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/jagged and imperfect edges: and all other harmful defects.

7.2. Minor surface defects may be removed by the manufacturer by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent, but not exceeding 7 percent, may be made subject to mutual agreement between the purchaser and the manufacturer.

7.2.1. Subject to agreement with the purchaser. Surface defects which cannot be dealt with as in 7.2 may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that: (a) after complete removal of the defects and before welding, the thickness of the item is in no place reduced by more than 20 percent; (b)

welding is carried out by approved procedure by competent operators with approved electrodes and that the welding is ground smooth to the correct nominal thickness; and (c) subsequent to the Finish grinding, the item may be required to be normalized or otherwise heat-treated at the purchaser's direction.

7.3. However, welding as mentioned in 7.2.1 is not permissible for Grade C material.

7.4. The material may be subjected to non-destructive testing to determine soundness of internal subject to mutual agreement between the purchaser and the manufacturer.

## 8. Chemical compositions

8.1. The ladle analysis of the steel, when carried out by the method specified in the relevant parts of IS 228 or any other established instrumental / chemical method, shall be as given in Table I. In case of dispute. The procedure given in IS: 228 and its relevant parts shall be the referee method.

However, where the method is not given in IS: 228 and its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

8.2. **Product analysis** - The product analysis shall be carried out on the finished product from the standard position.

Permissible limits of variation in case of product analysis from the limits specified in Table 1 shall be as given in Table 2.

Table 1 Chemical composition (Clause 5.8.1 and 8.2)

Grade composition	Ladle Analysis, Percent, Max					Carbon equivalent	Deoxidation Mode	Supply condition
	C	Mn	S	P	Si	(CE) Max		
A Fe 41 O W A	0.23	1.50	0.050	0.050	0.40	0.42	Semi-killed or killed	As rolled
B Fe 41 O W B	0.22	1.50	0.045	0.045	0.40	0.41	Killed	As rolled Plates above 12 mm may be normalized / controlled cooled if agreed to between the purchaser and the manufacturer
C Fe	0.20	1.50	0.040	0.04	0.4	0.39	Killed	As rolled

41				0	0			Plates above 12 mm shall be normalized / controlled cooled
0								
W								
C								

Notes:

$$1. CE \text{ based on ladle analysis} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

**2. When the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02 percent. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10 percent. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.**

3. When micro-alloying elements like Nb, V and Ti are used individually or in combination, the total content shall not exceed 0.20 percent.

4. if mutually agreed to between the purchaser and the manufacturer, the steel may be supplied in the copper bearing quality in which case the copper shall be present between 0.20 to 0.35 percent on ladle analysis. In case of product analysis, the copper content shall be between 0.17 and 0.38 percent. The copper bearing quality steel shall be designated with a suffix Cu, for example Fe 410 Cu-WA.

5. Nitrogen content of the steel should not exceed 0.012 percent, which shall be ensured by the manufacturer by occasional check analysis.

6. Details of elements other than those specified may be specified if agreed at the time of inquiry and order

Table 2 Permissible variations for product analysis (Clauses 5 and 8.2)

Constituent	Permissible variations over the specified limit, percent, max
Carbon	0.02
Manganese	0.05
Silicon	0.03
Sulphur	0.005
Phosphorus	0.005

**9. Selection and preparation of test samples**

9.1. The position from which test samples are taken shall be so located in the product as to yield the clearest possible information regarding properties in the cross-sectional and longitudinal planes. The recommended locations for taking less samples for plates, sections and bars are indicated in Fig. 1. Alternatively, in case of sections, the samples may be taken from the web.

9.2. Wherever practicable, the rolled surface of the steel shall be retained on the two opposite sides of the test samples.

9.3. In case of flat test samples for tensile test, both surfaces are normally to be left on the test samples for strips and plates up to 32 mm thick. At least one rolled surface shall be left on rectangular test samples taken from plates exceeding 32mm in thickness. Round test samples are permitted, but should only be adopted for thickness exceeding 28 mm.

9.4. In case of flats up to 16mm thick, the test sample shall undergo, if possible, no machining whatever, prior to use as a test piece. If this is not possible, the test sample shall undergo the minimum amount of machining.

9.5. Bars below 28 mm shall be tested without machining. In case of bars having diameters or thickness between 28 mm and 71 mm. the bars may, be symmetrically reduced by machining. For bars having diameters or thicknesses exceeding 71 mm. The test sample may be taken from the position shown in Fig. 1.

9.6. In case of plates, strips, sections and flats, bend tests shall be carried out on rectangular test samples which, as far as possible, should be of the full thickness of the product. In case of plates, sections and flats exceeding 28 mm in thickness, it is permissible to remove metal from one side of the test sample before using it as a test piece. The rolled surface of the test piece shall be on the outer side of the bend during the test.

9.7. Before-test samples are detached, full particulars regarding cast number, size and mass of

plates, strips, sections, flats and bars in each cast shall be furnished by the manufacturer to the purchaser. In case of plates, the number of plates in each cast shall also be given.

9.8. Test samples shall be cut in such a manner that the deformation is avoided as far as possible. If shearing or flame-cutting is employed; an adequate allowance shall be left for removal by machining.

9.9. Test samples shall not be subjected to heat treatment unless the material from which they are cut is similarly treated, in which case the test samples shall be similarly and simultaneously treated with the material before testing. Any slight straightening of test samples which may be required shall be done cold.

## 10. Tensile-test

### 10.1. Number of tensile tests

10.1.1. Plates, Strips, Sections (Angles, Tees, Beams, beams, Channels, etc and Flats) - One tensile test shall be made from finished steel for every 50 tonnes or part thereof rolled continuously from each cast, a separate test being made for each class of steel product (namely, plates, strips, sections and flats) rolled from a cast.

10.1.1.1. Where plates, strips, sections or flats of more than one thickness are rolled from the same cast, one additional tensile test shall be made from the material in each class of product for each variations in thickness of 6 mm.

10.1.2. **Bars (Round, Square and Hexagonal)** - One tensile test shall be made from finished

product for each 50 tonnes or part thereof. If more than one diameter or thickness of the bar is processed, one or additional tensile test shall be made for each variation of 3 mm above or below the diameter or thickness of the bar ordered.

10.2. **Tensile test pieces** - The tensile strength, yield strength and percentage elongation of steel shall be determined from standard test pieces cut crosswise from plates and strips and lengthwise from sections, flats and bars. The test shall be carried out on the standard test pieces prepared in accordance with IS 1608.

10.2.1. As a rule, test pieces with a non-proportional gauge length complying with the requirements to  $L_0 = 5.65 \sqrt{S_0}$  should be used for the tensile test, where  $L_0$  is the gauge length and  $S_0$  is the cross sectional area of the test piece.

10.2.1.1. Test pieces with a non-proportional gauge lengths, other than  $5.65 \sqrt{S_0}$ , may also be used in which case the elongation values shall be converted  $5.65 \sqrt{S_0}$  in accordance with IS: 3503 (Part 1).

10.3. **Tensile test** - Tensile strength, yield strength and percentage elongation when determined in accordance with IS: 1608 shall be as given in Table 3.

10.1.1. In case of sections the thickness of which is not uniform throughout the profile, the limits of sizes given in Table 3 shall be applied according to the actual maximum thickness of the piece adopted for testing.

10.3.2. Should a tensile test piece break-outside the middle half of the gauge length (see IS: 1608) and the percentage elongation obtained is less than the specified, the test may be discarded at manufacturer's option and another test made from the sample plate, strip, section, flat or bar.

## 11. Bend test

### 11.1. Number of bend tests

Bend test shall be made from finished steel from each cast. The number of tests for every 50 tonnes material or part thereof, rolled continuously, shall as even below. One additional test shall be made 1 to each class of product and for each variation of thickness.

11.2. **Bend test piece** - The test pieces shall be cut crosswise from plates and strips and length wise from sections, flats and bars. When section permits, these shall be not less than

40 mm wide. If the manufacturer so desires, round, square, hexagonal and flat bars and structural sections shall be bent in the full section as rolled.

11.2.1. In all bend test pieces, the rough edge or arris resulting from shearing may be removed by filing or grinding or machining but the test pieces shall receive no other preparation.

11.3. **Bend test** - Bend test shall be conducted in accordance with IS: 1599.

Table 3 Mechanical properties (Clauses 5, 10.3, 10.3.1, 11.3.1, 12.1.1, 12.2 and 12.4)

Grade	Designation	Tensile strength Min, Mpa	Yield stress, Min, MPa			Percent elongation at gauge length $5.60\sqrt{S_0}$	Internal diameter of bend	Charpy V-notch impact energy J, Min
			<20 mm	20-40 mm	>40 mm	Min	Min	
A	Fe 410 WA	410	250	240	230	23	3t	-
B	Fe 410 WB	410	250	240	230	23	2t for less than or equal to 25 mm thick products 3t for more than 25 mm thick products	27 (see Note 1)
C	Fe 410 WC	410	250	240	230	23	2t	27

#### Notes

1. For Grade B material, the minimum Charpy V-notch impact energy is to be guaranteed at 0°C, if agreed to between the manufacturer and the purchaser.
2. For Grade C materials, the minimum Charpy V-notch impact energy shall be guaranteed at any one of the three temperatures, namely 0°C, or -20°C or -40°C, as specified by the purchaser.
3. 't' is the thickness of the material.
4. The impact values are given for a standard test piece. When tested with subsidiary test pieces, the values shall not be less than the following:

Impact Energy	Test piece size	Charpy V-notch
	Mm	J, Min
	10 x 7.5	22
	10 x 5	19.5

11.3.1. For bend test, the test piece at room temperature shall withstand bending through 180° to an internal diameter not greater than that given in Table 3 without cracking.

#### 12. Impact test

12.1. Impact test shall normally be carried out on products having thickness/diameter greater than or equal to 12 mm. The test specimen shall be so machined that the axis of the test specimen is parallel to the direction of rolling and the base closer to the rolled surface is more than 1mm from it. The notch axis shall be perpendicular to the rolled surface.

12.1.1. If stated in the order, impact tests may be carried out on products having a thickness less than 12 mm the dimensions of the test pieces shall be in conformity with IS 1757 (see also Note 4 of Table 3).

12.2. This test is carried out using a V-notch test piece (see IS 1757) the value for consideration being the arithmetic mean of the results obtained on three test pieces taken side by side from the same product (see Table 3).

12.3. The test sample shall be taken from the thickest product. If the test sample taken from the thickest product rolled from a cast meets the requirements, the whole cast shall be deemed to meet the requirements of the test. If not, the test shall be performed on a section of next lower thickness rolled from the same cast and if it meets the requirements specified. This particular thickness as also other sections of lower thickness shall be deemed to satisfy the specification. If this thickness also does not meet the requirements. The test shall be carried out on the next lower thickness and so on, because the toughness of the product will be dependent on the rolling direction as well as on the section size.

12.3.1. A test sample shall be taken from each 50 tonnes or part thereof from the same cast.

12.4. The material represented shall be deemed to comply with the standard, if the average value of 3 test specimens, meets the requirements given in Table 3 provided no individual value shall be less than 70 percent of the specified value. If the average value of the three Charpy impact tests fails to comply by an amount not exceeding 15 percent of the specified minimum average value, three additional test pieces from the same sample shall be tested and the results added to those previously obtained and a new average calculated. Provided this new average complies with the specified requirement, the material represented shall be deemed to comply with this standard.

13. **Y Groove crackability test** - Y groove crackability tests may be carried out in accordance with IS: 10842 for products of only Grade C material having thickness above 12 mm, if specifically agreed to between the manufacturer and the purchaser.

NOTE: The V groove crackability test will not be applicable for rounds and it is mainly for plates and sections.

14. **Dimensions** - Unless otherwise agreed to between the purchaser and the manufacturer the nominal dimensions of rolled products conforming to this standard shall be in accordance with the relevant Indian Standard. The Currently available Indian Standards are listed in Table 4.

#### 15. **Tolerances**

The rolling and culling tolerances for steel product 2 conforming to this standard shall be those specified in IS: 1852. Stricter tolerances may be followed if agreed to between the purchaser and the manufacturer.

16. **Retest** - Should any one of test pieces first selected fail to pass (see any of the tests specified in this standard, two further samples shall be selected for testing in respect of

each failure. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirements of that particular test. Should the test pieces from either of these additional samples fail, the material represented by the test samples shall be considered as not having complied with this standard.

Table - 4 Indian Standards which give nominal dimensions of rolled steel products (Clause 14)

Product	Relevant Indian Standard
Beam, column, channel and angle sections	IS:808-1899 dimensions for hot rolled steel beam, column, channel and angle sections (third revision)
Tee-bars	IS: 1173-1978 Hot rolled slit steel tee bars (second revision)
Bulb angles	IS: 1252 - 1991 Hot rolled steel bulb angles - Dimensions (first revision)
Plates, strips and flats	IS:1730 - 1989 Steel plates sheets, strips and flats for structural and general engineering purposes (second revision)
Round and square bars	IS:1732-1989 Dimensions for round and square steel bars for structural and general engineering purposes (first revision)
Bulb flats	IS:1863-1979 Hot rolled steel bulb flats (first revision)
Sheet piling sections	IS:2314-1986 Steel sheet piling sections (first revision)
Channel sections	IS: 3954-1991 Hot rolled steel channel sections for general engineering purposes (first revision)
Track shoe sections	IS:10182 (Part 1)-1982 Dimensions and tolerances for hot rolled track shoe sections: Part 1 Section TS-L1 IS:10182 (Part 2)-1985 Dimensions and tolerances for hot rolled track shoe sections :Part 2 Section TS-H1

17. **Calculation of mass** - The mass of steel shall be calculated on the basis that steels weighs 7.85 g/cm<sup>3</sup>

18. **Delivery** - Subject to prior agreement between the purchaser and the manufacturer, suitable protective treatment may be given to the material after rolling.

#### 19. **Marking**

19.1. Each product, with the exception of round, square and hexagonal bar and flats, shall carry or be marked with the manufacturer's name or trade-mark. Bars and flats shall carry a tag bearing manufacturer's name or trade-mark, Designation of steel should also be similarly marked on the product or tag,

19.2. Every heavy and medium structural mill product and each plate of thickness 10 mm and over shall be marked with the cast number. In case of plates 10 mm thickness, the top plate of each pile (which consist of approximately 16 plates) shall be marked with the cast number and the remaining plates have suitable identification marking.

19.3. The ends of the rolled product shall be painted with a colour code as given below:



Grade A	Green
Grade B	Grey
Grade C	Orange

19.3.1. For the copper bearing quality, in addition the colour code as specified in 19.3, a white colour band shall be painted.

19.4. **BIS certification marking** - The material may also be marked with standard mark.

19.4.1. The use of the Standard Mark is governed by the provisions of Bureau of Indian Standard Act 1986 and the Rules and Regulations made there under. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the of Bureau of Indian Standard

#### Annexure 7-A.4

### SPECIFICATIONS FOR HIGH STRENGTH DEFORMED STEEL BARS AND WIRES FOR CONCRETE REINFORCEMENT (Extract of IS: 1786-1985)

0.1. Deformed bars for concrete reinforcement are being produced in the country for many years, the main processes being hot rolling or hot rolling followed by cold twisting. In the past decade there has been an increasing demand for higher strength deformed bars (415 N/m<sup>2</sup>, Min, yield strength/0.2 percent proof stress being the most common). This high yield strength was being first achieved by raising carbon and manganese and to a great extent by cold twisting.

0.2. Micro-alloying with Nb, V, Ti and B, in combination. Individually, and thermo-mechanical treatment process are worth mentioning in tills field. With these two processes higher strength values could be achieved at low carbon levels even in large diameter bars.

#### 1. Scope

1.1. This annexure covers the requirements of deformed steel bars and wires for use as reinforcement in concrete, in the following three strength grades:

(a) Fe 415, (b) Fe 500, and (c) Fe 550

Note: The figures following the symbol Fe indicates the specified minimum 0.2 percent proof stress or yield stress in N/mm<sup>2</sup>.

#### 2. Glossary of terms

2.1. **Batch** – Any quantity of bars / wires of same size and grade whether in coils or bundles presented for examination and test at one time.

2.2. **Bundle** – Two or more coils or a number of lengths properly bound together.

2.3. **Elongation** - The increase in length of a tensile test piece under stress. The elongation at fracture is conventionally expressed as a percentage of the original gauge length of a standard test piece.

2.4. **Longitudinal rib** – A rib of uniform cross-section, parallel to the axis of the bar/wire (before cold working, if any).

2.5. **Nominal diameter or size** - The diameter of a plain round bar/wire having the same

mass per metre length as the deformed bar / wire.

2.6. **Nominal perimeter of a deformed bar/wire** – 3.14 times the nominal diameter.

2.7. **Nominal mass** – The mass of the bar / wire of nominal diameter and of density 0.007 kg/mm<sup>2</sup> per metre run.

2.8. **0.2 Percent proof stresses** – The stress at which a non-proportional elongation equal to 0.2 percent of the original gauge length takes place.

2.9. **Tensile strength** – The maximum load reached in a tensile test divided by the effective cross sectional area of the gauge length portion of the test piece, also termed as ultimate tensile stress.

2.10. **Transverse rib** - Any rib on the surface of a bar wire other than a longitudinal rib.

2.11. **Yield stress** - Stress (that is, load per unit cross-sectional area) at which elongation first occurs in (lie test piece without increasing the load during tensile test. In the case of steels with no such definite yield point, proof stress shall be applicable.

### 3. Manufacture and chemical composition

3.1. Steel shall be manufactured by the open hearth, electric, duplex, basic oxygen, or a combination of these processes. In case the manufacturer employs any other process, prior approval of the purchaser should be obtained.

3.1.1. Steel shall be supplied semi-killed or killed.

3.1.2. The bars/wires shall be manufactured from properly identified heats of mould cast, continuously cast steel or rolled semis.

3.1.3. The steel bars/wires for concrete reinforcement shall be manufactured by the process of hot-rolling. It may be followed by a suitable method of cooling and/or cold working.

3.2. **Chemical composition** - The ladle analysis of steel when made as per relevant parts of IS: 228 shall be as follows:

Constituent	Percent, maximum		
	Fe 415	Fe 500	Fe 550
Carbon	0.30	0.30	0.30
Sulphur	0.060	0.055	0.055
Phosphorus	0.060	0.055	0.050
Sulphur and phosphorus	0.11	0.105	0.10

Note: 1) For guaranteed weldability, the percentage of carbon shall be restricted to 0.25 percent, maximum.

Note: 2) Addition of micro alloying elements is not mandatory for any of the above grades. When strengthening elements like Nb, V, B and Ti are used individually or in combination, the total contents shall not exceed 0.30 percent; in such case manufacturer shall supply the purchaser or his authorized representative a certificate stating that the total contents of the strengthening elements in the steel do not exceed the specified limit.

3.2.1. In case of product analysis, the permissible variation from the limits specified under 3.2 shall be as follows:

Constituent	Variation, over specified maximum limit, percent, max
Carbon	0.02
Sulphur	0.005
Phosphorus	0.005
Sulphur and phosphorus	0.010

3.2.2. For welding of cold-worked deformed bars, the recommendations of IS: 9417-1979 shall be followed.

3.2.3. In case of deviations from the specified maximum, two additional test samples shall be taken from the same batch and subjected to the test or tests in which the original sample failed. Should both additional test samples pass the test, the batch from which they were taken shall be deemed to comply with this standard. Should either of them fail, the batch shall be deemed not to comply with this standard.

### 3.3. Rolling and cold-working of bars/wires

3.3.1. All bars/wires shall be well and cleanly rolled and shall be round and free from surface defects and pipe, or oilier defects detrimental to its subsequent processing and to its end use. Rust, seams, surface irregularities or mill scale shall not be the cause for rejection provided hard wire brushed test specimen fulfils all the requirements of this specification.

3.3.2. Stretching may or may not be combined with cold working. The unworked length at each end of the bar/wire shall not exceed 100 mm or 4 times the nominal diameter, whichever is greater.

## 4. Requirements for bond

4.1. High strength deformed bars/wires shall satisfy the requirements given in either 4.2 or 4.7.

4.2. **Deformation and surface characteristics** - For high strength deformed bars/wires, the mean area of ribs ( in mm<sup>2</sup> ) per unit length (in mm) above the core of the bar/wire, projected on a plane normal to the axis of the bar/wire calculated in accordance with 4.4 shall not be less than the following values: 0.12  $\phi$  for  $\leq 10$  mm, 0.15  $\phi$  for  $10 \text{ mm} < \phi \leq 16$  mm, 0.17  $\phi$  for  $\phi > 16$  mm, where  $\phi$  is the nominal diameter of bar/wire in mm.

The mean projected area of transverse ribs alone shall be not less than one-third of the values given above.

4.3. The ribs contributing to the projected area considered in 4.2 shall consist of:

- Longitudinal ribs in the form of continuous or discontinuous helix; and
- Transverse ribs which after hot-rolling or cold-working are uniform in size and shape along the length of the hardwire, and are spaced along the bar/wire at substantially uniform distances.

4.4. The mean projected rib area per unit length  $A_r$  ( in mm<sup>2</sup> per mm ) may be calculated

$$A_r = \frac{n_{tr} A_{tr} \sin}{s_{tr}} + \frac{m_r d_r \pi \phi}{s_p}$$

from the following formula : Where

$n_{tr}$  = number of rows of transverse ribs ;

$A_{tr}$  = area of longitudinal section of a transverse rib on its own axis (see Fig.1) in  $mm^2$

$\theta$  = including of the transverse rib to the bar axis (after twisting for cold – worked twisted bars)

in degrees. Average value of two ribs from each row of transverse Fibs shall be taken;

$s_{tr}$  = spacing of transverse ribs in mm ;

$m_r$  = number of longitudinal ribs;

$d_{tr}$  = height of longitudinal ribs in mm ;

= nominal diameter of the bar / wire in mm ; and

$s_p$  = pitch of the twist in mm.

Note: 1. In the case of hot rolled bars / wires which are not subjected to cold twisting, the value of  $s_p$  in the second term of the expression for  $A_r$  shall be taken as infinity rendering the value of the second term to zero.

Note: 2.  $A_{tr}$  may be calculated as  $2/3 l_{tr} d_{tr}$  where  $l_{tr}$  and  $d_{tr}$  are shown in Fig.1

Note3. In the case of cold – worked bars / wires with some discontinuous longitudinal ribs, the number of longitudinal ribs,  $n_{1r}$  shall be calculated as an equivalent number using the following formula and accounted for in the expression for  $A_r$  :

$$m_r \frac{m_r' l' d_{tr}}{s_{tr}' d_{tr}} + \text{Number of continous longitudinal ribs}$$

Where

$m_r'$  = number of discontinuous longitudinal ribs,

$l'$  = average length of discontinuous longitudinal ribs

$d_{tr}'$  = height of discontinuous longitudinal ribs

$s_{tr}'$  = averaged spacing of discontinuous longitudinal ribs, and

$d_{tr}$  = height of continuous longitudinal ribs.

Note: 4. The average length of discontinuous longitudinal ribs shall be determined by dividing a measured length of the bar equal to at least  $10 \phi$  by the number of discontinuous longitudinal ribs in the measured length,  $\phi$  being the nominal diameter of the bar. The measured length of the bar shall be the distance from the center of one rib the center of another rib.

4.5. The heights of longitudinal land transverse ribs shall be obtained in the following manner

a) The average height of longitudinal ribs shall ribs shall be obtained from measurements

made at not less than 4 points, equally spaced, over a length of  $10\phi$  or pitch of rib, whichever is greater.

b) The height of transverse ribs shall be measured at the centre of 10 successive transverse ribs.

4.6. The average spacing of transverse ribs shall be determined by dividing a measured length of the bar / wire equal to at least  $10\phi$  by the number of spaces between ribs in the measured length,  $\phi$  being the nominal diameter of the bar / wire. The measured length of the bar / wire shall be the distance from the centre of one rib to the centre of another rib.

4.7. When subjected to pull-out test the bond strength calculated from the load at a measured slip of 0.025 mm and 0.25mm for deformed bars / wires shall exceed that of a plain round bar of the same nominal size by 40 percent and 80 percent respectively.

4.7.1. The pull-out test shall be conducted in accordance with IS: 2770 (part 1)-1967\* unless otherwise modified.

4.7.2. Bonded length of the bar embedded in the concrete shall be 5 times the diameter of the bar; the rest of the embedded length shall be made unbounded by providing plastic sleeve for that portion.

## 5. Nominal sizes

5.1. The nominal sizes of bars / wires shall be as follows :

Nominal size, 4,5,6,7,8,10,12,16,18,20,22,25,28,32,36,40,45 and 50mm.

Note: Other sizes may also be supplied by mutual agreement.

5.2. The exact values for the cross-sectional area and nominal masses of individual bars / wires, shall be as given in Table 1.

5.3. **Effective cross** – sectional area of deformed bars and wires

5.3.1. For bars / wires whose pattern of deformation is such that by visual inspection, the cross-sectional area is substantially uniform along the length of the bar / wire, the effective cross-sectional area shall be the gross sectional area determined as follows, using a bar / wire not less than 0.5 m in length :

$$\frac{1.03}{0.00785} \frac{w}{L}$$

$$\frac{W}{0.00785L}$$

Gross cross sectional area in  $\text{mm}^2 =$

Where

W = mass in kg weighed to a precision of  $\pm 0.5$  percent, and

L = length in m measured to a precision of  $\pm 0.5$  percent.

5.3.2. For a bar / wire whose cross – sectional area varies along its length, a sample not less than 0.5 m in long shall be weighed (w) and measured to a precision of  $\pm 0.5$  percent in the as rolled and / or

Fig. 1 Determination of longitudinal sectional area  $A_{lr}$  of A transverse  $R_{1B}$

cold – worked condition, and after the transverse ribs have been removed, it shall be re-weighed ( $w'$ ). The effective cross-sectional area shall then be round as follows:

Table d1 cross sectional area and mass ( clause 5.2 )

Nominal sized	Cross sectional area	Mass per meter
Mm	Mm <sup>2</sup>	kg
1	2	3
4	12.6	0.099
5	19.6	0.154
6	28.3	0.222
7	38.5	0.302
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
18	254.6	2.00
20	314.3	2.47
22	380.3	2.98
25	491.1	3.85
28	616.0	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.85
45	1591.1	12.50
50	1964.3	15.42

a) Where the difference between the two masses ( $w - w'$ ) is less than 3 percent of  $w'$ , the effective cross-sectional area shall be obtained as in 5.3.1., b) Where the difference is equal to or greater than 3 percent, the effective cross-sectional area in mm<sup>2</sup> shall be taken as:

Where

$W'$  = mass in kg of the bar with transverse ribs removed, and  $L$  = length in m.

For routine test purposes, a nominal ratio of effective to gross cross-sectional area of bars / wires covered by (b) shall be declared and used by the manufacturer.

## 6. Tolerances on dimensions and nominal mass

6.1. **Specified lengths** - If bars / wires are specified to be cut to certain lengths, each bar / wire shall be cut within deviations of  $\pm 75$  25 mm on the specified length, but if minimum lengths are specified, the deviations shall be + 50mm and - 0 mm.

### 6.2. Nominal mass

6.2.1. For the purpose of checking the nominal mass, the density of steel shall be taken as 0.007 85 kg /mm<sup>2</sup> of the cross-sectional area per metre run.

6.2.2. Unless otherwise agreed to between the manufacturer and the purchaser, the tolerances on nominal mass shall be as in Table 2. For bars / wires whose effective cross-sectional areas is determined as in 5.3.2 (b), the nominal mass per metre run shall correspond to the gross mass and the deviations in Table 2 shall apply to the nominal mass.

Table 2 Tolerances on nominal mass

Nominal size Mm	Tolerance on the nominal mass, percent		
	Batch	Individual sample*	Individual sample for coils only†
Up to and including 10	± 7	- 8	± 8
Over 10 up to and including 16	± 5	- 6	± 6
Over	± 3	- 4	± 4

\* For individual sample plus tolerance is not specified.

† For coils batch tolerance is not applicable.

6.2.3. The nominal mass per metre of individual sample, batch and coil shall be determined as given in 6.2.3.1 to 6.2.3.3.

6.2.3.1. **Individual sample** – The nominal mass of an individual sample shall be calculated by determining the mass of any individual sample taken at random as specified in 10.1 and dividing the same by the actual length of the sample. The sampled shall be of length not less than 1.5 meter.

6.2.3.2. **Batch** – The nominal mass of a batch shall be calculated from the mass of the test specimens taken as specified in 10.1 and dividing the same by the actual total length of the specimens. Each specimen shall be of length not less than 0.6 meter.

6.2.3.3. **Coils** – The nominal mass of a coil shall be calculated by determining the mass of two samples of minimum one meter length taken from each end of the coil and dividing the same by the actual total length of the samples.

## 7. Physical properties

7.1. Proof stress, percentage elongation and tensile strength for all sizes of deformed bars / wires determined on effective cross – sectional area (see 5.3) and in accordance with 8.2 shall be specified in Table 3.

Table 3 Mechanical properties of high strength deformed bars and wires

Sl. No.	Property	Grade		
		Fe 415	Fe 500	Fe 550
1	0.2 percent proof stress / yield stress, Min, N/mm <sup>2</sup>	415.0	500.0	550.0
2	Elongation, percent, Min, on gauge length $5.65 \sqrt{A}$ , where A is the cross-sectional area of the test	14.5	12.0	8.0

	piece			
3	Tensile strength, Min	10 percent more than the actual 0.2 percent proof stress but not less than 485.0 N/mm <sup>2</sup>	8 percent more than the actual 0.2 percent proof stress but not less than 545.0 N/mm <sup>2</sup>	6 percent more than the actual 0.2 percent proof stress but not less than 585.0 N/mm <sup>2</sup>

7.2. The bars / wires shall withstand the bend test specified in 8.3 and the rebend test specified in 8.4

7.3. **Bond** – Bars / wires satisfying the requirements given in 4 shall be deemed to have satisfied the bond requirements of a deformed bar / wire.

## 8. Tests

8.1. Selection and preparation of test sample – Unless otherwise specified in this standard, the requirements of IS: 226-1975 shall apply.

8.1.1. All test pieces shall be selected by the purchaser or his authorised representative, either;

(a) from the cuttings of bars / wires ; or (b) if, he so desires, from any bar / wire after it has been cut to the required or specified size and the test piece taken from any part of it. In neither case, the test piece shall be detached from the bar / wire except in the presence of the purchaser or his authorised representative.

8.1.2. The test pieces obtained in accordance with 8.1.1 shall be full sections of the bars / wires and shall be subjected to physical tests without any further modifications. No reduction in size by machining or otherwise shall be permissible, except in case of bars of size 28mm and above (see 8.1.2.1. No test piece shall be annealed or otherwise subjected to heat treatment except as provided in 8.1.3 Any straightening which a test piece may require shall be done cold.

8.1.3. Notwithstanding the provisions in 8.1.2 test pieces may be subjected to artificial ageing at a temperature not exceeding 100° C and for a period not exceeding 2 hours.

8.1.4. Before the test pieces are selected, the manufacturer or supplier shall furnish the purchaser or his authorised representative with copies of the mill records giving the mass of bars / wires from that cast can be identified.

8.2. **Tensile test** - The tensile strength, 0.2 percent proof stress and percentage elongation of bars / wires shall be determined in accordance with requirements of IS: 1608-1972 read in conjunction with IS : 226-1975

8.2.1. Alternatively and by agreement between the purchaser and the supplier, for routine testing, the proof stress may be determined in conjunction with the tensile strength test and may be taken as the stress measured on the specimen whilst under load corresponding to an increase measured by an extensometer of 0.4 percent for Fe 415 bars / wires, 0.45



percent for grade Fe 500 bars / wires and 0.47 percent for grade Fe 550 bars / wires the total strain on any convenient gauge length.

8.2.2. The stresses shall be calculated using the effective cross – sectional area of the bar / wire.

8.3. **Bend test** - The bend test shall be performed in accordance with the requirements of IS: 1599 – 1974 and the mandrel diameter shall be considered to have passed the test if there is no transverse crack in the bent portion.

Table 4 mandrel diameter for bend test

Nominal size mm	Mandrel diameter for different grades		
	Fe 415	Fe 500	Fe 550
Up to and including 22	3 Ø	4 Ø	5 Ø
Over 22	4 Ø	5 Ø	6 Ø

Where Ø is the nominal size in mm of the test piece.

8.4. **Rebend test** - The test piece shall be bent to an included angle of 135° ( see Fig.2 ) using a mandrel of appropriate diameter ( see 8.4.1 ) The bent piece shall be aged by keeping in boiling water ( 100° C ) for 30 minutes and then allowed to cool. The piece shall then be bent back to have an included angle of 157½°. The specimen shall be considered to have passed the test if there is no fracture in the bent portion.

8.4.2 The diameter of the mandrel shall be as given below:

Nominal size of specimen	Dia of mandrel for Fe 415 and Fe 500	Dia of mandrel for Fe 550
Up to and including 10 mm	5 Ø	7 Ø
Over 10 mm	7 Ø	8 Ø

8.5. **Retest** - Should any one of the test pieces first selected fail to pass any of the tests specified in this standard, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirements of that particular test. Should the test piece from either of these additional samples fail, the material presented by the samples shall be considered as not having complied with this standard.

## 9. Routine inspection and testing

9.1. All material shall be subject to routine inspection and testing by the manufacturer or supplier in accordance with this standard and a record of the test results of material conforming to this standard shall be kept by the manufacturer or the supplier. The records shall be available for inspection by the purchaser or his representative.

In the case of material delivered to a supplier, the manufacturer shall supply a certificate containing the results of all the required tests on samples taken from the delivered material.

## 10. Selection of test specimens

10.1. For checking nominal mass, tensile strength, bend test and rebend test, test specimen

of sufficient length shall be cut from each size of the finished bar / wire at random at a frequency not less than that specified in Table 5.

Table 5 Frequency for nominal mass, tensile, bend and rebend tests

Nominal size	Quantity	
	For casts / heats below 100 tonnes	For casts / heats over 100 tonnes
Under 10 mm	1 Sample from each 25 tonnes or part thereof	1 Sample from each 40 tonnes or part thereof
10 mm to 16 mm inclusive	1 Sample from each 35 tonnes or part thereof	1 Sample from each 45 tonnes or part thereof
Over 16 mm	1 Sample from each 45 tonnes or part thereof	1 Sample from each 50 tonnes or part thereof

10.2. **Bond test** - The frequency of bond test as required in 4.7 shall be as agreed to between the manufacturer and the purchaser / testing authority.

### 11. Delivery, inspection and testing facilities

11.1. Unless otherwise specified, general requirements relating to the supply of material, inspection and testing shall conform to IS: 1387-1968. (General requirements for the supply of metallurgical materials (first revision))

11.2. No material shall be dispatched from the manufacturer's or supplier's premises prior to its being certified by the purchaser or his authorized representative as having fulfilled the tests and requirements laid down in this standard except where the bundle containing the bars / wires is marked with the ISI certification mark.

11.3. The purchaser or his authorised representative shall be at liberty to inspect and verify the steel maker's certificate of cast analysis at the premises of the manufacturer or the supplier. When the purchaser requires an actual analysis of finished material, this shall be made at a place agreed to between the purchaser and the manufacturer or the supplier.

11.4. **Manufacturer's certificate** - In the case of bars/wires which have not been inspected at the manufacture's works, the manufacturer or supplier, as the case may be, shall supply the purchaser or his authorized representative with the certificate stating the process of manufacture and also the test sheet signed by the manufacturer giving the result of each mechanical test applicable to the material purchased and the chemical composition, if required. Each test sheet shall indicate the number of the cast to which it applies, corresponding to the number or identification mark to be found on the material.

### 12. Identification and marking

12.1. The manufacturer or supplier shall have ingots, billets and bars or bundles of bars / wires marked in such a way that all finished bars / wires can be traced to the cast from which they were made. Every facility shall be given to the purchaser or his authorized representative for tracing the bars/wires to the cast from which they were made.

12.2. For each bundle / coil of bars / wires a tag shall be attached indicating cast No. / lot

No., grade and size.

12.3. Distinguishing mark shall be given to identify the different grades of bar / wire.

12.3.1. Identification marks like brand name, trade mark etc., that are introduced during rolling shall be designed and located in such a manner that the performance in use of the bar is not affected.

12.3.2. Each bundle containing the bars / wires may also be suitably marked with the ISI certification mark in which case the concerned test certificate shall also bear the ISI certification mark.

Note - The use of the ISI certification mark is governed by the provisions of the Indian standards institution (certification marks) act and the rules and regulations made there under. The ISI mark on products covered by an Indian standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. If marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a license for the use of the ISI certification mark may be granted to manufacturers or processors, may be obtained from the Indian standards institutions.

## 8. SPECIFICATIONS FOR ALUMINIUM WINDOWS

(Extract of IS: 1949-1961)

1. **Scope** – Deals with aluminium windows suitable for use in industrial buildings and designed to suit openings based on a module of 10 cm.

2. **Designation** – By symbols IN (to indicate industrial window) x Width expressed in number of modules x Type (F = fixed sash; C = centre hung sash; B = bottom-hung sash; T = top-hung sash) x Height expressed in number of modules.

Examples:

c) IN 10 C 15 indicate window for opening 10 module wide (100 cm) by 15 module high (150 cm) with centre-hung ventilator.

d) Composite windows

IN 10 C 10/IN 10 C 10

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IN 10 C 15/IN 10 C 15

Indicates the combination of four windows, two of the type IN 10 C 10 on top and two of the type IN 10 C 15 at bottom, all the four of them coupled both horizontally and vertically.

### 3. Sizes and tolerances

a) Sizes

IN10C10	IN22C10	IN16C15	IN10C20	IN22C20	IN16F10
IN10T10	IN22T10	IN16T15	IN10T20	IN22T20	IN16F15
IN10B10	IN22B10	IN16B15	IN10B20	IN22B20	IN16F20
IN16C10	IN10C15	IN22C15	IN16C20	IN10F10	IN22F10
IN16T10	IN10T15	IN22T15	IN16T20	IN10F15	IN22F15
IN16B10	IN10B15	IN22B15	IN16B20	IN10F20	IN22F20

b) Ventilators (opening part of a sash) shall be of one size and designed to fit into outer frame of IN 10 C 10 and with 1.2-mm clearance.

c) Tolerance for overall dimensions  $\pm 3$  mm.

Note – The overall width and height of window is smaller than dimensions of modular opening by 2.5 cm, allowing a clearance of 1.25 cm all round. Thus, width and height of INC10C5 = 97.5 x 147.5 cm.

#### 4. Material

- e) Aluminium extruded section: IS Designation HE9 – WP. Hollow sections shall conform to IS Designation HV9 – WP.
- f) Cord-eyes, pulleys, brackets and catch plates shall be of aluminium or galvanized or cadmium plated steel.
- g) Pivots, peg stays and spring catches shall be of non-ferrous metal.
- h) Glass panes - Shall weigh 7.5 kg/m<sup>2</sup>. Sizes of glass panes shall be as given below:

Pane Designation	a	b	c	d	e	f
Width (mm)	265	300	290	300	300	290
Height (mm)	420	420	455	455	490	490

Note: For number of glass panes for each type of window sees Fig.5 of the standard.

5. **Holes for fixing, coupling and glazing** – Holes for fixing and coupling sashes shall be provided in the web of the outside frame sections and of outer ventilator frame sections where these occur at the perimeter of the sash. Holes for glazing chips shall also be provided, one hole being located in web of the section or tee, on each side of each pane.

#### 6. Fitting and fixing materials

6.1. Centre-hung ventilators shall be mounted on a pair of cup-pivots made out of aluminium alloy sheet or chromium plated brass and each pivot consisting of a inner and outer cup, permitting the swinging of the ventilator through at least 85°. The ventilator shall be so balanced that it can remain open in any desired position.

6.2. Centre-hung and bottom-hung ventilators shall have cast aluminium or bronze spring catch in the centre of the top section, suitable for operation by hand or pole (chord in case of centre-hung).

6.3. Bottom-hung and top-hung ventilators shall be hung on aluminium alloy hinges. The

former shall be provided with a pair of aluminium alloy folding side arms (to limit the opening) and the latter with a 300 mm long peg stay. Alternatively, top-hung ventilator may be provided with 30-cm cam opener.

6.4. Two spring glazing clips per pane shall be provided

7. **Composite windows** – Shall be dispatched unassembled, but complete with necessary components. Each coupling member will increase the overall height or width by 25 mm.

8. **Finish** - Matt, scratch-brush or polished may be anodized additionally. A thick layer of transparent lacquer, based on methacrylates or cellulose butyrate, shall be applied, by the suppliers, to protect the surface from action of wet cement during installation. This lacquer coating shall be removed after installation is completed.

## 9. STONE WORK

### 5.1. Stone

5.1.1. Requirements of a good structural stone - Structural stones should primarily be (a) strong against crushing, (b) durable, (resistance to weather), (c) good in appearance (colour), (d) susceptible of being quarried in large sizes, and (e) fire resisting.

The strength of a stone depends upon its density and weight.

5.1.12.6. Mortar - The mortar used for joining shall be as specified.

5.1.12.7. Laying - All stones shall be wetted before use. Each stone shall be placed close to the stones already laid so that the thickness of the mortar joints at the face is not more than 20 mm. Face stones shall be arranged suitably to stagger the vertical joints and long vertical joints shall be avoided. Stones for hearing or interior filling shall be hammered down with wooden mallet into the position firmly bedded in mortar. Chips or sprawls of stones may be used for filling of interstices between the adjacent stones in heartening and these shall not exceed 20% of the quantity of stone masonry. To form a bond between successive courses plum stones projecting vertically by about 15 to 20 cm shall be firmly embedded in the heartening at the interval of about one meter in every course. No hollow space shall be left anywhere in the masonry.

The masonry work in wall shall be carried out true to plumb or to specified batter.

Random rubble masonry shall be brought to the level course at plinth, windowsills, lintel and roof levels. Leveling shall be done with concrete comprising of one part of the mortar as used for masonry and two parts of graded stone aggregate of 20 mm nominal size.

The masonry in structure shall be carried out uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45 degree.

5.1.12.8. Bond stones - Bond or through stones running right through the thickness of walls, shall be provided in walls up to 60 cm thick and in case of wall above 60 cm

thickness, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from the face of the wall to the back. In case of highly absorbent types of stones (porous lime stone and sand stone etc.) single piece bond stones may give rise to dampness. For all thickness of such walls, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided. Length of each such bond stone shall not be less than two-third of the thickness of the wall.

Where bond stones of suitable lengths are not available precast cement concrete block of 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) of cross section not less than 225 square centimeters and length equal to the thickness of wall shall be used in lieu of bond stones. (This shall be applicable only in masonry below ground level and where masonry above ground level is finally required to be plastered). At least one bond stone or a set of bond stones shall be provided for every 0.5 sq m of the area of wall surface. All bond stones shall be marked suitably with paint as directed by the engineer.

5.1.12.9. Quoin and jamb stones - The quoin and jamb stones shall be of selected stones neatly dressed and hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15 cm.. Quoins shall be laid header and stretcher alternatively.

5.1.12.10. Joints - Stone shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20 mm thick.

The joints shall be struck flush and finished at the time of laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

5.1.12.11. Scaffolding - Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one meter in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 stone aggregate 20 mm nominal size).

5.1.12.12. Curing - Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

5.1.12.13. Protection - Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

#### 5.1.12.14. Measurements

5.1.12.14.1 The length, height and thickness shall be measured correct to a cm. The thickness of wall shall be measured at joints excluding the bushing. Only specified dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic metre nearest to two places of decimal.

5.1.12.14.2. The work under the following categories shall be measured separately.

From foundation to plinth level (level one): (a) Work in or under water and /or liquid mud, (b) Work in or under foul positions.

From plinth level (Level one) to floor two level.

From floor two levels to floor three level and so on.

Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

Note :( 1) Floor I is the lowest floor above ground level in the building unless otherwise specified in a particular case. The floors above floor 1 shall be numbered in sequence as floor 2, floor 3 and so on. Number will increase upwards. (2) For floor 1, top level of finished floor shall be the floor level and for all other floors above floor 1, top level of structural slab shall be the floor level. (3) Floor level or 1 or 1.2 m above the ground level whichever is less shall be the plinth level.

5.1.12.14.3. No deduction shall be made nor extra payment made for the following

Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters purlins, trusses, corbels, steps etc.) up to 0.1 sqm in section.(ii)Openings each up to 0.1 sqm in area. In calculating the area of openings, any separate lintels or sills shall be included along with the size of opening but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any, shall also be excluded. (iii) Wall plates and bed plates, and bearing or chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

Note: The bearing of floor and roof shall be deducted from wall masonry. (iv) Drain holes and recess for cement concrete blocks to embed hold fasts for doors, windows, etc.(v) Building in masonry, iron fixture, pipes up to 300 mm dia, hold fasts of doors and windows etc. (vi)Forming chases in masonry each up to section of 350 sq cm.

Masonry (excluding fixing brick work) in chimney breasts with smoke or air flues not exceeding 20 sq dm (0.20 sq m) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20 sq dm (0.20 sq m) sectional area, deduction shall be made for the same and pargetting and coring flues shall be measured in running meters stating size of flues and paid for separately.

Aperture for fire place shall not be deducted and no extra payment made for splaying of jambs and throatings.

5.1.12.14.4. Apertures for fireplaces shall not be deducted and extra labour shall not be measured for splaying of jambs, throating and making arch to support the opening.

5.1.12.14.5. Square or rectangular pillars - These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed two and a half times the thickness.

5.1.12.14.6. Circular pillars (columns) - These shall be measured as per actual dimensions, but extra payment shall be allowed for stone work in circular pillars over the rate for stone work in walls. The diameter as well as length shall be measured correct to a cm.

5.1.12.14.7. Tapered walls - shall be measured net, as per actual dimensions and paid for as other walls.

5.1.12.14.8. Curved masonry - Stone masonry curved on plan to a mean radius exceeding 6 meters shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6 meters shall be measured separately and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

5.1.12.15. Rate - The rate shall include the cost of materials and labour required for all the operations described above and shall include the following:

Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds. (b)Preparing tops and sides of existing walls for raising and extending.(c) Rough cutting and waste for forming gables cores, skew backs or spandrels of arches, splays at eaves and all rough cutting in the body of walling unless otherwise specified.(d) Bond stones or cement concrete bond blocks. (e) Leading and making holes for pipes etc. (f) Bedding and pointing wall plates, lintels, sills etc., in or on walls, bedding roof tiles and corrugated sheets in or on walls.(g) Building in ends of joists, beams, lintels etc.

## **10. SPECIFICATION FOR FINISHING WORKS**

### **15.5. SPECIFICATIONS FOR CEMENT PLASTERING**

15.5.0. The cement plaster shall be 12 mm, 15 mm or 20 mm thick as specified in the item.

15.5.1. Scaffolding and preparation of surface shall be as specified in 15.1

15.5.2 **Mortar** - The mortar of the specified mix using the type of sand described in the item shall be used. It shall be as specified. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing cost work the fine aggregate conforming to grading zone V shall be used.



15.5.3. **Application** - The specifications as in 15.1.4 shall apply except in the following respects -

- a) Beating with thin bamboo strips shall not be done on the cement plaster, and
- b) No lime putty solution shall be applied on the face when finishing. Further the plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

15.5.4. **Thickness** - Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15 mm while in case of stone work the minimum thickness over the bushings shall be not less than 12 mm.

15.5.5. **Curing** - Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the engineer may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

Specifications for Finish, Precautions, Measurements and Rate shall be as described in 15.1

#### **15.6. SPECIFICATIONS FOR CEMENT PLASTER WITH A FLOATING COAT OF NEAT CEMENT**

15.6.0. The cement plaster shall be 12, 15 or 20 mm thick, finished with a floating coat of neat cement, as described in the item.

15.6.1. Specifications for this item of work shall be same as described except for the additional floating coat which shall be carried out as below.

When the plaster has been brought to a true surface with the wooden straight edge (clause 13.5.3 It shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications as described in 15.5.3 shall apply.

#### *15.27. SPECIFICATIONS FOR WHITE WASHING WITH WHITING*

15.27.1. Preparation of Mix - Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form thin slurry which shall then be screened through a clean coarse cloth. Two kg of gum and 0.4 kg of copper sulphate

dissolved separately in hot water shall be added for every cum of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use.

15.27.2. Other specifications described shall apply in this case also.

#### *15.29. SPECIFICATIONS FOR DRY DISTEMPERING*

15.29.1. Materials - Dry distemper of required colour (IS-427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using 6 decilitres (0.6 litre) of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency.

Distemper shall not be mixed in larger quantity than is actually required for one day's work.

#### **15.29.2. Preparation of Surface**

15.29.2.1. Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

15.29.2.2. New plastered surfaces shall be allowed to dry for at least two months, before applying distemper.

15.29.2.3. In the case of old work, all those pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

15.29.2.4. Pitting in plaster shall be made good with Plaster of Paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

15.29.3. Priming Coat - A priming coat of whiting shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper.

The treated surface is allowed to dry before distemper coat is given.

#### **15.29.4. Application**

15.29.4.1 In the case of new work, the treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface attains an even colour.

15.29.4.2 For old work, the surface prepared as described shall be applied one or more coats of distemper till the surface attains an even colour.

15.29.4.3. The application of each coat shall be as follows - The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

15.29.4.4. The subsequent coats shall be applied only after the previous coat has dried.

15.29.4.5. The finished surface shall be even and uniform and shall show no brush marks.

15.29.4.6. Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

15.29.4.7. After each day's work, the brushes shall be washed in hot water and hung down to dry. Old brushes which are dirty or caked with distemper shall not be used.

15.29.5. The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described.

### *15.33. SPECIFICATIONS FOR PAINTING*

15.33.1. Materials - Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint the brand of thinner recommended by the manufacturer or as instructed by the Engineer shall be used.

Approved paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the engineer. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the engineer.

15.33.2. Commencing Work - Painting shall not be started until the engineer has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the paint work being started.

15.33.3. Preparation of Surface - The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly

removed before painting is started. The prepared surface shall have received the approval of the engineer after inspection, before painting is commenced.

#### 15.33.4. Application

15.33.4.1. Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its containers, when applying also, the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

15.33.4.2. The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over the paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and lying off will constitute one coat.

15.33.4.3. Where so stipulated, the painting shall be done by spraying. Spray machine used be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed to the requisite consistency by adding a suitable thinner.

15.33.4.4. Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next-coat is applied. This should be facilitated by thorough ventilation. Each one except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

15.33.4.5. No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

15.33.4.6. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings etc. shall be left on the work.

15.33.4.7. In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need not be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

15.33.4.8. On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

14.33.4.9. The additional specifications for primer and other coats of paints shall be as according to the detailed specifications under the respective headings.

15.33.5. Brushes and containers - After work, the brushes shall be completely cleaned of paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use shall be kept closed and free from air so that paint does not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

#### 15.33.6. Measurements

15.33.6.1. The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated.

15.33.6.2. Small articles not exceeding 10 sq. decimeter (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

15.33.6.3. Painting up to 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running meters and shall include cutting to line where so required.

Note: Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sq. meters irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

15.33.6.4. In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

Table 1 Equivalent plain areas of uneven surface

Sl. No.	Description of work	How measured	Multiplying coefficients
1	2	3	4
I.	Wood work doors, windows etc.		
1	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2	Ledged and battened or ledged, battened and braced doors, windows etc.	Frame, edges chocks, cleats, etc. shall be deemed to be included in the item.	
3	Flush doors etc.	- do -	1.20 (for each side)
4	Part panelled and part glazed or	- do -	1.00 (for each

	gauzed doors, windows etc. (Excluding painting of wire gauze portion)		side)
5	Fully glazed or gauged doors, windows etc. (Excluding painting of wire gauze portion)	- do -	0.80 (for each side)
6	Fully venetianed or louvered doors,	- do -	1.80 (for each windows etc. side)
7	Trellis work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2 ( for painting all over)
8	Carved or enriched work	Measured flat	2 ( for each side)
9	Weather boarding	Measured flat (not girthed supporting frame work shall not be measured separately)	1.20 (for each side)
10	Wood shingle roofing	Measured flat (not girthed)	1.10 (for each side)
11	Boarding with cover fillets and	Measured flat (not girthed)	1.05 (for each match boarding side)
12	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.80 (for painting all over)
<b>II.</b>	Steel Work Doors, Windows, etc.		
13	Plain sheeted steel doors or windows	Measured flat (not girthed including frame edges etc.)	1.10 (for each side)
14	Fully glazed or gauzed steel doors and windows (excluding painting of	- do -	0.50 (for each side)

	wire gauze portion)		
	Partly panelled and partly glazed doors and windows (excluding painting of wire gauze portion)	- do -	0.80 (for each side)
16	Corrugated sheeted steel doors or windows	- do -	1.25 (for each side)
17	Collapsible gates	Measured flat	1.50 (for painting all over)
18	Rolling shutters of interlocked laths	Measured flat (size of opening) all over ; jamb guides, bottom rails and locking arrangement etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)
III.	<b>General</b>		
19	Expanded metal, hard drawn steel Wire fabric of approved quality, grill works and gratings in guard Bars, balustrades, railing partitions and MS bars in windows frames	Measured flat overall, no deduction shall be made for open spaces; supporting members shall not be measured separately.	1 (for paint all over)
	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel.	- do - (see note No. 12)	1 (for paint all over)
	Corrugated iron sheeting in roofs, side cladding etc.	- do - Measured flat (not girthed)	1.14 (for each side)
	AC semi-corrugated sheeting in roofs, side cladding etc.	- do -	1.20 (for each side)
	AC semi-corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets	- do -	1.10 (for each side)

	Wire gauze shutters including painting of wire gauze.	- do -	1.00 (for each side)
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**Explanatory notes for Table 1:**

- 1) Measurements for doors windows etc., shall be taken flat (and not girthed) over all including frames, where provided. Where frames are not provided, the shutter measurements shall be taken.
- 2) Where doors, windows, etc., are of composite types other than those included in Table 1 the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.
- 3) The coefficients for door and windows shall apply irrespective of the size of frames and shutter members.
- 4) In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.
- 5) When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer and measurement of this will be deemed to be included in the measurement of the face treated with that finish.
- 6) In the case where shutters are fixed on both faces of the frames, the measurement for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.
- 7) Where shutters are provided with clearance at top or / and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.
- 8) Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
- 9) Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings, etc.
- 10) Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.
- 11) The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is



once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

12) For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), up to the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or the palisades.

15.33.6.5. Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.

15.33.6.6. For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas shall be measured in sq. meters and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

15.33.6.7. Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for those or for painting brackets, clamps etc.

15.33.6.8. Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

15.33.6.9. Flag staffs, steel chimneys, aerial masts, spires and other each objects requiring special scaffolding shall be measured separately.

15.33.7. **Precautions** - All furnitures fixtures, glazing, floors, etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damages done shall be made good by the contractor at his cost.

15.33.8. **Rate** - Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items.

## **11. GALVALUME SHEET**

Galvalume Troughed Sheet 0.50 mm TCT, 550 Mpa from the Firms, TATA Blue scope / Tiger / Cril / Kirby or any other approved make. These shall be of the thickness specified in the description of the item and shall conform to IS : 9364. The sheets shall be of AZ-150 grade of coating unless otherwise specified in the description of item.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanizing shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

## **8.2 Galvalume Ridge Sheet**

Galvanised Ridge sheets from the Firms, TATA Blue scope / Tiger / Cril / Kirby or any other approved make

Ridges and hips of C.G.S. roof shall be covered with ridge and hip sections of plain G. S. sheet with a minimum lap of 20 cm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G. sheet, 0.47 mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.

## **12. EPOXY BONDING OF NEW CONCRETE TO OLD CONCRETE**

### **2801 DESCRIPTION**

Repair of structures shall be carried out in accordance with the repair plans and these Specifications or as directed by the Engineer. Where repair work is not covered by these Specifications, special specification may be framed. Implementation of repair schemes shall also conform to provisions of IRC: SP: 40, IRC: SP: 74 and IRC: SP: 80.

### **2802 GENERAL**

#### **2802.1 Environmental Aspect**

Care shall be taken to ensure suitable mitigation measures against noise and dust, pollution and damages to the environs whether temporary or permanent.

#### **2802.2 Phasing**

The sequence of work shall be in accordance with the drawings or as directed by the Engineer.

#### **2802.3 Traffic Management**

Traffic management, signage, signaling, barricading, and lighting arrangement shall be in accordance with Section 100 of these Specifications.

#### **2802.4 Safety Precautions**

Adequate precautions shall be taken for safety of personnel, road users and existing services.

## **2805 EPOXY BONDING OF NEW CONCRETE TO OLD CONCRETE**

2805.1 Epoxy resin used for bonding shall be obtained from a reputed manufacturer. The pot life of such bonding epoxy shall not be less than 60 minutes at normal temperature.

2805.2 The entire surface of the existing concrete member should be thoroughly cleaned by wire brush and then with compressed air to remove dust and loose particles from the surface. Any crack or spalling of concrete shall be sealed by epoxy

injection/epoxymortar/grouting as decided by the Engineer. A coating of suitable epoxy resin at the rate of 0.8 kg/sq.m (minimum) should then be applied on the surface of the existing concrete members. Fresh concrete shall then be placed within the pot life of the resin system.

### **2805.3 Testing**

**2805.3.1 Epoxy** used for bonding work shall satisfy the criteria mentioned in Clause 2803.9

#### **2803.9.1 Material Testing**

Prior to approval of material, the following tests shall be carried out by the Contractor at site or in an authorized laboratory for each batch of resin and hardener and each combination.

- i. Viscosity test for resin and hardener and the mix' three specimens each.
- ii. Pot life test: three specimens each.
- iii. Bond test: three specimens each.
- iv. Shear test: six specimens each, 3 after 24 hours and the other thereafter 72 hours of curing.

Subsequent tests shall be carried out as directed by the Engineer. Procedure for tests shall be as follows:

##### **i) Pot Life Test**

- a. 500 gm of resin formulation shall be prepared by thoroughly mixing the resin and hardener/accelerator /catalyst component in proposed proportion in a 1 kg capacity hemispheric porcelain bowl by means of a spatula or any other agitating device and time and the ambient temperature noted.
- b. The resin formulation shall be applied with a clean dry 25 mm size painter's brush, on a clean dry surface such as cement concrete over 150 mm - 200 mm length, starting immediately after mixing the formulation and repeating the operation every five minutes. When it becomes just difficult to spread the resin properly with the brush, the time is noted. The time elapsed since completion of mixing of resin formulation, is taken as its pot life.
- c. One pot life test shall be performed on commencement of work and the same shall be repeated every four hours.
- d. In case the material fails to satisfy the pot life test, it shall not be used for injection. Where the resin and hardener get mixed at point of injection, the pot life is not important and no tests may be required.

##### **ii) Bond Test**

A standard 150 mm diameter and 300 mm long concrete cylinder shall be cast in 2 pieces by providing a separating medium at an axis of 45 degrees to the longer axis of

the cylinder as shown in Fig. 1 of Appendix 2800/1. Three such split cylinders shall be prepared. Two pieces of each cylinder shall be joined with epoxy mortar at four points to give a clear gap of about 0.2 mm, which will be injected with epoxy resin at site. After epoxy has been cured, load test shall be carried out on the cylinder. The failure shall not take place at the joint injected with epoxy resin. Also the strength of cylinder at failure shall not be less than 80 percent of the 28 days cube strength of the concrete mix.

### iii) Shear Tests

Two steel plates, minimum 3 mm thick, shall be bonded with epoxy at site using the same resin mix as used/proposed to be used for injection. The assembly shall be kept in mechanical clamp till epoxy is cured. A total of six specimens shall be prepared for each batch of materials. Three test specimens shall then be subjected to a shear force along the axis after 24 hours and the minimum shear strength before failure shall not be less than 1 MPa (Refer Fig. 2 of Appendix 2800/1).

The remaining test specimens shall be similarly tested after 72 hours of curing. The shear strength before failure shall not be less than 2.5 MPa.

- Slant Shear Strength : BS 6319, Part 4
- Bond strength : ASTM C882

2805.3.2 Two concrete cubes of 150 mm size cast as per approved design mix shall be placed at a distance of 150 mm from each other, as shown in Fig. 3 of Appendix-2800/1.

Epoxy resin system suggested for bonding new to old concrete shall be applied on the opposite faces of the cubes. Fresh cement concrete cube of grade as per approved design mix shall be cast with water cement ratio of 0.4 or less in the manner shown in Fig. 3 of Appendix 2800/1. The assembly shall be cured in water for 28 days and steel spacer removed thereafter. The cube assembly shall be subjected to compression load after 28 days of curing, there by subjecting the bond to shearing load. Failure must not occur at this joint.

### 13. ZINC PRIMING PAINT EPOXY BASED, TWO PACK SPECIFICATION

1. Composition: The primer shall be based on a two pack epoxy binder cured with polyamide and solvent, depending upon requirements and pigmented with zinc dust and suitable extenders. The metallic Zinc content when calculated, as given in Annex B, on the non-volatiles portion of the paint for grade 2 shall be not less than 85 percent (By mass) as per IS14589:1999 (Reaffirmed 2004)
2. Grades :
  - Grade 2: Paint priming zinc, used alone or as primer coat for paint system.
3. Metallic zinc dust used in the formulation shall be as per grade 2 of IS 4611.
4. The mixing portion of two component materials shall be a simple ratio by mass.

5. Mass per 10 Liters : The mass of 10 liters of the material when determined by method described in IS 101 (Part 1/ Sec. 7) shall be between 15-18 Kg for Grade I and Minimum 21.5 Kg for grade 2

The materials for grade 2 shall also comply with requirement given in Table 1

Table 1 Requirements of Zinc Priming Plant Epoxy Based Two Pack

Sl. No.	Characteristic	Requirements	Method of test Ref. to IS 101 Annex.
		Grade 1	
1	2	3	4
i)	Consistency	Paint shall be in such a condition that power mixing produces a smooth and uniform paint suitable for application	Part 1/ Sec 5
ii	Drying time, Max	30min	Part 3/ Sec 1
iii	Finish	Smooth and matt	Part 3/ Sec 4
iv	Color	Grey	Part 4/ Sec 2
v	Volatile matter, percent by mass, Max.	30	Part 2/ Sec 2
vi	Pigment Content, percent by mass Min.	65	Part 8/ Sec 2
vii	Volume Solids, percent by mass, Min.	35	Part 8/ Sec 6
viii	Dry Film thickness, micron Min.	45	Part 3/ Sec 2
ix	Flash Point, °C Min	15	Part 1/ Sec 6
x	Protection against corrosion under condensation conditions using abrasive blasted steel panel.	28 Days	Part 6/ Sec 1
xi	Resistance to salt spray"	30 Days	Annex C
xii	Effect of welding	To pass the test	Annex D
xiii	Keeping quality	Not less than 1 year	Part 6/ Sec 2
xiv	Pot life, Min	6h	Annex E
" This test shall be done at approval stage only			

6. Packing and Marking :

- i. Packing : The material shall be packed as agreed to between the purchaser and the supplier
- ii. Marking : The material shall be marked with the following particulars:

- a) Name and grade of the material;
  - b) Indication of the source of manufacture;
  - c) Net Mass of materials;
  - d) Batch No. or lot No., in Code or otherwise;
  - and
  - e) Month and year of manufacture
- iii. BIS Certifications Marking and year of Manufacturing: The Product may also be marked with Standard Mark.
7. Sampling: Representative samples of the materials shall be drawn as prescribed in IS 101 (Part I / Sec. I)
8. Test Methods :
- i. Quality of Reagents: Unless specified otherwise, pure chemicals and distilled water (see IS1070) shall be employed in tests.

#### **14. EPOXY ENAMEL PAINT BASED, TWO COMPONENT GLOSSY SPECIFICATION**

##### **1. SCOPE**

This standard prescribes requirements and method of sampling and test for two component epoxy enamel

This material is expected to have adhesion on inorganic zinc coating and epoxy-primers, high toughness and abrasion resistance. This material is used as a finish coat for the painting of steel plant equipment where protection to salt water, chemicals, mineral oils, solvents and resistance to moisture protection under marine conditions are required.

##### **2. REFERENCE:**

The Indian Standards listed in Annex A, are necessary adjuncts to this standard.

##### **3. TERMINOLOGY**

For the purpose of this standard the terms and definitions used in IS 1303 : 1983 shall apply.

##### **4. REQUIREMENTS**

###### **Composition**

Paints complying with this standard shall comprise of epoxy resin as the principal binder. The manufacturer shall specify that the principal type of binder used in the paint has epoxy equivalent in the range of 350 to 600. The composition shall be such that it satisfies the requirement of this standard.

The paint shall consist essentially of two components base and hardener or catalyst solution to be mixed in the appropriate ratio by volume as specified by the paint supplier to satisfy all the requirements of this standard.

###### **Keeping Properties**

The material shall conform all the requirements as mentioned in Table 1 for a minimum period of one year from the date of manufacture when stored in original sealed containers under normal atmospheric condition.

The material shall conform to the requirements given in Table 1 on the blasted panels. Reference to the relevant

## 5. TESTS

Unless specified otherwise, tests shall be conducted as prescribed in IS 101, preferably sections of that standard are given in col 4 of Table 1. The preparation of metal panels shall be according to IS 101 (Part 1/Sec 3): 1986.

### Quality of Reagents

Unless specified otherwise, pure chemicals and distilled water (see IS1070 : 1992 ) shall be employed.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

## 6. PACKING AND MARKING

### Packing

The material shall be packed in dual container. It shall ensure that the quality does not deteriorate during storage and shall be as agreed to between purchaser and supplier.

### Marking

Each container shall be marked with the following information:

- i. Indication of the source of manufacture,
- ii. Batch No. or lot No. and month and year of manufacture,
- iii. Date of expiry, and
- iv. Mass of the material.

### BIS Certification Marking

The product may also be marked with Standard Mark.

The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

## 7. SAMPLING

Representative samples of the material shall be drawn according to 6 of IS 101 ( Part 1/Sec 1 ) : 1986.

Sl. No	Characteristic	Requirement	Method of test Ref. to IS 101	Annx

(1)	(2)	(3)	(4)	(5)
A	Wet paint			
i	Mass in Kg per 10 Litre, Min	9	Part 1/Sec7 : 1987	
ii	Consistency	Smooth and uniform	Part 1/Sec 5 : 1989	
iii	Flash point	Above 20°C	Part 1/Sec 6 : 1986	
iv	Drying time, <i>Max</i>		Part 3/Sec 1 :1986	
	Surface dry	3 h		
	Hard dry	24 h		
v	Percent volume, solids, <i>Min</i>	40		
vi	Pot life, <i>Min</i>	6h		B

NOTE — Tests from SI No. (i) to (vi) are for mixed paint.

#### 15. RELEVANT BIS CODE FOR TECHNICAL SPECIFICATION

S. No.	IS Code	Description
<u>A. EARTHWORK IN EXCAVATION AND BACKFILLING</u>		
1	IS: 783	Code of Practice for laying of concrete pipes.
2	IS: 1200 (Part 1)	Method of measurement of building and civil engineering works - Earth Work.
3	IS: 1489	Specification for Portland Pozzolana Cement
4	IS:2720 (All Parts)	Methods of test for soils.
5	IS:2809	Glossary of terms and symbols relating to soil engineering.
6	IS:3764	Safety code for excavation work.
7	IS:4081	Safety code for blasting and related drilling operations.



8	IS:4988 (All Parts)	Glossary of terms and classifications of earth moving machinery.
<u>B. PLAIN, REINFORCED AND PRESTRESSED CONCRETE</u>		
1	IS: 269	Specification for 33 Grade Ordinary Portland Cement.
2	IS: 303	Specification for Plywood for General Purpose.
3	IS: 383	Specification for Coarse and Fine Aggregates from Natural Source for Concrete.
4	IS: 432 (All Parts)	Specifications for Mild Steel and Medium-tensile Steel Bars and Hard-drawn Steel Wire for Concrete Reinforcement.
5	IS: 432 (Part - I)	Mild Steel and Medium-tensile Bars.
6	IS: 432 (Part - II)	Hard-drawn Steel Wire.
7	IS: 455	Specification for Portland Slag Cement.
8	IS: 456	Code of Practice for Plain and Reinforced Concrete.
9	IS: 460	Specification for Test Sieves.
10	IS: 515	Specification for Natural and Manufactured Aggregates for use in Mass Concrete.
11	IS: 516	Methods of Tests for Strength of Concrete.
12	IS: 650	Standard Sand for Testing of Cement.
13	IS:1199	Sampling and Analysis of Concrete.
14	IS:1200	Method of Measurement of Building Works.
15	IS:1489	Specification for Portland Pozzolana Cement.
16	IS:1542	Sand for Plaster.
17	IS:1566	Specification for Hard-drawn Steel Wire Fabric for Concrete Reinforcement.
18	IS:1785	Specification for Plain Hard-drawn Steel Wire for Prestressed Concrete (Part - I) - Cold Drawn Stress Relieved Wire.
19	IS:1786	Specification for High Strength Deformed Steel Bars and Wires for

		Concrete Reinforcement.
20	IS:1791	Batch Type Concrete Mixers.
21	IS:2386	Methods of Test for Aggregates for Concrete (8 Parts).
22	IS:2502	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.
23	IS:2505	General Requirements for Concrete Vibrators.
24	IS:2506	General Requirements for Screed Board Concrete Vibrators.
25	IS:2722	Specification for Portable Swing Weigh Batcher (single and double bucket type).
26	IS:2911	Code of Practice for Design and Construction of Pile Foundation.
27	IS:3366	Pan Vibrators.
28	IS:3558	Code of Practice for the use of Immersion Vibrators for Consolidating Concrete.
29	IS:3370	Code of Practice for Concrete Structures for the (All Parts) Storage of Liquids.
30	IS:4656	Form Vibrators for Concrete.
31	IS:5525	Recommendation for Detailing of Reinforcement in Reinforced Concrete Works.
32	IS:5640	Method of Test for Determining Aggregate Impact Value of Soft, Coarse Aggregate.
33	IS:5816	Method of Test for Splitting Tensile Strength of Concrete Cylinder.
34	IS:6006	Specification for Uncoated Stress Relieved Strand for Prestressed Concrete.
35	IS:6461	Cement Concrete : Glossary of Terms.
36	IS:8041	Specifications for Rapid Hardening Portland Cement.
37	IS:8043	Specifications for Hydrophobic Cement.
38	IS:8112	Specification for 43 Grade Ordinary Portland Cement.
<u>C. STEEL REINFORCEMENT</u>		
1	IS:1785	Cold Drawn Stress relieved wire (Part I).
2	IS:1786	Specification for Cold Twisted Steel Bars for Concrete Reinforcement.

3	IS:2751	Code of Practice for Welding of M.S.Bars.
4	IS:5525	Recommendation for detailing of Reinforcement in Reinforced Concrete Works.
5	IS:6006	Uncoated Stress Relieved Strand for Prestressed Concrete.
6	IS:14268	Specifications for uncoated stress Relieved Low Relaxation Seven Ply Strand for Prestressed Concrete.
7	IS:800	General Construction in Steel
8	IS:816	Metal-arc welding for general construction in mild steel
9	IS:817	Training & Testing of metal-arc welders
10	IS:226	Structural Steel Sections
11	IS:2062	Weldable Structural Steel
12	IS:814	Welding Electrodes
13	IS:919	Recommendations for limits and fits for Structural Engineering.
14	IS:1477	Code of Practice for painting of ferrous metals in buildings.
15	IS:1977	Structural Steel (Ordinary quality)
16	IS:7205	Safety Code for erection of structural steel work
17	IS:7215	Tolerances for fabrication of steel structures
18	IS:8500	Weldable structural steel (medium and high strength qualities).
<u>D. RUBBLE MASONRY</u>		
1	IS:1121 (All Parts)	Methods of test for determination of strength properties of natural building stones.
2	IS:1122	Methods of test for determination of true specific gravity of natural building stones.
3	IS:1123	Method of identification of natural building stone.
4	IS:1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
5	IS:1125	Method of test for determination of weathering of natural building stones.
6	IS:1126	Method of test for determination of durability of natural building stones.

7	IS:1127	Recommendations for dimensions and workmanship of natural building stones for masonry work.
8	IS:1129	Recommendation for dressing of natural building stones.
9	IS:1597	Code of Practice for construction of stone masonry.
10	IS:1597 (Part I)	Rubble stone masonry
11	IS:1597 (Part II)	Ashlar masonry
12	IS:2250	Code of Practice for preparation and use of masonry mortars.
<u>E. PLASTERING AND POINTING</u>		
1	IS: 269	Specification for 33 Grade Ordinary Portland Cement.
2	IS: 712	Specification for Building Limes.
3	IS:1542	Specification for Sand for Plaster.
4	IS:1630	Specification for Mason's Tools for plaster work and pointing work.
5	IS:1661	Code of Practice for application of cement lime plaster finishes.
6	IS:2402	Code of Practice for external rendered finishes.
7	IS:8041	Specification for Rapid Hardening Portland Cement.
8	IS:8112	Specification for 43 Grade Ordinary Portland Cement.
9	IS:12600	Specification for Low Heat Portland Cement.
<u>F. PAINTING</u>		
1	IS: 63	Whiting for Paints.
2	IS:110	Reading mixed paint, brushing, gray filler for Enamels, for use over primers.
3	IS:426	Specification for paste filler for color coats.
4	IS:428	Specification for Distemper, Oil Emulsion, color as required.
5	IS:710	Specification for Marine Plywood.
6	IS:1477 (Part I)	Code of Practice for painting of ferrous metals in buildings - Pretreatment.
7	IS:1477 (Part II)	Code of Practice for painting of ferrous metals in buildings - Painting.

8	IS:2338 (Part I)	Code of Practice for finishing of wood and wood based materials - Operations and Workmanship for finishing.
9	IS:2338 (Part II)	Code of Practice for finishing of wood and wood based materials - Schedules.
10	IS:2395 (Part I)	Code of Practice for painting concrete masonry and plaster surfaces - Operation and workmanship.
11	IS:2395 (Part II)	Code of Practice for painting concrete masonry and plaster surfaces - Schedules.
12	IS:2524 (Part I)	Code of Practice for painting of non-ferrous metals in buildings - Pre-treatment.
13	IS:2524 (Part II)	Code of Practice for painting of non-ferrous metals in buildings - Painting.
14	IS:3140	Code of Practice for painting asbestos cement building products.
15	IS:5410	Specification for cement paints, colour as required.
<b>G. STEEL, ALUMINIUM AND IRON WORK</b>		
1	IS:1956	Glossary of terms relating to iron and steel.
2	IS:814 (Part I)	Specifications for covered electrodes for metal arc welding of structural steel - For welding products other than sheets.
3	IS:814 (Part II)	Specifications for covered electrodes for metal arc welding of structural steel - For welding sheets.
4	IS:815	Classification and Coding of covered electrodes for metal arc welding of structural steel.
5	IS:818	Code of Practice for safety and health requirements in electric and gas welding and cutting operations.
6	IS:1182	Recommended Practice for Radiographic examination of fusion welded butt joint in steel plates.
7	IS:1148	Specification for Rivet Bars for structural purposes.
8	IS:816	Code of Practice for use of metal arc for general construction in mild steel.
9	IS:3600	Method of testing fusion welded joints and weld metal in steel.
10	IS:6227	Code of Practice for use of metal arc welding in tubular structure.

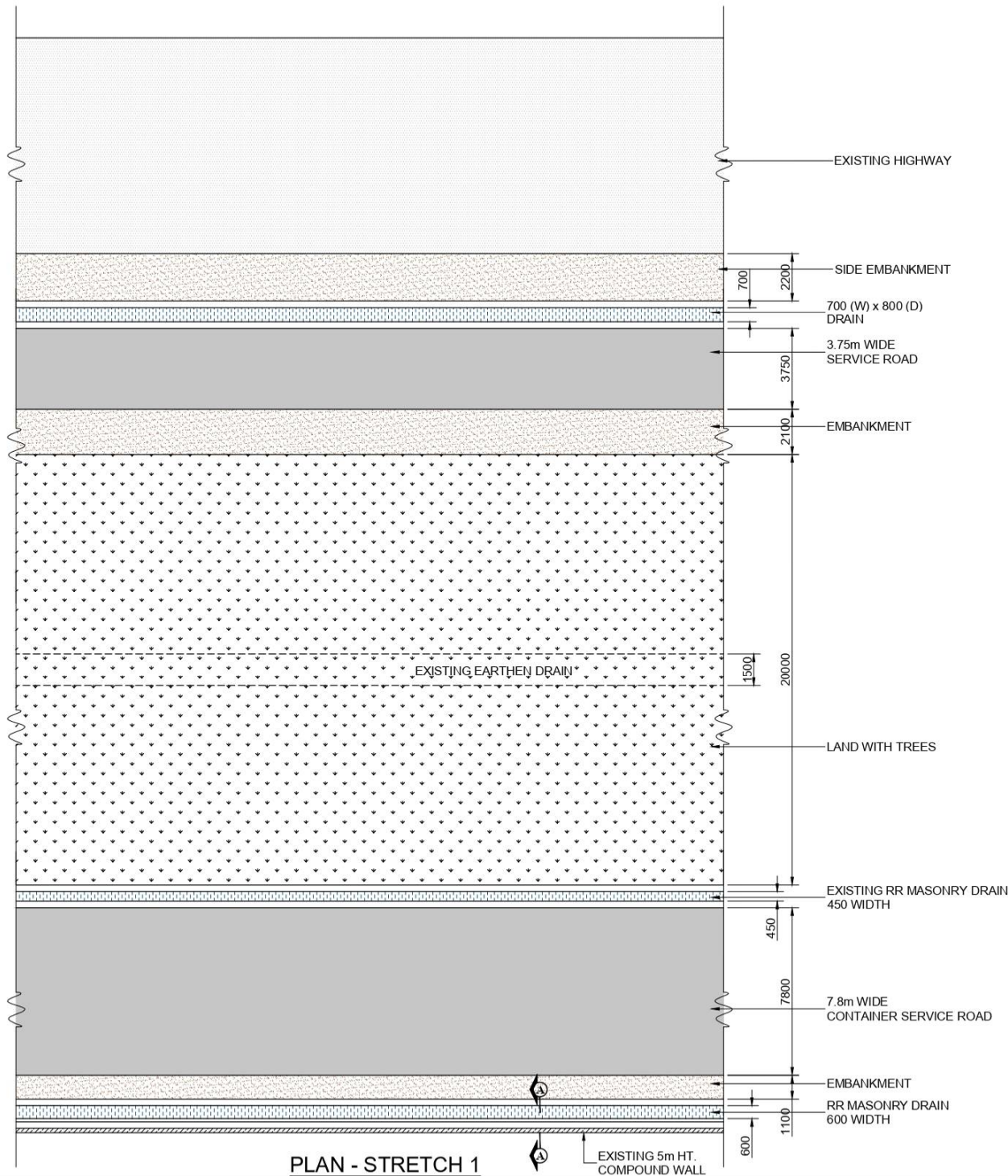
11	IS:6248	Specifications for metal rolling shutter and rolling grill.
12	IS:1081	Code of Practice for fixing and glazing of metal (steel and aluminium) Doors, Windows and Ventilators.
13	IS:1361	Specifications for steel windows for Industrial Buildings.
14	IS:1200 (part VIII)	Method of Measurement of steel work and iron work
15	IS:1038	Specifications for steel doors, windows and ventilators.
16	IS:226	Specifications for structural steel (Standard Quality).
17	IS:823	Code of Procedure for manual metal arc welding of metal steel.
18	IS:102	Ready mixed paint, brushing, red lead non-sitting, priming.
19	IS:1363	For black hexagonal bolts, nuts and lock-nuts (dia 6 to 39 mm) & black hexagonal screws (dia 6 to 24 mm)
20	IS:813	Scheme of symbols for welding.
21	IS:817	Code of Practice for training and testing of metal arc welders. (Revised)
22	IS:800	Code of Practice for use of structural steel in general building construction.

## SECTION V

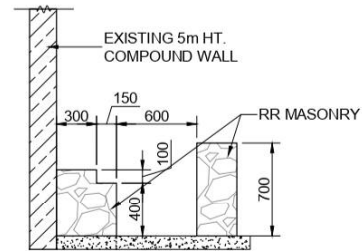
**DRAWINGS****Brief Description of drawing**

The Works are shown in the following drawings that are issued as a part of the Tender Documents:

SL. NO	DRAWING NO.	DESCRIPTION
1	DP1033DRG CL 01010	Entrance & Exit Gate-2 Plan, Elevation & section
2	DP1033DRG CL 01011	Entrance & Exit Gate Layout & Details of Footing & Column
3	DP1033DRG CL 01012	Layout & Details of Grade Beam
4	DP1033DRG CL 01013	Layout of RCC Sloping Roof & Lintel +2.10Mlvl.(Bottom & Tie Beam @+1.85m LVL.(Top)
5	DP1033DRG CL 01014	Layout of RCC Beam & slab at 3.85m & +5.35m LVL. TOP
6	DP1033DRG CL 01015	Layout of RCC Sloping Roof & Beam @ 5.85m LVL.(Bottom)
7	DP1033DRG CL 01016	Site Development Stretch-1
8	DP1033DRG CL 018	Waiting shelter Plan, Elevation & Section
9	DP1033DRG CL 019	Layout & detail of strip footing, column seat & slope roof
10	DP1033DRG CL 020	Typical details of Box Culverts



**PLAN - STRETCH 1**



**SECTION A - A**

**NOTES:-**

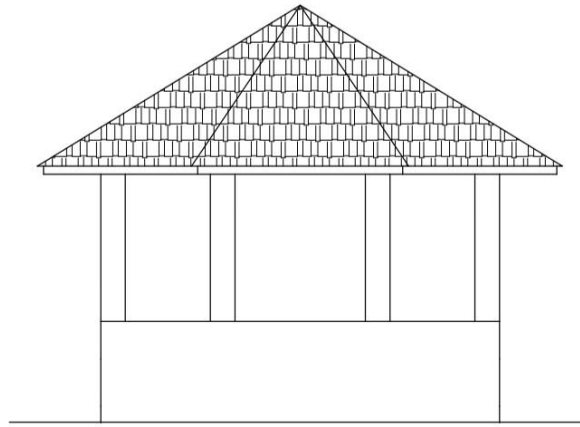
1. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED

Rev.No.	PARTICULARS	INITIAL	DATE
REVISION			

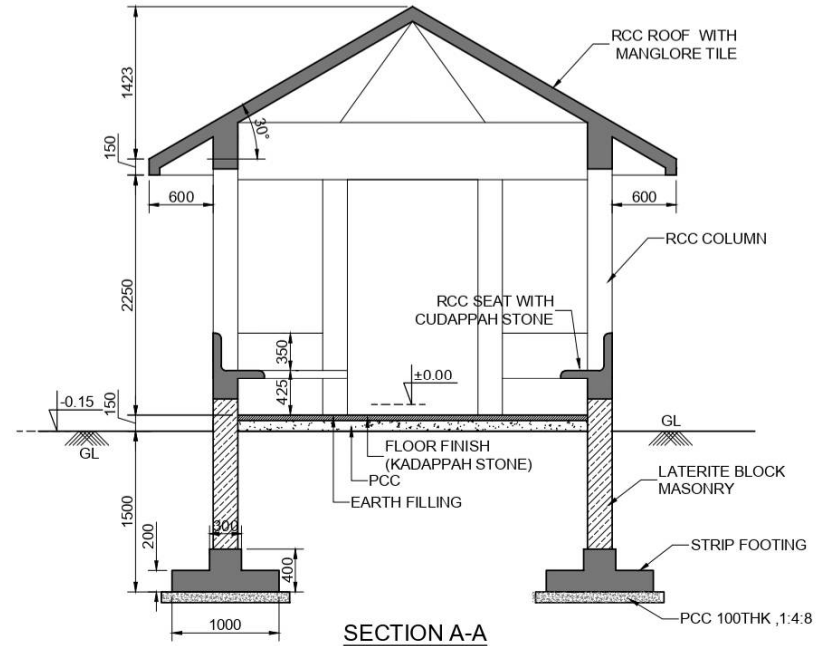
 <b>KITCO Ltd.</b> <small>(Est. in 1972 by IDBI &amp; Govt. of Kerala)</small> <small>PUTHIYA ROAD - NH BYPASS, KOCHI - 28</small>				
CLIENT:				
NEW MANGLORE PORT TRUST				
PROJECT:				
CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT				
TITLE:				
SITE DEVELOPMENT - STRETCH 1				
DRG NO:	SHEET NO:	REV.	SCALE:	A3
DP 1033 DRG CL 01 016	1 OF 1		1 : 600	
DESIGNED: Monisha P	DRAWN: Paul Bernard	CHECKED: Sansu Sunny	VERIFIED: Lipin K	APPROVED: Shalimar M S
ISSUED FOR:			UNIT:	DATE:
<b>ESTIMATE PURPOSE</b>			Metres	12.05.2021

This drawing is the property of KITCO Ltd. and is to be used only for the purpose for which it was lent and must not be in any way detrimental to the interest of the company and is subject to return on demand

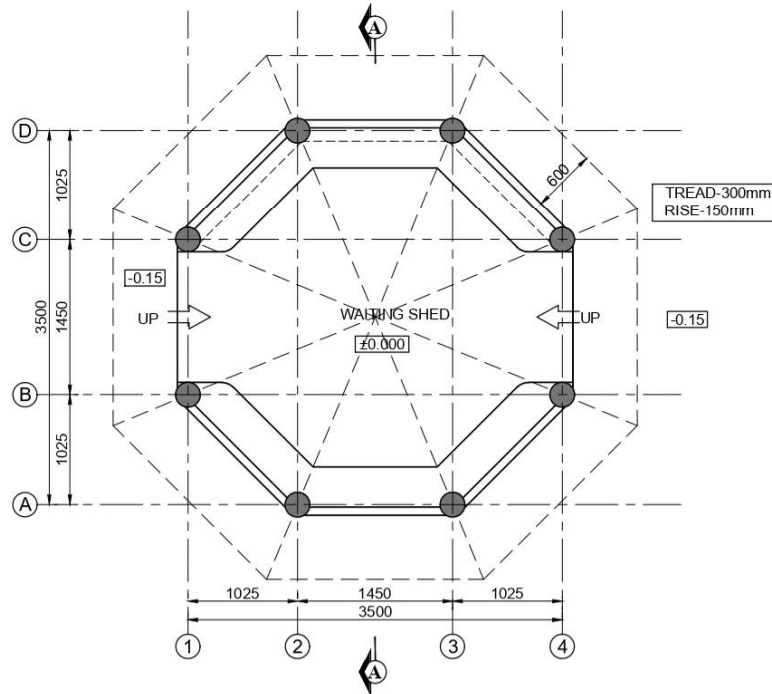




ELEVATION



SECTION A-A



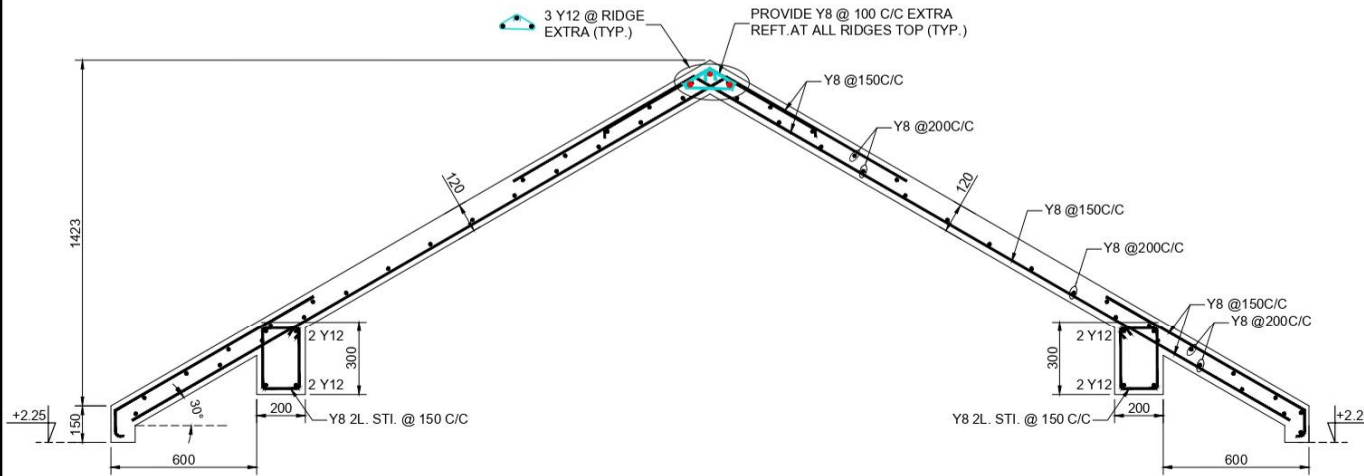
GROUND FLOOR PLAN  
AREA-11 SQM

Rev.No.	PARTICULARS	INITIAL	DATE
REVISION			

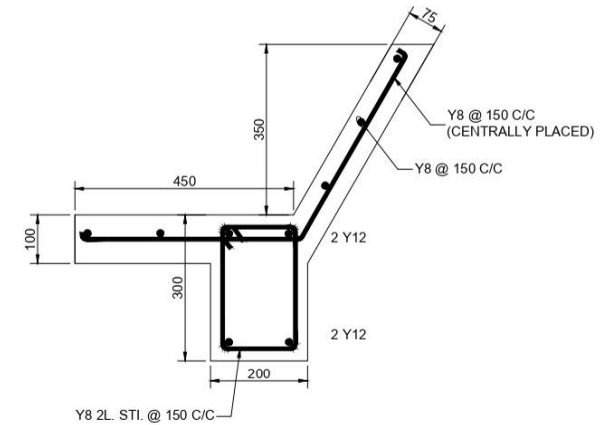
		<b>KITCO Ltd.</b> (Estd. in 1972 by IDBI & Govt. of Kerala) PUTHIYA ROAD - NH BYPASS, KOCHI - 28	
CLIENT: NEW MANGLORE PORT TRUST			
PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT			
TITLE: -WAITING SHELTER:- PLAN , ELEVATION & SECTION			
DRG NO: DP 1033 DRG CL 01 018	SHEET NO: 1 OF 1	REV.	SCALE: NTS
DESIGNED: Monisha	DRAWN: Remya.P.K	CHECKED: Sansu	VERIFIED: Lipin.K
ISSUED FOR: <b>ESTIMATE PURPOSE</b>		UNIT: mm.	DATE: 14.05.2021

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D:\kitco\Ongoing\DWGS\1033\MPPT\CIVIL\WORKING\016\_SHELTER-PLAN,ELEV& SECTION\_14.05.2021



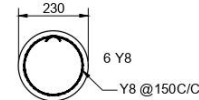
TYPICAL REFT. DETAIL OF SLOPED ROOF



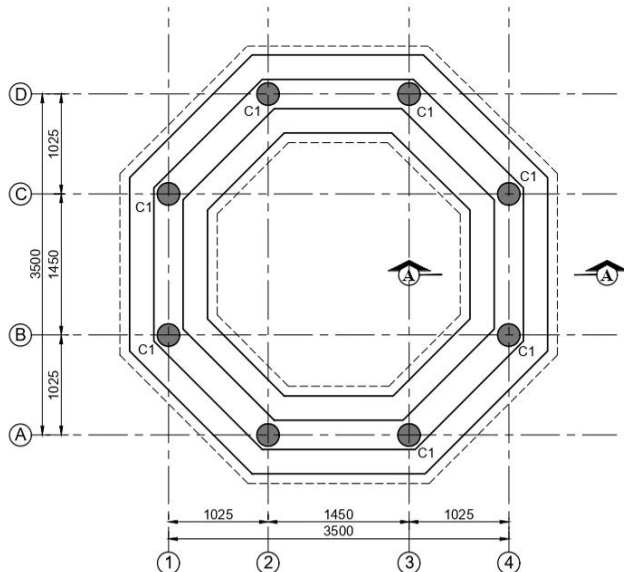
TYPICAL REFT. DETAIL OF SEAT

**NOTE:**

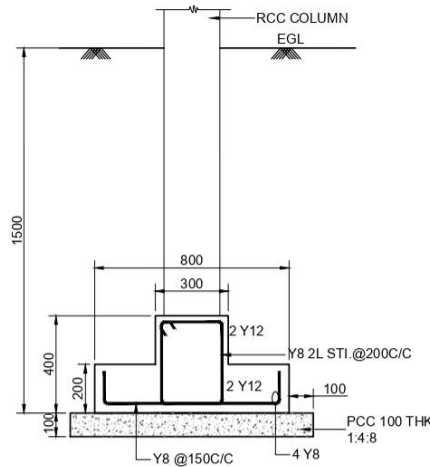
1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
3.  $\pm 0.00$  LVL. CORRESPONDS TO FINISHED GROUND FLOOR LEVEL
4. CONCRETE SHALL BE CONTROLLED QUALITY AS PER IS:456-2000, MIX. M30.
5. BEND, HOOK, ETC., SHOULD BE TAKEN AS PER IS:456-2000
6. REINFORCEMENT MARKED Y DENOTES HYSD BARS OF GRADE Fe. 500D.
7. CLEAR COVER TO OUTER REFT. : STRIP FOOTING - 50mm , COLUMN - 40mm BEAM-30mm & SLAB - 30mm
8. DEVELOPMENT LENGTH IN TENSION ( $L_d$ )= 46 x BAR DIA.



DETAIL OF COLUMN -C1  
230mm $\phi$



LAYOUT OF STRIP FOOTING



SECTION A-A

Rev.No	PARTICULARS	INITIAL	DATE

REVISION



**KITCO Ltd.**  
(Estd. in 1972 by IDBI & Govt. of Kerala)  
PUTHIYA ROAD - NH BYPASS, KOCHI - 28

CLIENT:  
NEW MANGLORE PORT TRUST

PROJECT:  
CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT

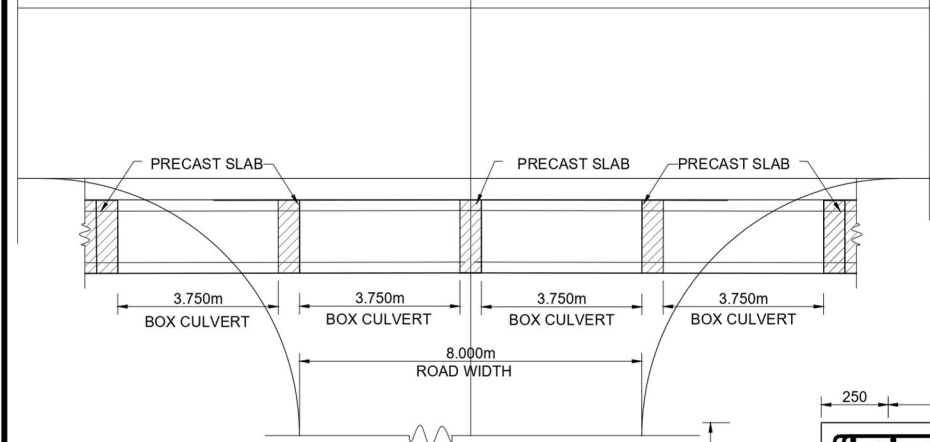
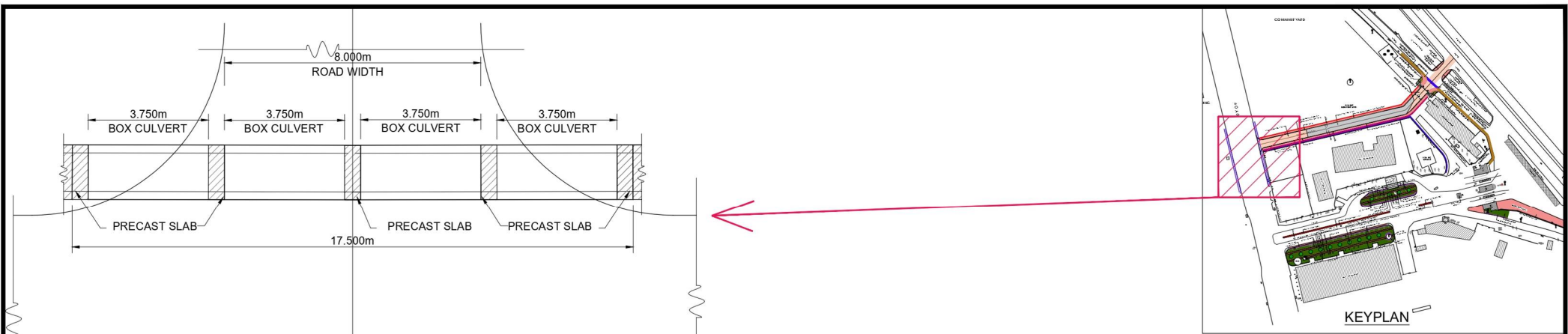
TITLE:  
-.WAITING SHED:-  
LAYOUT AND DETAIL OF STRIP FOOTING, COLUMN , SEAT & SLOPE ROOF

DRG NO: DP 1033 DRG CL 01 019	SHEET NO: 1 OF 1	REV.	SCALE: NTS	A3
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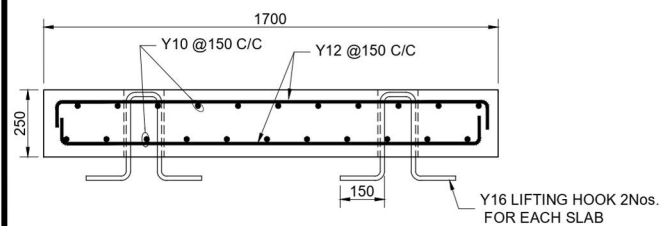
DESIGNED: Veena Chand V L	DRAWN: Remya P K	CHECKED: Kuriachan Simon	VERIFIED: Sindhu Anna George	APPROVED: Shalimar.M.S
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ISSUED FOR: ESTIMATE PURPOSE	UNIT: mm.	DATE: 14.05.2021
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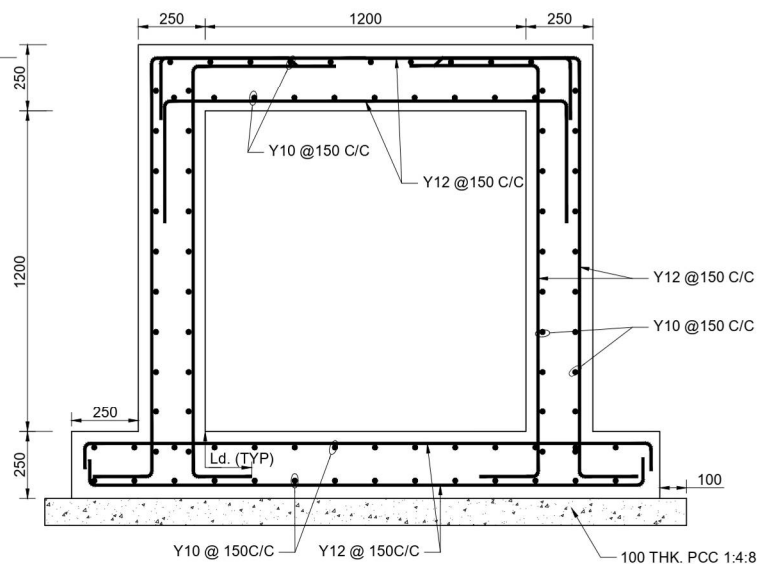
This drawing is the property of KITCO Ltd. and is to be used only for the purpose for which it was lent and must not be in any way detrimental to the interest of the company and is subject to return on demand



PLAN



TYP. RIGHT DETAILS OF PRECAST SLAB  
(1700x500)



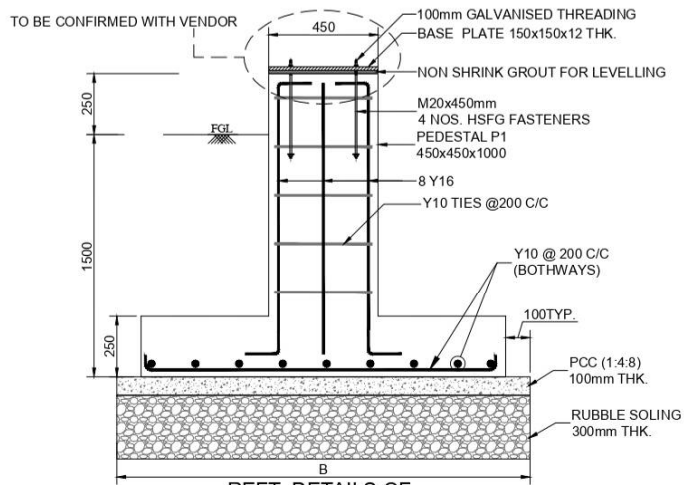
TYP. CROSS SECTION OF BOX CULVERT

**NOTES:**

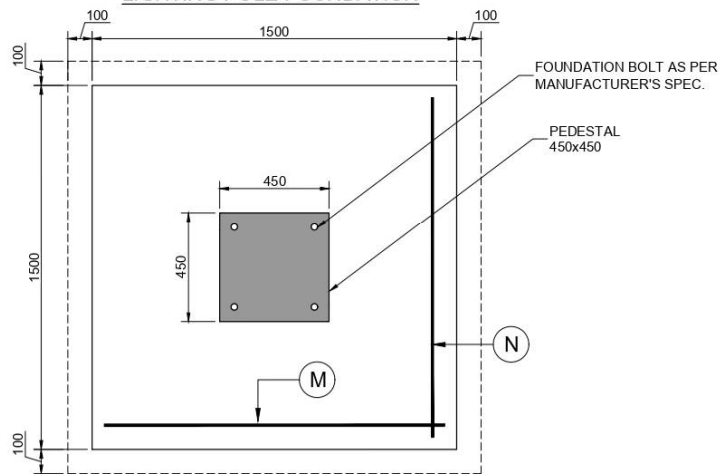
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. DRAWING IS NOT TO BE SCALED. ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.
3. CONCRETE SHALL BE CONTROLLED QUALITY AS PER IS:456-2000, MIX M30
4. BEND, HOOK, LAP LENGTH ETC., SHOULD BE TAKEN AS PER IS:456-2000
5. REINFORCEMENT MARKED Y DENOTES GRADE Fe 500D AS PER IS 1786:2008.
6. MINIMUM LAP LENGTH FOR REFT. BARS SHALL BE 46 x DIA. OF BAR.
7. DEVELOPMENT LENGTH IN TENSION (Ld) - 49xDIA. OF BAR
8. LAPS SPLICES SHALL BE STAGGERED. NOT MORE THAN 50% OF BARS SHALL BE LAPPED AT ONE SECTION.
9. LAP SPLICES SHALL BE CONSIDERED AS STAGGERED IF CENTER TO CENTER DISTANCES OF SPLICES IS NOT LESS THAN 1.3 TIMES THE LAP LENGTH
10. CLEAR COVER TO OUTER REFT. WALL-50mm & BASE SLAB - 50mm, COVER SLAB & PRECAST SLAB - 30mm
11. VENTILATING PIPE MAY BE CONNECTED AT SUITABLE LOCATION AS PER SITE CONDITION AND TAKING THE COWL UP TO SUITABLE HEIGHT.

Rev.No.	PARTICULARS	INITIAL	DATE
<b>REVISION</b>			
 <b>KITCO Ltd.</b> (Estd. in 1972 by IDBI & Govt. of Kerala) PUTHIYA ROAD - NH BYPASS, KOCHI - 28			
CLIENT: NEW MANGLORE PORT TRUST			
PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT			
TITLE: TYPICAL DETAILS OF BOX CULVERT			
DRG NO: DP 1033 DRG CL 020	SHEET NO: 1 OF 1	REV. ---	SCALE: 1 : 600
DESIGNED: ---	DRAWN: Hari	CHECKED: ---	APPROVED: Shalimar M S
ISSUED FOR: <b>ESTIMATE PURPOSE</b>		UNIT: Metres	DATE: 26.07.2021
<small>This drawing is the property of KITCO Ltd. and is to be used only for the purpose for which it was lent and must not be in any way detrimental to the interest of the company and is subject to return on demand.</small>			

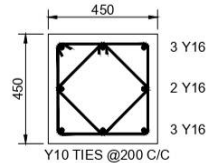
S:\DWG\1033\NMP\ESTIMATE\GATE 2\020L BOX CULVERT.dwg \_29.07.2021



REFT. DETAILS OF LIGHTING POLE FOUNDATION



PLAN OF LIGHTING POLE FOUNDATION

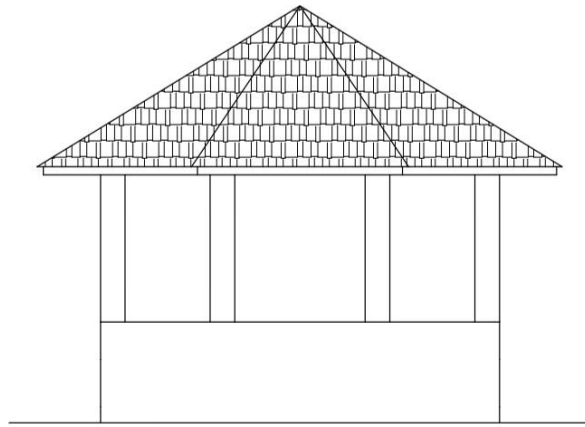


REFT. DETAILS OF PEDESTAL P1 (450x450)

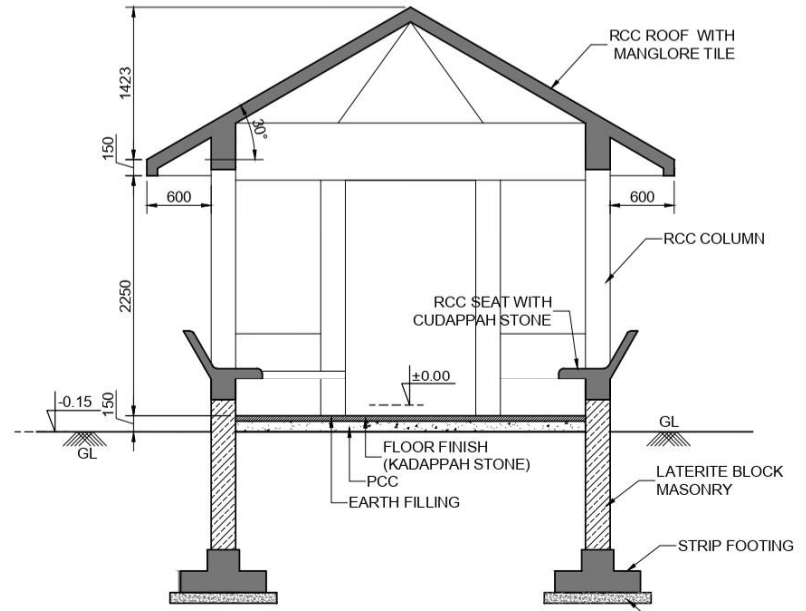
- NOTE:
01. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES
  02. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
  03. CONCRETE SHALL BE CONTROLLED QUALITY AS PER IS:456-2000, MIX. M30
  04. BEND, HOOK, LAP LENGTH ETC., SHOULD BE TAKEN AS PER IS:456-2000
  05. REINFORCEMENT MARKED Y DENOTES HYSD BARS OF GRADE FE 500D CRS.
  06. CLEAR COVER TO OUTER REFT. : PEDESTAL -50mm.
  07. DEVELOPMENT LENGTH (LD) = 46 X BAR DIA
  09. BASE PLATE AND ANCHOR BOLT LOCATIONS/ SIZE/NOS etc. SHALL BE CONFIRMED WITH VENDOR DRAWING .

Rev.No	PARTICULARS	INITIAL	DATE
REVISION			
 <b>KITCO Ltd.</b> (Estd. in 1972 by IDBI & Govt. of Kerala) PUTHIYA ROAD - NH BYPASS, KOCHI - 28			
CLIENT: NEW MANGLORE PORT TRUST			
PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT			
TITLE: REFT. DETAILS OF LIGHTING POLE FOUNDATION			
DRG NO: DP 1033 DRG CL 01 020	SHEET NO: 1 OF 1	REV.	SCALE: NTS
DESIGNED: Veena	DRAWN: Remya	CHECKED: Kuriachan Simon	APPROVED: Sindhu Anna George Shalimar.M.S
ISSUED FOR: <b>EXECUTION</b>		UNIT: mm.	DATE: 02.07.2021
This drawing is the property of KITCO Ltd. and is to be used only for the purpose for which it was lent and must not be in any way detrimental to the interest of the company and is subject to return on demand.			

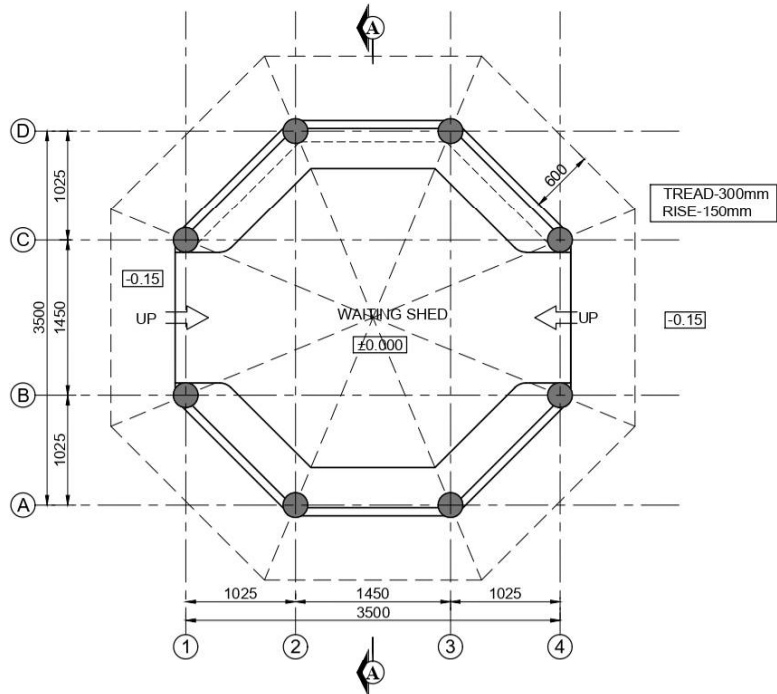
S:\DWG\1033\NMP\WORKING\STRUCT\022 LAYOUT AND DETAILS OF LIGHT POLE FOUNDATION\_R1.dwg \_02.07.2021



**ELEVATION**



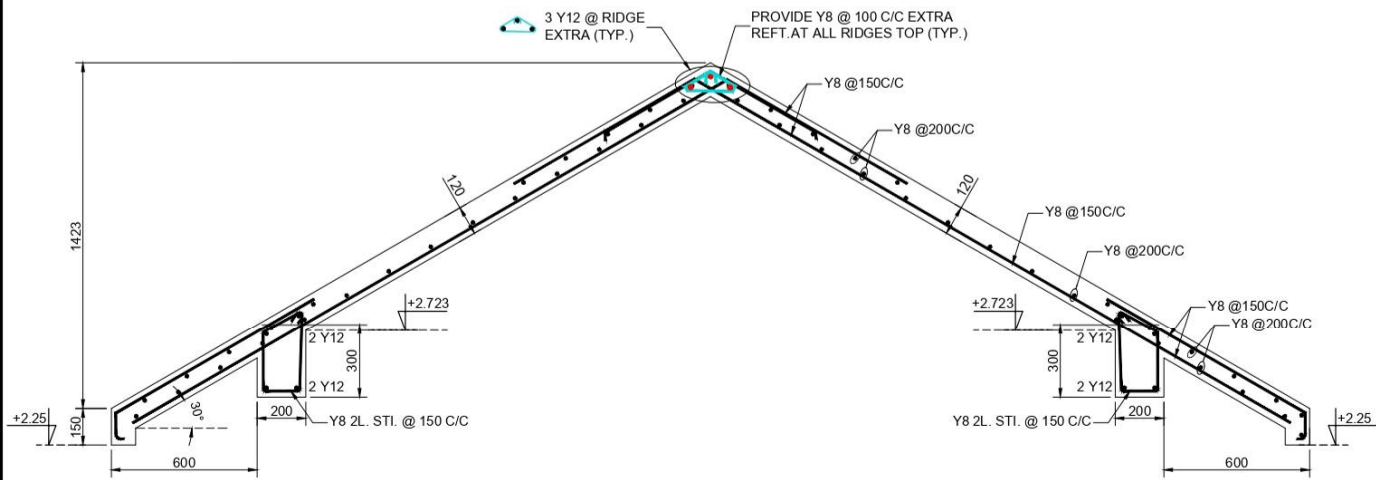
**SECTION A-A**



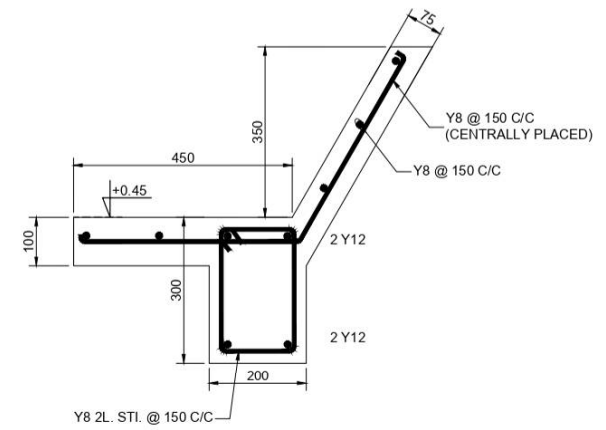
**GROUND FLOOR PLAN**  
AREA-11 SQM

Rev.No.	PARTICULARS	INITIAL	DATE
<b>REVISION</b>			
 <b>KITCO Ltd.</b> (Estd. in 1972 by IDBI & Govt. of Kerala) PUTHIYA ROAD - NH BYPASS, KOCHI - 28			
CLIENT: NEW MANGLORE PORT TRUST			
PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT			
TITLE: -WAITING SHELTER:- PLAN , ELEVATION & SECTION			
DRG NO: DP 1033 DRG CL 01 ....	SHEET NO: 1 OF 1	REV.	SCALE: NTS
DESIGNED: Monisha	DRAWN: Remya.P.K	CHECKED: ----	VERIFIED: Lipin.K
ISSUED FOR: <b>ESTIMATION</b>		UNIT: mm.	DATE: 26.04.2021
<small>This drawing is the property of KITCO Ltd. and is to be used only for the purpose for which it was lent and must not be in any way detrimental to the interest of the company and is subject to return on demand.</small>			

S:\DWG\1033\NMP\WORKING\ARCH\SHELTER -PLAN\ELE& SECTION.dwg \_02.07.2021

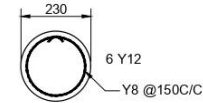


TYPICAL REFT. DETAIL OF SLOPED ROOF

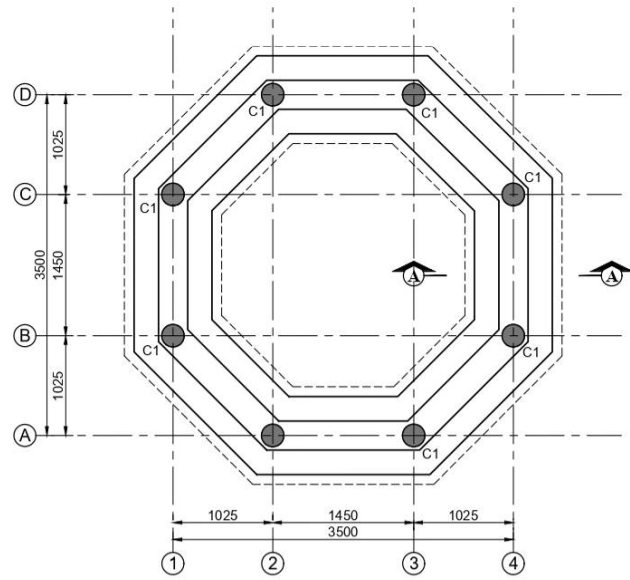


TYPICAL REFT. DETAIL OF SEAT

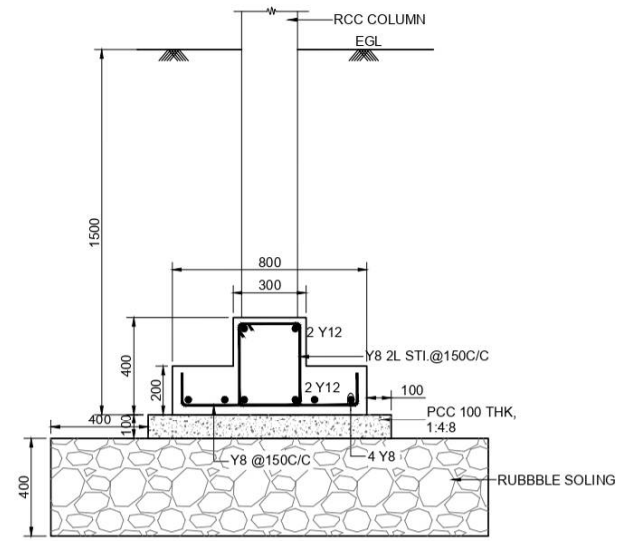
- NOTES:**
1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS
  2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED
  3. ±0.00 LVL. CORRESPONDS TO FINISHED GROUND FLOOR LEVEL
  4. CONCRETE SHALL BE CONTROLLED QUALITY AS PER IS:456-2000, MIX. M30.
  5. BEND, HOOK, ETC., SHOULD BE TAKEN AS PER IS:456-2000
  6. REINFORCEMENT MARKED Y DENOTES HYSD BARS OF GRADE Fe<sub>500</sub>D.
  7. CLEAR COVER TO OUTER REFT.: STRIP FOOTING - 50mm, COLUMN - 40mm BEAM-30mm & SLAB - 30mm
  8. DEVELOPMENT LENGTH IN TENSION (L<sub>d</sub>)= 46 x BAR DIA.



DETAIL OF COLUMN - C1  
230mmØ



LAYOUT OF STRIP FOOTING



SECTION A-A

Rev.No	PARTICULARS	INITIAL	DATE

REVISION

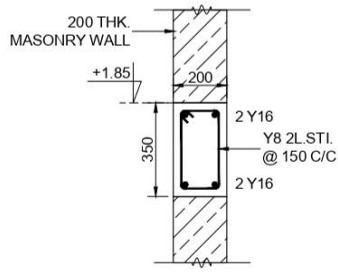


**KITCO Ltd.**

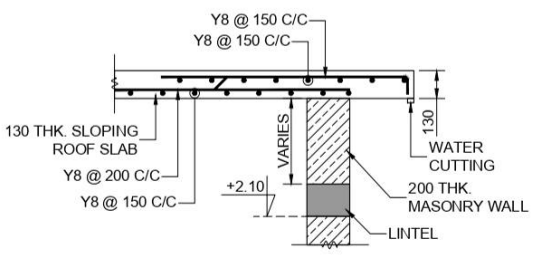
(Estd. in 1972 by IDBI & Govt. of Kerala)  
PUTHIYA ROAD - NH BYPASS, KOCHI - 28

CLIENT: NEW MANGLORE PORT TRUST				
PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT				
TITLE: -:WAITING SHED:- LAYOUT AND DETAIL OF STRIP FOOTING, COLUMN, SEAT & SLOPE ROOF				
DRG NO: DP 1033 DRG CL 01 019	SHEET NO: 1 OF 1	REV.	SCALE: NTS	A3
DESIGNED: Veena	DRAWN: Remya	CHECKED: Kurthachan Simon	VERIFIED: Sindhu Anna George	APPROVED: Shallimar.M.S
ISSUED FOR: <b>EXECUTION</b>			UNIT: mm.	DATE: 25.06.2021

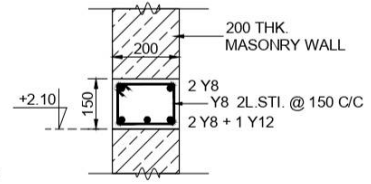
This drawing is the property of KITCO Ltd. and is to be used only for the purpose for which it was lent and must not be in any way detrimental to the interest of the company and is subject to return on demand



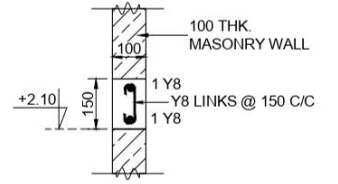
**SECTION B - B**  
TYPICAL REF. DETAILS OF  
TIE BEAM TB1 - 200x350



**SECTION C - C**  
REF. DETAILS OF  
RCC BEAM B1 - 200 x 600



TYPICAL REF. DETAILS  
OF LINTEL LB1 - 200 x 150

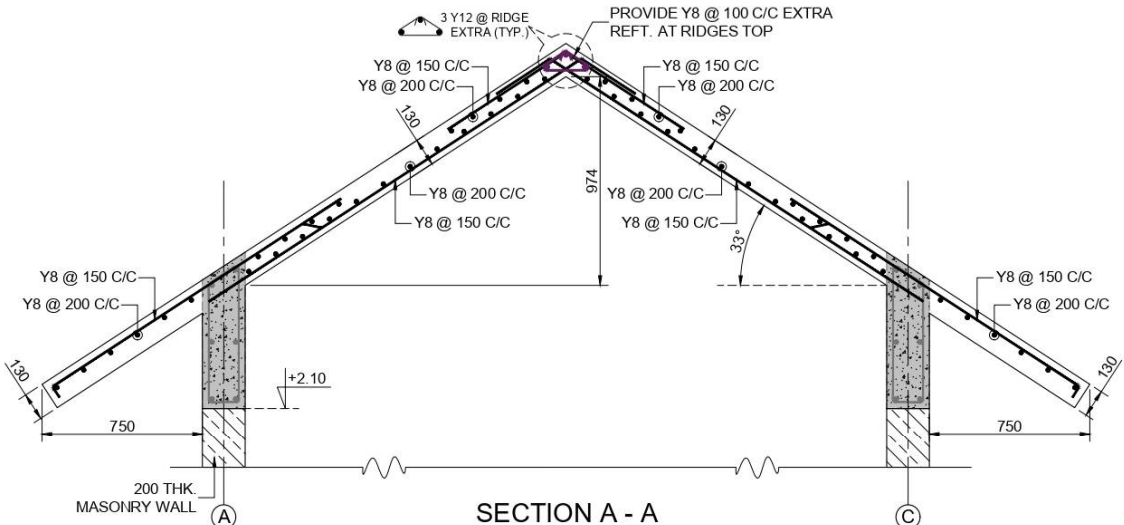


TYPICAL REF. DETAILS  
OF LINTEL LB2 - 100 x 150

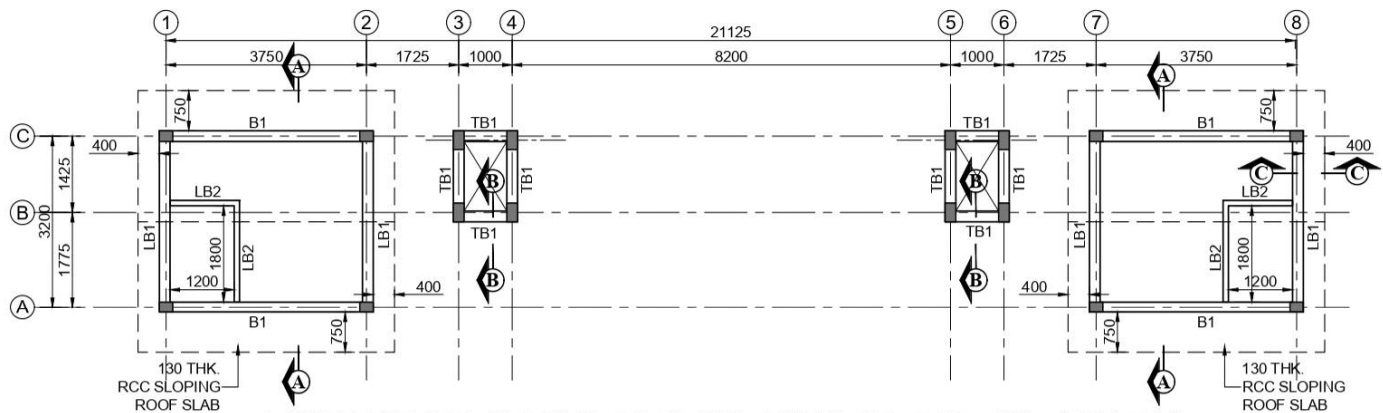
**SPECIAL NOTES:-**

- LINTEL LEVELS INDICATED IS TO BE TAKEN FROM FINISHED GROUND FLOOR TILE TOP.
- TILE LAYING THICKNESS AS PER SPECIFICATION SHALL BE CONSIDERED WHILE FIXING THE TILE TOP LEVEL

- NOTES:-**
- ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.
  - ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED.
  - ±0.00m LVL. CORRESPONDS TO FINISHED GROUND FLOOR LEVEL
  - CONCRETE SHALL BE CONTROLLED QUALITY AS PER IS:456-2000, MIX. M30.
  - BEND,HOOK,LAP LENGTH,ETC., SHOULD BE TAKEN AS PER IS:456-2000.
  - REINFORCEMENT MARKED Y DENOTES HYSD BARS OF GRADE Fe. 500D.
  - CLEAR COVER TO OUTER REINFORCEMENT: LINTEL & BEAM- 25mm & SLAB- 20mm
  - DEVELOPMENT LENGTH IN TENSION (L<sub>dt</sub>) = 46 x BAR DIA.
  - LINTEL AND BEAM SHALL BE DONE ALONG WITH THE SOLID BLOCK MASONRY.**
  - THE DRAWING SHOULD BE READ ALONG WITH ARCHITECTURAL DRAWING, REFER DRG.NO. DP 1033 DRG CL 01 010 SHEETS 1 OF 1
  - FOR DUCTILE DETAIL, REFER DRG.NO. DP 1033 DRG CL 01 002\_SHEET 1 OF 1
  - TYPICAL CURTAILMENT DETAILS FOR REF. OF RCC BEAM AND SLAB, REFER DRG.NO. DP 1033 DRG CL 01 003\_SHEET 1 OF 1



**SECTION A - A**  
REF. DETAILS OF SLOPING ROOF SLAB



LAYOUT OF RCC SLOPING ROOF AND LINTEL AT +2.10m LVL. (BOTTOM),  
AND TIE BEAM AT +1.85m LVL. (TOP)

Rev.No.	PARTICULARS	INITIAL	DATE
REVISION			



**KITCO Ltd.**  
(Est. in 1972 by IDBI & Govt. of Kerala)  
PUTHIYA ROAD - NH BYPASS, KOCHI - 28

CLIENT: NEW MANGLORE PORT TRUST

PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT

TITLE: -: ENTRANCE AND EXIT GATE :-  
LAYOUT OF RCC SLOPING ROOF AND LINTEL AT +2.10m LVL. (BOTTOM) AND TIE BEAM AT +1.85m LVL. (TOP)

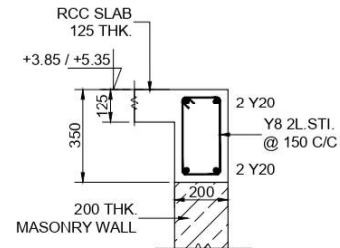
DRG NO: DP 1033 DRG CL 01 013	SHEET NO: 1 OF 1	REV.	SCALE: 1 : 100	A3
DESIGNED: Anu Sebastian	DRAWN: Paul Bernard	CHECKED: Jatin Edampadam	VERIFIED: Sindhu Anna George	APPROVED: Shalimar M S

ISSUED FOR: ESTIMATE PURPOSE

UNIT: mm. DATE: 04.02.2020

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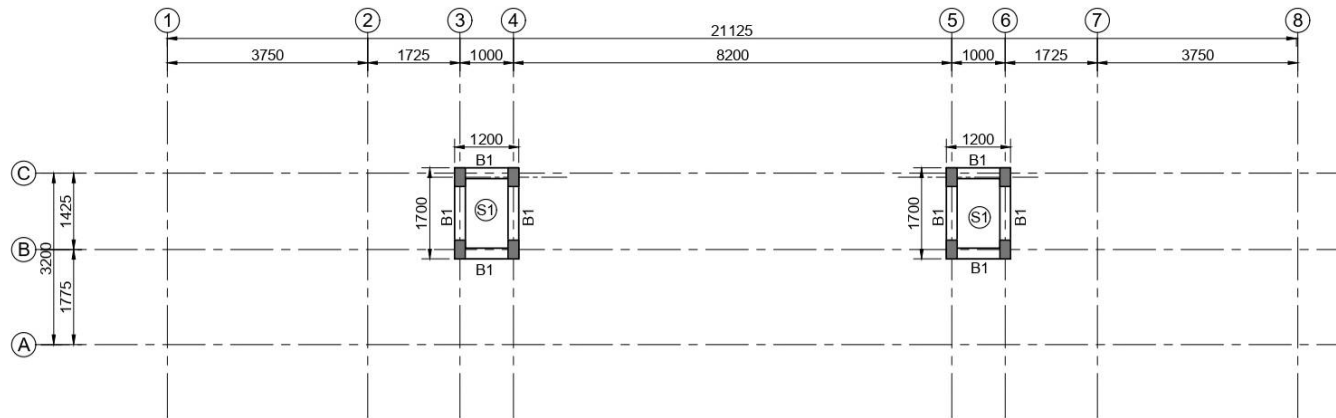
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**TYPICAL REFT. DETAILS  
OF RCC BEAM B1 - 200 x 350**

**NOTES:-**

1. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.
2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED.
3.  $\pm 0.00$ m LVL. CORRESPONDS TO FINISHED GROUND FLOOR LEVEL
4. CONCRETE SHALL BE CONTROLLED QUALITY AS PER IS:456-2000, MIX. M30.
5. BEND,HOOK,LAP LENGTH,ETC., SHOULD BE TAKEN AS PER IS:456-2000.
6. REINFORCEMENT MARKED Y DENOTES HYSD BARS OF GRADE Fe. 500D.
7. CLEAR COVER TO OUTER REINFORCEMENT: BEAM- 25mm & SLAB- 20mm
8. DEVELOPMENT LENGTH IN TENSION (Ldt) = 46 x BAR DIA.
9. THE DRAWING SHOULD BE READ ALONG WITH ARCHITECTURAL DRAWING, REFER DRG.NO. DP 1033 DRG CL 01 010 SHEETS 1 OF 1
- 10.FOR DUCTILE DETAIL, REFER DRG.NO. DP 1033 DRG CL 01 002\_SHEET 1 OF 1
- 11.TYPICAL CURTAILMENT DETAILS FOR REFT. OF RCC BEAM AND SLAB, REFER DRG.NO. DP 1033 DRG CL 01 003 \_SHEET 1 OF 1

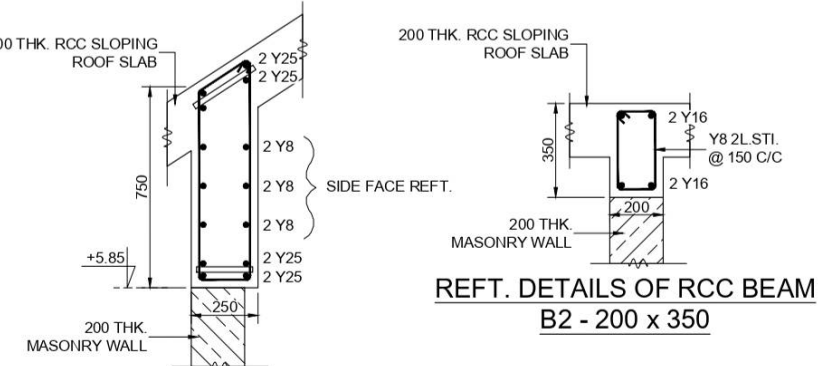


**LAYOUT OF RCC BEAM AND SLAB AT +3.85m AND +5.35m LVL. (TOP)**

RCC SLAB SCHEDULE				
TYPE	THICK	SHORT SPAN	LONG SPAN	REMARKS
S1	125	Y8 @ 150 C/C	Y8 @ 150 C/C	TWO WAY

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REVISION			
 <b>KITCO Ltd.</b> (Est. in 1972 by IDBI & Govt. of Kerala) PUTHIYA ROAD - NH BYPASS, KOCHI - 28			
CLIENT: NEW MANGLORE PORT TRUST			
PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT			
TITLE: -: ENTRANCE AND EXIT GATE :- LAYOUT OF RCC BEAM AND SLAB AT +3.85m AND +5.35m LVL. (TOP)			
DRG NO: DP 1033 DRG CL 01 014	SHEET NO: 1 OF 1	REV.	SCALE: 1 : 100
DESIGNED: Anu Sebastian	DRAWN: Paul Bernard	CHECKED: Jatin Edampadam	APPROVED: Shalimar M S
ISSUED FOR: <b>ESTIMATE PURPOSE</b>		UNIT: mm.	DATE: 04.05.2021
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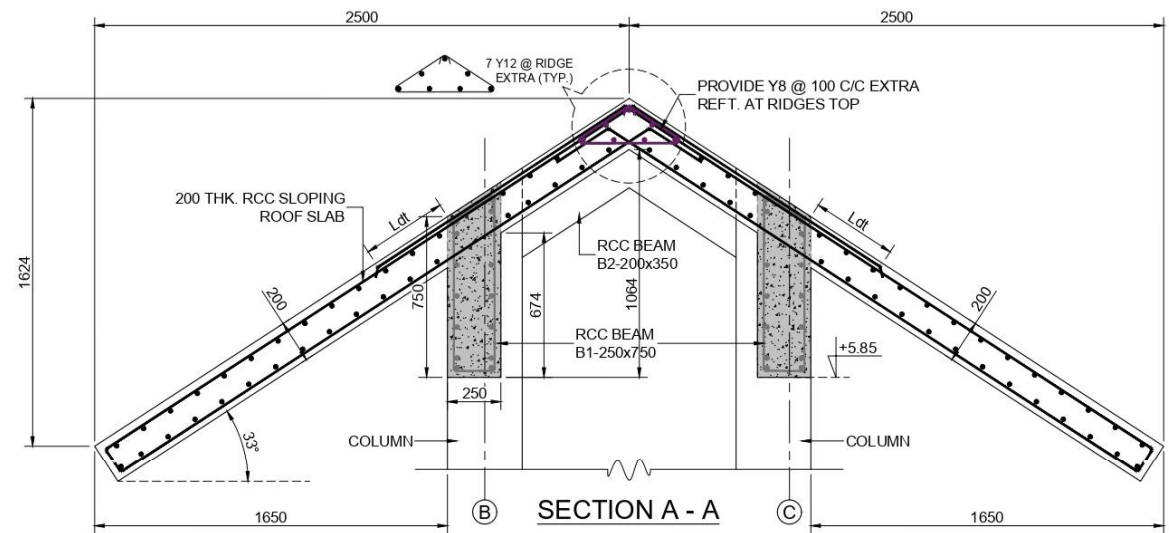




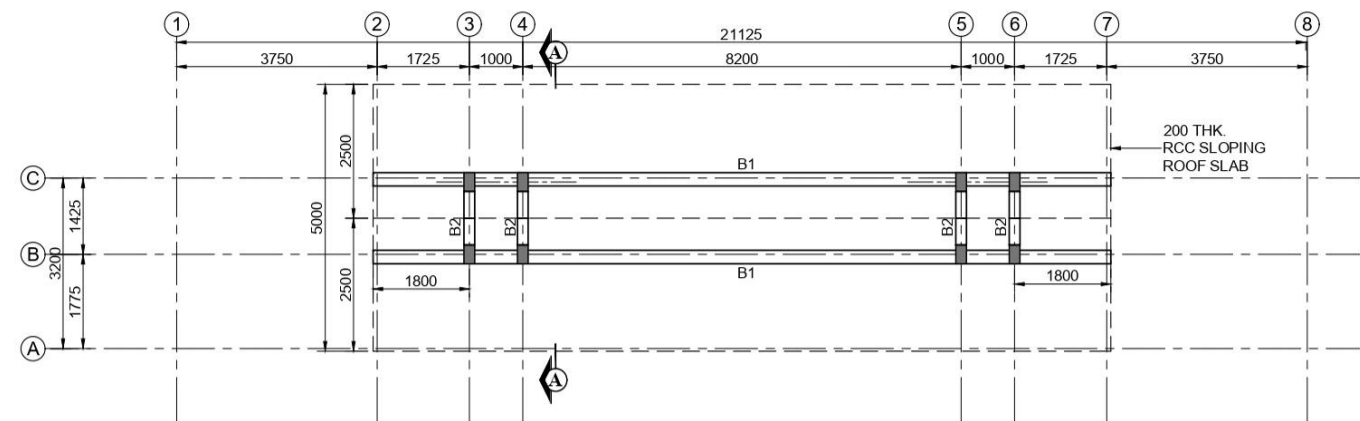
**REF. DETAILS OF RCC BEAM  
B2 - 200 x 350**

**REF. DETAILS OF RCC BEAM  
B1 - 250 x 750**

- NOTES:-**
1. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.
  2. ONLY WRITTEN DIMENSIONS SHOULD BE FOLLOWED.
  3. ±0.00m LVL. CORRESPONDS TO FINISHED GROUND FLOOR LEVEL
  4. CONCRETE SHALL BE CONTROLLED QUALITY AS PER IS:456-2000, MIX. M30.
  5. BEND, HOOK, LAP LENGTH, ETC., SHOULD BE TAKEN AS PER IS:456-2000.
  6. REINFORCEMENT MARKED Y DENOTES HYSD BARS OF GRADE Fe. 500D.
  7. CLEAR COVER TO OUTER REINFORCEMENT: BEAM- 25mm & SLAB- 20mm
  8. DEVELOPMENT LENGTH IN TENSION (Ldt) = 46 x BAR DIA.
  9. THE DRAWING SHOULD BE READ ALONG WITH ARCHITECTURAL DRAWING, REFER DRG. NO. DP 1033 DRG CL 01 010 SHEETS 1 OF 1
  10. FOR DUCTILE DETAIL, REFER DRG. NO. DP 1033 DRG CL 01 002\_SHEET 1 OF 1
  11. TYPICAL CURTAILMENT DETAILS FOR REF. OF RCC BEAM AND SLAB, REFER DRG. NO. DP 1033 DRG CL 01 003\_SHEET 1 OF 1



**SECTION A - A**



**LAYOUT OF RCC SLOPING ROOF AND BEAM AT +5.85m LVL. (BOTTOM)**

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<b>REVISION</b>			
 the consultants		<b>KITCO Ltd.</b> (Estd. in 1972 by IDBI & Govt. of Kerala) PUTHIYA ROAD - NH BYPASS, KOCHI - 28	
CLIENT: NEW MANGLORE PORT TRUST			
PROJECT: CONSULTANCY SERVICES FOR DEVELOPMENT OF ADDITIONAL FACILITIES AT NEW MANGLORE PORT			
TITLE: -: ENTRANCE AND EXIT GATE :- LAYOUT OF RCC SLOPING ROOF AND BEAM AT +5.85m LVL. (BOTTOM)			
DRG NO: DP 1033 DRG CL 01 015	SHEET NO: 1 OF 1	REV.	SCALE: 1 : 100 A3
DESIGNED: Anu Sebastian	DRAWN: Paul Bernard	CHECKED: Jatin Edampadam	VERIFIED: Sindhu Anna George APPROVED: Shalimar M S
ISSUED FOR: <b>ESTIMATE PURPOSE</b>		UNIT: mm.	DATE: 04.02.2020

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**NEW MANGALORE PORT AUTHORITY**  
**Panambur, Mangalore**

**"CONSTRUCTION OF CRUISE TERMINAL GATE AT  
NEW MANGALORE PORT"**

**TENDER DOCUMENT**  
**Volume - III**

**BILL OF QUANTITIES**

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**VOLUME III****SECTION VI****(i) PREAMBLE TO BILL OF QUANTITIES****1. General Instructions****1.1 General**

- 1.1.1 This Bill of Quantities must be read with the Drawings, Conditions of Contract and the Specifications, and the Contractor shall be deemed to have examined the Drawings, Specifications, Conditions of Contract and to have acquainted himself with the detailed descriptions of the Works to be done, and the way in which they are to be carried out.
- 1.1.2 Notwithstanding that the work has been sectionalized every part of it shall be deemed to be supplementary to and complementary of every other part and shall be read with it or into it so far as it may practicable to do so.
- 1.1.3 The detailed descriptions of work and materials given in the Specifications are not necessarily being repeated in the Bill of Quantities.
- 1.1.4 The Contractor shall be deemed to have visited the Site before preparing his tender and to have examined for himself the conditions under which the work will proceed and all other matters affecting the carrying out of the works and cost thereof.
- 1.1.5 The Tenderer will be held to have familiarised himself with all local conditions, in so far as they affect the work, means of access and the locality of existing services, in order to execute the Works measured and described hereinafter. No claims for want of knowledge in this respect will be reimbursed.

**1.2 Rates and Prices to be Inclusive**

- 1.2.1 Rates and prices set against items are to be the all inclusive value of the finished work shown on the Drawings and/or described in the Specification or which can reasonably be inferred there from and are to cover the cost of provision of plant, labour, supervision, materials, test charges, freight, transportation, erection, installation, performance of work, care of works, insurance, maintenance, overheads and profits and every incidental and contingent cost and charges whatsoever including taxes if any excluding GST including every kind of temporary work executed or used in connection therewith (except those items in respect of which provision has been separately made in the general condition of contract) and all the Contractor's obligations under the Contract and all matters and things necessary for

the proper completion and maintenance of the Works.

- 1.2.2 The rates and prices set down against the items are to be the full inclusive value of the finished work shown on the Drawing and/or described in the Specification or which can reasonably be inferred the reform and to cover the cost of every description of Temporary Works executed or used in connection therewith (except those items in respect of which specific provision has been separately made in these Bills of Quantities) and all the Contractor's obligations under the Contract including testing, giving samples and all matters and things necessary for the proper execution, completion and maintenance of the Works.
- 1.2.3 The Specifications are intended to cover the supply of material and the execution of all work necessary to complete the works. Should there be any details of construction or material which have not been referred to in the Specifications or in the Bill of Quantities and Drawings, but the necessity for which may reasonably be implied or inferred there from, or which are usual or essential to the completion of all works in all trades, the same shall be deemed to be included in the rates and prices entered in the Bill of Quantities. The rates and prices are to cover the item as described in the Bill of Quantities and if there is inconsistency in the description between the Bill of Quantities, Specifications or Drawings, the interpretation will be done according to General Conditions of Contract.
- 1.2.4 The quantities given in the Bill are approximate and are given to provide a common basis for tendering. They are not to be taken as a guarantee that the quantities scheduled will be carried out or required or that they will not be exceeded. The Employer / Engineer reserves the right to delete any item and / or increase / reduce quantities indicated in the Bills of Quantities at any time. Payment will be made according to the actual quantities of work ordered and carried out in the contract. However, the rates quoted shall be valid for any extent of variation in quantity of each individual item provided that the total contract value does not get altered by more than indicated in conditions of contract. No claim whatsoever for extra payment due to variation of quantities within the above said limit would be entertained.
- 1.2.5 The drawings for tender purposes are indicative only of the work to be carried out. However, the Tenderer must allow within his price for the items of work included in the Tender Documents for the details which will appear on subsequent drawings developed for construction purposes. Rate and price shall include any additional design/ detailing to be carried out by contractor.
- 1.2.6 The rates and prices shall include (except where separate items are given) for the provision and operation of the following items, for compliance with the Conditions of Contract, Special Conditions, the specifications and Tender drawings:

- i) Supervision and labour for the Works;
- ii) All materials, installation/erection, handling and transportation;
- iii) All Contractor's Equipment;
- iv) All testing, commissioning, insurance, maintenance, security, welfare facilities, overheads and profit and every incidental and contingent costs and charges whatsoever including;
- v) All temporary fencing, watching, lighting, sanitary accommodation, general security arrangements, welfare facilities and first aid provision;
- vi) Provision and maintenance of Contractor's site offices, cabins, huts, maintenance and storage areas;
- vii) Taxes if on the transfer of property in goods in the execution of works, other than GST, Customs Duty for materials to be permanently incorporated into the Works);
- viii) All necessary temporary services including fresh water, compressed air lines, electrical cabling and switchgear, telephone, walkie-talkie and facsimile facilities;
- ix) The maintenance of all Contractor's services;
- x) All insurances for the Works;
- xi) Allowance for complying with all environmental aspects as specified;
- xii) Detail design of components of temporary works, wherever necessary as directed by Engineer.

#### **1.4 Method of Measurement**

1.4.1 Measurement of Work shall be in accordance with IS 1200 and shall be net off the dimensions of the works shown on the drawings except as mentioned below:

1.4.2 Units of Measurement: The units of measurement used in this Bill of Quantities are in metric units as follows:

- i) Linear: Linear metre, centimeter or millimeter abbreviated to 'Rm', 'cm' or 'mm' respectively.
- ii) Superficial: Square metre or Square centimeter abbreviated to 'Sq.M' or 'sq.cm' respectively.
- iii) Volumetric: Cubic metre abbreviated to 'cu.m'. Litre abbreviated to 'L'
- iv) Weight: Tonne = 1000 Kilograms, abbreviated to 'T', / 'MT' Kilogram abbreviated to 'kg'
- v) Numbers: Numbers abbreviated to Nos. or No.
- vi) Lump sum: Lump sum abbreviated to 'L.S.'

#### **1.5 Currency**

1.5.1 All monetary reference herein and the Bill of Quantities shall be priced in Indian Rupee Currency.

## **2. Civil Works**

2.2 Precast Concrete

2.2.1 Shuttering for precast concrete shall not be measured and paid for separately.

2.2.2 Effort for placement of precast concrete at the final locations shall not be measured

unless a specific item is provided in the Bill of Quantities.

- 2.2.3 The precast concrete units shall be measured as shown on the detailed drawings.
- 2.3 In-situ Concrete
  - 2.3.1 Shuttering for In-situ concrete shall not be measured and paid for separately.
  - 2.3.2 No deduction will be made for chamfers smaller than 50 sq.cm. sectional area, reinforcement bolts and other embedded parts unless larger than 0.1 sq.m. sectional area and 0.03 cu.m. in volume. No extra volume will be measured for splays or fillets smaller than 50 sq.cm. sectional area.
  - 2.3.3 The rates for reinforced concrete shall include for all batching, mixing, transporting, hoisting or lowering to any height / depth, placing in position and compaction in work of any sectional area or thickness including shuttering, forming necessary construction joints, shear keys and stop ends, and for curing and protecting etc. all as specified.
  - 2.3.4 The rates shall include for preparing construction joints, shear keys and surfaces against which next stage concrete is to be cast and building in fittings including pipes and bolts except where specifically billed separately. No separate payment will be made for making openings/pockets/pits of any size and shape. Where surfaces are to receive finishes the rates shall include for leaving the surface rough or for hacking and roughening the surface to form a key.
  - 2.3.5 Unless otherwise noted, rates shall include for inserting pipes and other inserts in position accurately, concreting while they are in position and also for protecting the same as the work proceeds.
  - 2.3.6 Unless otherwise noted, the rates for concrete items shall include for finishing the top surface to levels and slopes and surface finish as specified. Rates for concrete shall include for finishing the slab to specified slope towards drains, etc.
- 2.4 Reinforcement
  - 2.4.1 Steel reinforcement will be measured by weight and fixed in accordance with Drawings and Specifications. The weight of reinforcement bars -whether plain, deformed or ribbed etc., -of various diameters will be calculated in accordance with Table 1 of IS:1732 'Dimensions for Round and Square Steel Bars for Structural and General Engineering Purposes'.
  - 2.4.2 The rates shall include for cutting, welding laps, and waste, straightening short and long lengths, bending, fixing, rolling margin and the provision of spacer bars or

support, chairs, binding wire, saddles, forks and all dense concrete spacer blocks, etc., including preparing bending schedules from the Drawings.

- 2.4.3 The rates shall include for all necessary descaling, wire brushing and cleaning to remove all rust and mill scale, dirt, grease and other deleterious matter before fixing and whilst still exposed during construction.
- 2.5 Structural and Miscellaneous Steel work
- 2.5.1 Rates for structural steel work and iron work shall include supply, fabrication, delivery and erection/embedment in concrete at Site and all charges for welding, cutting, bending, bolting, site connections, fixing to foundations.
- 2.5.2 The rates for Structural Steelwork shall include:
- i) Supply, fabrication, delivery and erection
  - ii) Rolling margin, cutting and waste, weld metal, bolts, fixings and fittings
  - iii) Hoisting, drilling, bolting or welding and fixing in the manner specified or indicated in the drawing
  - iv) Fabrication drawings
  - v) Welding trials and tests
  - vi) Erection trials
  - vii) Protective treatment (painting, hot dip galvanising etc), including making good any damage if provided in the BOQ item.
- 2.5.3 Metalwork items are described in the Bills of Quantities and the Tenderer is to include for all the fittings, etc., described. All items shall include the necessary fabrication, joints, angles, intersections and ends, all bolts or fixing lugs, all hoisting and scaffolding required and casting in fixings or later cutting out or forming pockets for same, grouting, supporting and making good.
- 2.5.4 Rates are to include for all necessary scaffolding, working over water and at any height staging and hoisting and tarpaulin or other protective covers and the cleaning and removal of paint stains and spots, etc.
- 3.4.1 The Contractor's unit rates and prices shall include all equipment, apparatus, material indicated in the Drawings, and/or Specifications in connection with the item in question and also associated labour as well as all additional equipment, apparatus, material, consumables usually necessary to complete the system even though not specifically shown, described or otherwise referred to and also associated labour.
- 3.4.2 The rate for providing and fixing above items shall include all fittings, fixtures, base and sole plates, anchor bolts, including epoxy grouting, etc. all complete as specified, including the necessary additional supervision to ensure accurate alignment

### 3. Abbreviations

- 4.1.1 The following abbreviations are used in the Specifications and Bill of Quantities:

IS :	Indian Standard
------	-----------------



BS :	British Standard
Qty. :	Quantity
mm :	Millimeters
cm :	Centimeters
M / m / MTR :	Meters
LM :	linear metre
LS :	lump sum
Rs. :	Rupees
P. :	Paise
Nos. :	Numbers
do :	Ditto
MS :	mild steel
T :	Tones
Kg :	Kilogram
EO :	Extra over (previous sum unless specified otherwise)
sq.m. /m <sup>2</sup> /SQMT:	square metre
sq.cm. :	square centimeters
mm <sup>2</sup> :	Square Millimetre
Cu.m/CUM. :	cubic meters
YST :	yield stress
dia :	Diameter
wt. :	Weight
Drg.No.:	drawing number
max. :	Maximum
min :	Minimum
approx :	Approximately
n.e.:	not exceeding
incl:	Including
circ:	Circular
set :	set / sets
c/c	centre to centre
@ :	at the rate of

## ii) BILL OF QUANTITIES

-----

<b>NAME OF WORK : CONSTRUCTION OF CRUISE TERMINAL GATE AT NEW MANGALORE PORT</b>					
<b>Item No.</b>	<b>DESCRIPTION OF ITEM</b>	<b>QTY</b>	<b>UNIT</b>	<b>RATE IN figures</b>	<b>AMOUNT (Rs. Ps.)</b>
I	<b>PART A - CIVIL WORKS</b>				
1	<b>EARTH WORK</b>				
1.01	A Clearing and grubbing road land including uprooting rank vegetation, grass, bushes, shrubs, saplings and trees girth up to 300 mm, removal of stumps of trees cut earlier and disposal of unserviceable materials and stacking of serviceable material to be used or auctioned, including removal and disposal of top organic soil not exceeding 150 mm in thickness.	0.025	HA	168300.00	4,207.50
1.02	Earth work excavation by manual means for drains ,canals, waste weir, draft, approach channels, key trenches, foundation of bridges and such similar works in all kinds of soils , as per drawing and technical specifications, including setting out, shoring, strutting, barricading, caution lights, removal of stumps and other deleterious matter, excavated surface leveled and sides neatly dressed disposing off the excavated stuff or sorting & stacking the selected stuff for reuse in a radius of 50 m and lift up to 1.5 m including cost of labour, tools & other appurtenances required to complete the work.	871.00	CUM	186.00	1,62,006.00
1.03	Earth work excavation by manual means for drains, canals, waste weir, draft, approach channels, key trenches, foundation of bridges and such similar works in all kinds of soils , as per drawing and technical specifications, including setting out, shoring, strutting, barricading, caution lights, removal of stumps and other deleterious matter, excavated surface leveled and sides neatly dressed disposing off the excavated stuff or sorting & stacking the selected stuff for reuse in a radius of 50 m and lift upto 1.5 m including cost of labour, tools & other appurtenances required to complete the work. Extra depth exceeding 1.5m, but not exceeding 3m.	154.00	CUM	199.00	30,646.00

1.04	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations and other similar works etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	730.00	cum	204.00	148920.00
1.05	Providing and Filling in foundation with granite / trap broken metal 100mm. and down size, with approved sand including hand packing, ramming, watering, including cost of all materials and labour with all lead and lift. Complete as per specifications. Specification. No. KBS	61.00	cum	2561.00	1,56,221.00
<b>2.00</b>	<b>ANTI TERMITE TREATMENT</b>				
2.01	Providing and injecting chemical emulsion for Pre-constructural Anti-Termite Treatment, creating continuous chemical barrier under and around the column pits, walls, trenches, basement excavation, top surface of the plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, over the top surface of consolidated earth on which apron is to be laid, surrounding of pipes and conduits with Chlorpyriphos 20% E.C. / Lindane 20% E.C. @ 3.19 l/m <sup>2</sup> including cost of chemical, diluting in water to one percent concentration, labour, usage charges of machinery, complete as per specifications.	33.00	Sqm	95.00	3135.00
<b>3.00</b>	<b>CEMENT CONCRETE WORK</b>				
3.01	Providing and laying in position plain cement concrete for levelling course for all works in foundation. The granite/trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed, laid in layers not exceeding 150 mm thickness, well compacted using plate vibrators, including all lead & lifts, cost of all materials of quality, labour, Usage charges of machineries, curing, and all the other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement & formwork shall be paid separately) Mix 1:4:8(M5) Using 40 mm nominal size graded crushed coarse aggregates.	65.00	cum	5,364.00	3,48,660.00

3.02	Providing and laying in position Reinforced cement concrete for all Sub structures of building, Irrigation works, Sub-structure works of bridges, Drain works & other parallel works from 0.50m to 3.50 m height. The granite/trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticizers, laid in layers, well compacted using needle vibrators, providing weep holes wherever necessary, including all lead & lifts, cost of all materials of quality, confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement & formwork to be paid separately)Mix 1:2:4 (M15) Using 20 mm nominal size graded crushed coarse aggregates.	44.00	CUM	6096.00	268224.00
3.03	Providing and laying in position Reinforced cement concrete for all Sub structures of building, Irrigation works, Sub structure works of bridges, Drain works & other parallel works from 0.50m to 3.50 m height. The granite/trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticisers, laid in layers, well compacted using needle vibrators, providing weep holes wherever necessary, including all lead & lifts, cost of all materials of quality, confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement to be paid separately) M30 Design Mix Using 20 mm nominal size graded crushed coarse aggregates (The cost of Shuttering included)Foundation up to Plinth(1)	299.00	Cum	7364.52	22,01,991.48

3.04	Providing and laying in position Reinforced cement concrete for all Sub structures of building, Irrigation works, Sub structure works of bridges, Drain works & other parallel works from 0.50m to 3.50 m height. The granite/trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticisers, laid in layers, well compacted using needle vibrators, providing weep holes wherever necessary, including all lead & lifts, cost of all materials of quality, confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement to be paid separately) M30 Design Mix Using 20 mm nominal size graded crushed coarse aggregates (The cost of Shuttering included)Columns & Piers(8)	8.00	Cum	7500.90	60007.20
3.05	Providing, hoisting and fixing at all floor level precast reinforced cement concrete work in slabs , string courses, bands, copings, bed plates, anchor blocks, plain window sills and the like, including the cost of required centering, shuttering but excluding cost of reinforcement, with M-30mix with all lead and lift etc., complete.	3.00	Cum	11747.90	35,243.70
3.06	Providing Thermo - Mechanically Treated Corrosion resistant steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position, binding and anchoring to adjacent members wherever necessary complete as per Design including cost of material, labour, usage charges complete as per specifications. (The laps and wastages shall not be measured separately)	37.00	Ton	107737.60	39,86,291.20
3.07	Providing and laying in position Reinforced cement concrete for all Super structures of building, Road works, Water works, Irrigation works & super structure works of bridges upto 3.50 m height. The granite/ trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticizers laid in layers, well compacted using needle vibrators. The cost includes all lead & lifts, cost	6.00	CUM	7724.20	46345.20

	of all materials, quality confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement, dowel bars to be paid separately)M30 Design Mix Using 20 mm nominal size graded crushed coarse aggregates. (The cost of Centring/Shuttering included) Columns & Piers up to 5m lvl				
3.08	Providing and laying in position Reinforced cement concrete for all Super structures of building, Road works, Water works, Irrigation works & super structure works of bridges upto 3.50 m height. The granite/ trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticizers laid in layers, well compacted using needle vibrators. The cost includes all lead & lifts, cost of all materials, quality confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement, dowel bars to be paid separately)M30 Design Mix Using 20 mm nominal size graded crushed coarse aggregates. (The cost of Centring/Shuttering included) Columns & Piers above 5m up to 10m lvl	1.00	CUM	7864.64	7864.64
3.09	Providing and laying in position Reinforced cement concrete for all Super structures of building, Road works, Water works, Irrigation works & super structure works of bridges upto 3.50 m height. The granite/ trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticizers laid in layers, well compacted using needle vibrators. The cost includes all lead & lifts, cost of all materials, quality confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement, dowel bars to be paid separately)M30 Design Mix Using	9.00	CUM	8426.40	75837.60

	20 mm nominal size graded crushed coarse aggregates. (The cost of Centring/Shuttering included) Beams & Lintels of Building up to 5m lvl				
3.10	Providing and laying in position Reinforced cement concrete for all Super structures of building, Road works, Water works, Irrigation works & super structure works of bridges upto 3.50 m height. The granite/trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticizers laid in layers, well compacted using needle vibrators. The cost includes all lead & lifts, cost of all materials, quality confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement, dowel bars to be paid separately)M30 Design Mix Using 20 mm nominal size graded crushed coarse aggregates. (The cost of Centring/Shuttering included) Beams & Lintels of Building above 5m up to 10m lvl	2.00	CUM	8707.28	17414.56
3.11	Providing and laying in position Reinforced cement concrete for all Super structures of building, Road works, Water works, Irrigation works & super structure works of bridges upto 3.50 m height. The granite/trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticizers laid in layers, well compacted using needle vibrators. The cost includes all lead & lifts, cost of all materials, quality confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement, dowel bars to be paid separately)M30 Design Mix Using 20 mm nominal size graded crushed coarse aggregates. (The cost of Centring/Shuttering included) Roof (Straight & Arched) up to 5m lvl	30.00	CUM	8426.40	252792.00
3.12	Providing and laying in position	1.00	CUM	8707.28	8707.28

	Reinforced cement concrete for all Super structures of building, Road works, Water works, Irrigation works & super structure works of bridges upto 3.50 m height. The granite/trap/basalt crushed graded coarse aggregates and fine aggregates as per relevant IS Codes machine mixed with super plasticizers laid in layers, well compacted using needle vibrators. The cost includes all lead & lifts, cost of all materials, quality confirming to the requirements of relevant IS codes, labour, Usage charges of machinery, curing and all other appurtenances required to complete the work as per technical specifications. (The cost of steel reinforcement, dowel bars to be paid separately)M30 Design Mix Using 20 mm nominal size graded crushed coarse aggregates. (The cost of Centring/Shuttering included)Roof (Straight & Arched) above 5m up to 10m lvl				
4	<b>MASONRY WORK</b>				
4.01	Providing and constructing laterite size stone masonry including cost and conveyance of all materials curing etc. complete as per specification. I.S. 3620/1979 having compressive strength not less than 3.5 N/mm <sup>2</sup> for saturated dry samples. For basement in CM 1:6	10.00	CUM	5691.00	56910.00
4.02	Providing and constructing laterite size stone masonry including cost and conveyance of all materials curing etc complete as per specification. I.S. 3620/1979 having compressive strength not less than 3.5 N/mm <sup>2</sup> for saturated dry samples. For Superstructure in CM 1:6	31.00	Cum	5945.00	184295.00
4.03	Providing and constructing load bearing wall with Solid Concrete blocks of size 400x100x200mm having block density more than 1800kg/m <sup>3</sup> and minimum compressive strength of 4.00 N/mm <sup>2</sup> conforming to IS 2185 (Part - I) - 2005 and constructed with CM 1:4 as per IS 2572:2005 including cost of all materials, labour, scaffolding and curing, usage charges of machinery etc. complete as per specifications.	12.00	Sqm	946.00	11352.00
4.04	Random rubble masonry with Departmental hard stone in	4.00	cum	3776.80	15107.20



	foundation and plinth including levelling up with cement concrete 1:6:12 (1 cement : 6 coarse sand : 12 graded stone aggregate 20 mm nominal size) upto plinth level with : 5.1.1 Cement mortar 1:6 (1 cement : 6 coarse sand)				
4.05	Ruled / Flush pointing on Sand stone masonry surface with lime, surkhi and marble dust mortar in the ratio of 1:1.5:1/2 {One lime: 1.5 surkhi (50% red and 50% light yellow surkhi ) : 1/2 marble dust}. (The rate is inclusive of all materials &labours involved except scaffolding).	12.00	Sqm	192.00	2304.00
5.	<b>STEEL AND ALUMINUM WORK</b>				
5.01	Providing and fixing M.S. grills of required pattern in frames of windows etc. with M.S. flats, square or round bars etc. including priming coat with approved steel primer all complete. Fixed to openings / wooden frames with rawl plugs screws etc.	113.00	KG	143.00	16159.00
5.02	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/ appropriate sections and other sections of approved make conforming to IS: 733 and IS:1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately):For Fixed Portion: Powder coated aluminium (minimum thickness of powder coating 50 micron) including cost of materials, labour, usage charges of machinery complete as per specifications.	89.00	KG	388.00	34532.00
5.03	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/	34.00	KG	455.00	15470.00

	<p>appropriate sections and other sections of approved make conforming to IS: 733 and IS:1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :For shutters of doors, windows &amp; ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately) Powder coated aluminium (minimum thickness of powder coating 50 micron) including cost of materials, labour, usage charges of machinery complete as per specifications.</p>				
5.04	<p>Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge. (Cost of aluminium snap beading shall be paid in basic item):With float glass panes of 4.0 mm thickness (weight not less than 10kg/ m<sup>2</sup>) including cost of materials, labour, usage charges of machinery complete as per specifications and as per directions of the Engineer-in-Charge.</p>	17.00	SQM	798.00	13566.00
5.05	<p>Providing and fixing Steel work in built up tubular (round, square or rectangular hollow tubes etc.) trusses etc., including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer, including welding and bolted with special shaped washers etc. complete. Electric resistance or induction butt welded tubes including cost of materials, labour, usage charges of</p>	1373.00	Kg	110.00	151030.00

	machinery complete as per specifications and as per directions of the Engineer-in-Charge.				
5.06	Providing and fixing Steel work welded in built up sections/ framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer using structural steel etc. as required. In gratings, frames, guard bar, ladder, railings, brackets, gates and similar works including cost of materials, labour, usage charges of machinery complete as per specifications and as per directions of the Engineer-in-Charge.	234.00	KG	108.00	25272.00
6	<b>ROOFING WORK</b>				
6.01	Providing and Fixing 15 mm thick densified regular edged eco friendly light weight calcium silicate false ceiling tiles of approved texture of size 595 x 595 mm in true horizontal level, suspended on inter locking metal grid of hot dipped galvanised steel sections (galvanising @ 120 grams per m <sup>2</sup> including both side) consisting of main 'T' runner suitably spaced at joints to get required length and of size 24x38 mm made from 0.33 mm thick (minimum) sheet, spaced 1200 mm centre to centre, and cross "T" of size 24x28 mm made out of 0.33 mm (Minimum) sheet, 1200 mm long spaced between main 'T' at 600 mm centre to centre to form a grid of 1200x600 mm and secondary cross 'T' of length 600 mm and size 24 x28 mm made of 0.33 mm thick (Minimum) sheet to be inter locked at middle of the 1200x 600 mm panel to form grid of size 600x600 mm, resting on periphery walls /partitions on a Perimeter wall angle pre-coated steel of size(24x24X3000 mm made of 0.40 mm thick (minimum) sheet with the help of rawl plugs at 450 mm centre to centre with 25 mm long dry wall screws @ 230 mm interval and laying 15 mm thick densified edges calcium silicate ceiling tiles of approved texture in the grid, including, cutting/ making opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc., wherever required. Main 'T' runners to be suspended from ceiling using G.I.	5.00	SQM	1956.00	9780.00

	slotted cleats of size 25x35x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm G.I. adjustable rods with galvanised steel level clips of size 85 x 30 x 0.8 mm, spaced at 1200 mm centre to centre along main 'T', bottom exposed with 24 mm of all T sections shall be pre-painted with polyester baked paint, for all heights, as per specifications, drawings and as directed by Engineer-in-Charge.				
6.02	Providing and fixing GI Clip in Metal Ceiling System of 600x600 mm module which includes providing and fixing 'C' wall angle of size 20x30x20 mm made of 0.5 mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300 mm center to centre, suspending the main C carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000 mm c/c. Inverted triangle shaped Spring Tee having height of 24 mm and width of 34 mm made of GI steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600 mm centers with help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/ m2 (both side inclusive), fixing with clip in tiles into spring T with :GI Metal Ceiling Clip in plain Beveled edge global white color tiles of size 600x600 and 0.5 mm thick with 25 mm height, made of G I sheet having galvanizing of 100 gms/ m2 (both sides inclusive) and 20% perforation area with 1.8 mm dia holes and having NRC of 0.5, electro statically polyester powder coated of thickness 60 microns (minimum), including factory painted after bending and perforation	18.00	SQM	1621.00	29178.00
6.03	Providing Mangalore Ridge tiles set in C.M. 1:2 and pointed with C.M. 1:2.	48.00	M	330.00	15840.00
6.04	Providing and setting Mangaluru tile over RCC sloped roof including plastering in C. M. 1:3 20mm average	282.00	SQM	673.00	189786.00

	thickness with W PC. and providing 50mmx20mm CM 1:3 patties for placing tiles lime mortar bands etc. complete.				
7.	<b>WOOD WORK</b>				
7.01	Providing Teak wood frames of doors, windows, clerestory windows, ventilators and other frames, wrought, framed or assembled including making plaster groves (excluding cost of cement concrete and side clamps ), but including cost of materials, labour, usage charges complete as per specifications.	1.00	CUM	235649.00	235649.00
7.02	Providing and fixing flush door shutter made out of solid core block board type, well seasoned ,chemically treated hard wood battens and internal frame with minimum 45 mm wide wooden frame alround door shutters covered with cross bonded wooden sheets (core veneer) hot pressed and fastened on both sides of the door useing liquid phenol formaldehyde resin as per IS specifications 2202 (part-I) 1991 from manufacturer complete as per spcification. 30 mm thick one side teak and one side commercial	4.00	SQM	3249.00	12996.00
8	<b>FLOORING WORK</b>				
8.01	Providing and laying Vitrified tiles in different sizes (thickness to be specified by manufacturer), with water absorption less than 0.08 % and conforming to I.S. 15622, of approved make, in all colours& shade, over 12 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand), jointing with grey cement slurry @ 3.3 kg/ m2 including grouting the joint with white cement & matching pigments etc. complete.	27.00	SQM	1111.00	29997.00
8.02	Providing and fixing of clay tiles for cladding tiles of size 230x75x10mm thick on 12mm thick cement mortar 1:3 (1 cement : 3 coarse sand) & jointed with Adhesive/cement slurry over rough plaster surface excluding cost of rough plastered surface and the surface is painted with red apex paint and black apex paint into the groves. The work includes cost of all materials, labour charges for all items of work, usage charges for equipment, etc., complete as per specification	46.00	SQM	1854.00	85284.00
8.03	Providing flooring with 25mm thick	25.00	SQM	1246.00	31150.00

	polished Cuddapah slabs using cement mortar 1:6, 25mm thick over existing cement concrete bed or top of roof laid to line and level and jointed with cement slurry mixed with pigment to match the shade of the slab , including cost of materials, labour, curing, polishing complete as per specifications.				
9.	<b>FINISHING WORK</b>				
9.01	Providing 6 mm cement plaster with cement mortar 1:3 (1 cement : 3 fine sand) including rounding off corners wherever required smooth rendering, providing and removing scaffolding, including cost of materials, labour, curing complete as per specifications and as per directions of Engineer-in-charge.	490.00	Sqm	176.00	86240.00
9.02	Providing 12 mm cement plaster finished with a floating coat of neat cement of mix :1:4 (1 cement: 4 fine sand) to brick masonry including rounding off corners wherever required smooth rendering, providing and removing scaffolding, including cost of materials, labour, curing complete as per specifications and as per directions of Engineer-in-charge.	189.00	Sqm	268.00	50652.00
9.03	Providing 20 mm cement plaster of mix :1:4 (1 cement: 4 fine sand) to brick/stone masonry including rounding off corners wherever required smooth rendering, providing and removing scaffolding, including cost of materials, labour, curing complete as per specifications and as per directions of Engineer-in-charge.	246.00	Sqm	307.00	75522.00
9.04	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications: Two coats applied on walls @ 1.25 ltr/10 m <sup>2</sup> over and including one coat of Special primer applied @ 0.75 ltr /10 m <sup>2</sup> with paint of approved quality to give an even shade, after thoroughly brooming the surface to remove all dirt, dust, mortar drops and foreign matter including preparing the surface even and sand paper smooth, cost of materials, labour complete as per specifications and as per directions of Engineer-in-charge.	694.00	Sqm	118.00	81892.00
9.05	Applying priming coat: With ready mixed pink or Grey primer of	4.00	SQM	41.00	164.00

	approved brand and manufacture on wood work (hard and soft wood) including preparing the surface after thoroughly cleaning oil, grease, dirt and foreign matter, cost of materials, labour complete as per specifications and as per directions of Engineer-in-charge.				
9.06	Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade :Two coats on new work over an under coat of suitable shade with ordinary paint of approved brand and manufacture after thoroughly brooming the surface to remove all dirt, dust, mortar drops and foreign matter including preparing the surface even and sand paper smooth, cost of materials, labour complete as per specifications and as per directions of Engineer-in-charge.	4.00	SQM	130.00	520.00
9.07	Finishing walls with Acrylic Smooth exterior paint of required shade :New work (Two coat applied @ 1.67 ltr/10 m <sup>2</sup> over and including priming coat of exterior primer applied @ 2.20 kg/10 m <sup>2</sup> ) with paint of approved quality to give an even shade, after thoroughly brooming the surface to remove all dirt, dust, mortar drops and foreign matter including preparing the surface even and sand paper smooth, cost of materials, labour complete as per specifications and as per directions of Engineer-in-charge.	201.00	SQM	136.00	27336.00
10.	<b>OTHER ITEMS</b>				
10.01	Providing and fixing chromium plated brass 100 mm mortise latch and lock with 6 levers and a pair of lever handles of approved quality with necessary screws etc. complete.	2.00	NO.	832.00	1664.00
10.02	Providing and fixing aluminum die cast body tubular type universal hydraulic door closer (having brand logo with ISI, IS : 3564, embossed on the body, door weight upto 35 kg and door width upto 700 mm), with necessary accessories and screws etc. complete.	2.00	No.	880.00	1760.00
10.03	Providing and fixing expansion hold fasteners on C.C. /R.C.C./Brick masonry surface backing including drilling necessary holes and the cost of bolt etc complete. Fastener with threaded dia 12 mm	12.00	Each	30.00	360.00

10.04	Supplying and fixing C.I with out frame for manholes: 560 mm diameter ( heavy duty) the weight of the cover to be not less than 108 kg.	2.00	Each	7808.70	15617.40
10.05	Constructing soak pit 1.20x1.20x1.20 m filled with brickbats including S.W. drain pipe 100 mm diameter and 1.20 m long complete as per standard design.	1.00	Each	3293.02	3293.02
10.06	Extra for providing and mixing water proofing material in cement plaster work in proportion recommended by the manufacturers including cost of material etc as per specifications and as per directions of the Engineer- in-Charge.	517.00	Sqm	51.00	26367.00
10.07	Providing and laying reinforced cement concrete pipe NP3 for culverts on first class bedding of granular material in double row including fixing collar with cement mortar 1:2 but excluding excavation, protection works, backfilling, concrete and masonry works in head walls and parapets as per Clause 1101.6. 750mm. dia	21.00	M	6388.00	134148.00
10.08	Providing and laying Chequerred precast cement concrete tiles 22 mm thick in footpath & courtyard, jointed with neat cement slurry mixed with pigment to match the shade of tiles, including rubbing and cleaning etc. complete, on 20 mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand) Dark shade pigment using ordinary cement.	1826.00	Sqm	585.00	1068210.00
10.09	G.I Barbed Wire Fencing 1.2 m High Providing and fixing 1.2 m high GI barbed wire fencing with 1.8 m angle iron posts 40 mm x 40 mm x 6 mm placed every 3 m center to center founded in M15 grade cement concrete, 0.6 m below ground level, every 15th post, last but one end post and corner post shall be strutted on both sides and end post on one side only and provided with 9 horizontal lines and 2 diagonals interwoven with horizontal wires, fixed with GI staples, turn buckles etc. complete as per clause 817.	42.00	M	218.00	9156.00
11	<b>INNOVATIVE ITEMS</b>				
11.01	Providing and supplying crystalline integral concrete waterproofing admixture that waterproofs concrete by forming crystals deep in the pores,	280.00	SQM	563.00	157640.00



	capillaries and microcracks of the concrete, self-seal waterproofing compound to bridge shrinkage cracks upto 0.5mm in width & resist hydrostatic pressure upto 16bar for both positive & negative pressure confirming to DIN 1048 part 5 for 56% reduction in depth of penetration against control, resistance to chloride penetration confirming to ASTM C 1202 with 64% improvement against control & protecting steel reinforcement against corrosion mixed @ 1% by weight of cementitious content in concrete. ie., integral crystalline waterproofing admix @ 0.5 kg/bag of cement. (For calculation purpose 320 kg of Cement for M-20 grade of Concrete is considered in the analysis)				
11.02	Providing and applying of swellable type water stop tape, 19mm x 25mm thick in linear meter (expansive nature) for construction joints treatment of RCC structure such as raft slab, retaining walls, water storage tank and at the junctions of raft slab with the retaining walls etc.. After cleaning the surface, one coat of required primer for swellable water stop tape shall be applied throughout the length of the joint @3.78 litre per 240 running meter. Over the primed surface swellable type water stop tape shall be placed. The work shall be carried out all complete as per specification and the direction of the Engineer-In-Charge. The product performance shall carry guarantee for 10 years against any leakage.	34.00	M	554.85	18864.90
11.03	Structural Steel Coatings: Cleaning the existing steel surface by mechanical means such as sand blasting so as to remove all the existing loose rust etc. Using cotton waste swab apply rust converting,steel passivating, flash rust preventing sulphate and chloride free, non-alkaline, inorganic single component, rust converter and nano film forming surface passivator. After 24 hours remove the free I loose rust particles by simple dusting with brush. Providing and applying one coat of Two component, anticorrosive, solvent free, substituted long chain nylon reticulant based epoxy coating/primer This should be	62.00	Sqm	330.00	20460.00

	followed by two coats of protective two component, APR based, UV resistant anticorrosive coating. Apply the coats by brush or spray at 4-6 hours interval between each coat.				
12	<b>ADDITIONAL ITEMS</b>				
12.01	Providing and fixing 1st quality ceramic glazed wall tiles conforming to IS: 15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer- in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per m <sup>2</sup> , including pointing in white cement mixed with pigment of matching shade complete.	23.00	SQ,M	974.00	22402.00
12.02	Providing and fixing Fiber Glass Reinforced plastic (FRP) Door Frames of cross- section 90 mm x 45 mm having single rebate of 32 mm x 15 mm to receive shutter of 30 mm thickness. The laminated shall be moulded with fire resistant grade unsaturated polyester resin and chopped mat. Door frame laminate shall be 2 mm thick and shall be filled with suitable wooden block in all the three legs. The frame shall be covered with fiber glass from all sides. M.S. stay shall be provided at the bottom to steady the frame, etc complete at all levels.	12.00	M	631.00	7572.00
12.03	Providing and fixing to existing door frames 30 mm thick Fiberglass Reinforced Plastic (F.R.P) flush door shutter in different plain and wood finish made with fire retardant grade unsaturated polyester resin, moulded to 3 mm thick FRP laminate all around, with suitable wooden blocks inside at required places for fixing of fittings and polyurethane foam (PUF) / Polystyrene foam to be used all filler material throughout the hollow panel, casted monolithically with testing parameters of F.R.P. laminate conforming to table - 3 of IS : 14856, complete at all levels as per direction of Engineer-in-charge.	4.00	SQM	3125.00	12500.00
12.04	Providing and fixing Brass 100mm mortice latch and lock with 6 levers	2.00	No.	345.00	690.00

	without pair of handles (best make of approved quality) for aluminium doors including necessary cutting and making good etc. complete including cost of materials, labour, usage charges of machinery complete as per specifications.				
12.05	Supplying and fixing of 200F Exterior Plain Aluminium Panel Ceiling of approved colour consisting of panel 200mm wide x 17mm deep x 0.7mm thick, panel length up to 6mtr, Coil Coated on a Continuous Paint Line, Double baked and Roll formed from enamelled Corrosion Resistance Aluminium Alloy AA3005 for higher strength and good Roll Forming characteristics. Panel shall be clipped to a Baked enamelledAluminium Panel Carrier of 34.5mm wide x 48mm x 1.2mm thick in standard length of 5mtrs made of double baked enamelledAluminium Alloy AA 5050 (Al.Mg) colour Black with cut outs to hold the panels of module 200mm at a distance at 1.2mtrs c/c. The panel carrier shall be suspended by means of a suitable rigid suspension support (By others) at a distance of 0.550mtr c/c. The system should meet the required standards for GreenPro certification and should qualify as green product as per CII green products and services council. Paint Finish: Aluminium panels shall be chromatised for maximum bond between metal and paint, enamelled twice under high temperature one side with full primer and Luxacote finish, the other side (inner side) with a primer coat and skin coat on a Continuous Paint Line. at all heights all complete at all levels as per manufacturer recommendation and as directed by engineer in charge.	29.00	SQM	4085.00	118465.00
12.06	Providing and fixing stainless steel (Grade 316) railing made of Hollow tubes, channels, plates etc.at all levels , including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc., of required size on the top of the floor or the side	2642.00	KG	685.72	1811672.24

	of waist slab with suitable arrangement as per approval of Engineer-in-charge, (for payment purpose only weight of stainless steel members shall be considered including fixing accessories such as nuts, bolts, fasteners etc.)				
13	<b>ROAD WORKS</b>				
13.01	Construction of Granular Sub-Base of required grading as per design mixing in a mechanical mix plant at OMC, carriage of mixed Material to work site, spreading in uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per clause 401 For Grading -V Material.	161.00	CUM	2347.00	377867.00
13.02	Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver/grader in sub-base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density.	161.00	CUM	2394.00	385434.00
13.03	Construction of dry lean cement concrete Sub- base over a prepared sub-grade with coarse and fine aggregate conforming to IS: 383, the size of coarse aggregate not exceeding 25 mm, aggregate cement ratio not to exceed 15:1, aggregate gradation after blending to be as per table 600-1, cement content not to be less than 150 kg/ m3, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant, transported to site, laid with a paver with electronic sensor, compacting with 8-10 t vibratory roller, finishing and curing	161.00	CUM	4196.00	675556.00
13.04	Construction of M40 grade unreinforced, dowel jointed, plain cement concrete pavement over a prepared sub base with Cement @	321.00	CUM	8738.00	2804898.00

	315 kg/m <sup>3</sup> and GGBS@ 105 kg/m <sup>3</sup> , coarse and fine aggregate conforming to IS 383:2016, maximum size of coarse aggregate not exceeding 25 mm, mixed in a batching and mixing plant as per approved mix design transported to site, laid with a paver finisher, spread, compacted and finished in a continuous operation including provision of contraction, expansion, construction and longitudinal joints, joint filler, separation membrane, sealant primer, joint sealant, debonding strip, dowel bar, tie rod, admixtures as approved, curing compound, finishing to lines and grades as per drawing				
13.05	Construction of cement concrete kerb with channel with top and bottom width 115 and 165 mm respectively, 250 mm high in M 20 grade PCC on M10 grade foundation 150 mm thick, kerb channel 300 mm wide, 50 mm thick in PCC M20 grade, sloped towards the kerb, kerb stone with channel laid with kerb laying machine, foundation concrete laid manually, all complete as per clause 409	691.00	M	222.00	153402.00
13.06	Painting two coats after filling the surface with synthetic enamel paint in all shades on new plastered concrete surfaces.	425.00	SQM	85.00	36125.00
13.07	Earth work excavation for Foundation by mechanical means for all works & depth upto 3 m, as per drawing and technical specifications, including setting out, shoring, strutting, barricading, caution lights, including dressing of excavated surfaces, disposing off or levelling the excavated earth or sorting & stacking the selected earth for reuse in a radius of 50 m and lift upto 1.5 m including cost of labour, tools, usage of machinery & other appurtenances required to complete the work.	161.00	M	73.00	11753.00
13.08	Construction of sub-grade and earthen shoulders with approved material obtained from borrow pits with all lifts & leads, transporting to site, spreading, grading to required slope and compacted to meet requirement of table No. 300-2	161.00	SQM	413.00	66493.00

14	<b>DEMOLITION &amp; REPAIR WORKS</b>				
14.01	Dismantling of existing structures like culverts, bridges, retaining walls and other structure comprising of masonry, cement concrete, wood work, steel work, including T&P and scaffolding wherever necessary, sorting the dismantled material, disposal of unserviceable material and stacking the serviceable material with all lifts and lead. C.) Pre stressed / Reinforced cement concrete grade M-20 &above .	14.00	CUM	1853.00	25942.00
14.02	Dismantling of existing structures like culverts, bridges, retaining walls and other structure comprising of masonry, cement concrete, wood work, steel work, including T&P and scaffolding wherever necessary, sorting the dismantled material, disposal of unserviceable material and stacking the serviceable material with all lifts and lead B. ) Cement Concrete Grade M-15 & M-20	15.00	CUM	731.00	10965.00
14.03	Dismantling of existing structures like culverts, bridges, retaining walls and other structure comprising of masonry, cement concrete, wood work, steel work, including T&P and scaffolding wherever necessary, sorting the dismantled material, disposal of unserviceable material and stacking the serviceable material with all lifts and lead A.Lime Concrete, cement concrete grade M-10 and below.	30.00	CUM	618.00	18540.00
14.04	Dismantling of existing structures like culverts, bridges, retaining walls and other structure comprising of masonry, cement concrete, wood work, steel work, including T&P and scaffolding wherever necessary, sorting the dismantled material, disposal of unserviceable material and stacking the serviceable material with all lifts and lead .Rubble stone masonry in cement mortar.	68.00	CUM	481.00	32708.00
14.05	Scraping of Stone from Dismantled Stone masonry. In cement and lime mortar	68.00	CUM	797.00	54196.00

14.06	Dismantling of cement concrete pavement by mechanical means using pneumatic tools, breaking to pieces not exceeding 0.02 m <sup>3</sup> in volume and stock piling at designated locations and disposal of dismantled materials and stacking serviceable and unserviceable materials separately.	3.00	CUM	422.00	1266.00
14.07	Disposal of building rubbish / malba / similar unserviceable, dismantled or waste materials by mechanical means, including loading, transporting, unloading to approved municipal dumping ground or as approved by Engineer-in-charge to the appropriate disposal area.	121.00	CUM	87.00	10527.00
14.08	Laying at or near ground level old kerb stones of all types in position to the required line, level and curvature, jointed with cement mortar 1:3 (1 cement : 3 coarse sand), including making joints with or without grooves ( thickness of joints, except at sharp curve, shall not be more than 5 mm), including making drainage opening wherever required etc. complete as per direction of Engineer-in-charge. (Length of finished kerb edging shall be measured for payment). (Old kerb stones shall be supplied by the department free of cost)	21.00	M	101.75	2136.75
14.09	Dismantling of barbed wire fencing/ wire mesh fencing including posts, foundation concrete, back filling of pit by manual means including disposal of dismantled material with all lifts and lead, stacking serviceable material and unserviceable material separately.	31.00	M	75.00	2325.00
<b>II</b>	<b>PART B – WATER SUPPLY &amp; SANITARY WORKS</b>				
15.00	<b>SANITARY INSTALLATION</b>				
15.01	Providing and fixing white vitreous china pedestal type water closet (European type) with seat and lid, 10 litre low level white vitreous china flushing cistern & C.P. flush bend with fittings & C.I. brackets, 40 mm flush bend, overflow arrangement with specials of standard make and	2.00	No.	5488.00	10976.00

	mosquito proof coupling of approved municipal design complete, including painting of fittings and brackets, cutting and making good the walls and floors wherever required : W.C. pan with ISI marked black solid plastic seat and lid				
15.02	Providing and fixing wash basin with C.I. brackets, 15 mm C.P. brass pillar taps, 32 mm C.P. brass waste of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever require: White Vitreous China Wash basin size 630x450 mm with a single 15mm C.P. brass pillar tap	2.00	No.	2415.00	4830.00
15.03	Providing and fixing CP brass hand spray with lever control (health faucet) of approved make 1meter long flexible tube and CP brass wall hook,CP brass angle valve and all fittings etc. complete, testing and commissioning, cost and conveyance of all materials, labour charges ,cutting, making good the walls wherever required, lead, lift, etc as per the direction of Engineer in Charge.	2.00	No.	2291.00	4582.00
15.04	Providing and fixing brass bib cock of approved quality:15 mm nominal bore	2.00	No	365.12	730.24
15.05	Providing and fixing 600x450mm bevel lead edge mirror of superior glass with 6mm hard board backing and fixed to wooden cleats with C. P screws, washers, including cost of materials, labourcomplete as per specifications.	2.00	No	1087.52	2175.04
15.06	Providing and fixing SS floor trap of 110mm outer dia including SS cockroach free floor grating with cup, PVC multitrap etc. complete, testing and commissioning to the satisfaction of Engineer in Charge at all levels.	4.00	No	841.00	3364.00
15.07	Providing and fixing C.P. brass angle valve for basin mixer and geyser points of approved quality conforming to IS:8931	4.00	No	493.00	1972.00
15.08	Providing and fixing CP Brass 32mm size Bottle Trap of approved quality & make and as per the direction of Engineer-in-charge.	2.00	No	957.00	1914.00
15.09	Providing and fixing Cleanout with Spigot, with SS 304 Square Frame &	1.00	No	544.00	544.00



	Round Frame with Flat Round Cover with Rubber Seal & SS Screw including cost and conveyance of all materials, labour charges, sundries etc complete as directed by the Engineer in charge at all levels. 75mm dia				
16.00	<b>WATER SUPPLY PIPING WORKS</b>				
16.01	Providing and fixing Chlorinated Poly Vinyl Chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threaded fittings. This includes jointing of pipes and fittings with one step solvent cement, trenching, refilling & testing of joints complete as per direction of Engineer in Charge. External work. 50mm nominal dia Pipe	42.00	M	702.00	29484.00
16.02	Providing and fixing Chlorinated Poly Vinyl Chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threaded fittings. This includes jointing of pipes and fittings with one step solvent cement, trenching, refilling & testing of joints complete as per direction of Engineer in Charge. External work. 32mm nominal dia Pipe	6.00	M	358.00	2148.00
16.03	Providing and fixing Chlorinated Poly Vinyl Chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threaded fittings. This includes jointing of pipes and fittings with one step solvent cement, trenching, refilling & testing of joints complete as per direction of Engineer in Charge. External work. 25mm nominal dia Pipe	30.00	M	299.00	8970.00
16.04	Providing and fixing Chlorinated Poly Vinyl Chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threaded fittings, including fixing the pipe with clamps at 1.00m spacing. This includes jointing of pipes and fittings with one step solvent cement, and testing of joints complete as per direction of Engineer in Charge. Internal work-Exposed on wall. 25mm	6.00	M	316.00	1896.00

	nominal dia Pipe				
16.05	Providing and fixing Chlorinated Poly Vinyl Chloride (CPVC) pipes having thermal stability for hot and cold water supply including all CPVC plain and brass threaded fittings, including fixing the pipe with clamps at 1.00m spacing. This includes jointing of pipes and fittings with one step solvent cement, and testing of joints complete as per direction of Engineer in Charge. Internal work-Exposed on wall. 50mm nominal dia Pipe	12.00	M	767.00	9204.00
16.06	Providing and fixing Chlorinated Poly Vinyl Chloride (CPVC) pipes, having thermal stability for hot and cold water supply including all CPVC plain and brass threaded fittings including fixing the pipe with clamp at 1.00 mtr spacing. This includes jointing of pipes and fittings with one step CPVC solvent cement & the cost of cutting chases & making good the same including testing of Joints complete. (Concealed work including cutting chases and making good walls). 25mm nominal dia Pipe	6.00	M	476.00	2856.00
16.07	Providing and fixing Chlorinated Poly Vinyl Chloride (CPVC) pipes, having thermal stability for hot and cold water supply including all CPVC plain and brass threaded fittings including fixing the pipe with clamp at 1.00 mtr spacing. This includes jointing of pipes and fittings with one step CPVC solvent cement & the cost of cutting chases & making good the same including testing of Joints complete. (Concealed work including cutting chases and making good walls). 20mm nominal dia Pipe	12.00	M	373.00	4476.00
16.08	Providing and fixing Brass full way valve gate with CI wheel of approved quality (screwed end). 50 mm nominal bore	2.00	No	834.00	1668.00
16.09	Providing and fixing Brass full way valve gate with CI wheel of approved quality (screwed end). 32 mm nominal bore	1.00	No	577.00	577.00
16.10	Providing and fixing Brass full way valve gate with CI wheel of approved quality (screwed end). 25 mm nominal bore	2.00	No	591.36	1182.72
16.11	Providing and placing on terrace (at all floor levels) polyethylene water storage tank, IS : 12701 marked, with	1.00	No	4480.00	4480.00

	cover and suitable locking arrangement and making necessary holes for inlet, outlet and overflow pipes but without fittings and the base support for tank.				
17.00	<b>SANITARY PIPING WORKS</b>				
17.01	Supplying, laying, jointing, testing and commissioning of PVC pipes with PVC specials such as tees, bends, door bend, door tee, elbows, unions, etc. with clamps including earth work, refilling, testing the lines rectifying any leakages or defects etc. complete for soil, waste, rain water, drains, vent pipe, etc. concealed or open at all levels including cost and conveyance of all materials, labour charges, sundries etc complete for external works as directed by the Engineer-in-Charge. 160mm OD(6 kg/cm <sup>2</sup> )	36.00	M	1392.00	50112.00
17.02	Supplying, laying, jointing, testing and commissioning of PVC pipes with PVC specials such as tees, bends, door bend, door tee, elbows, unions, etc. with clamps including earth work, refilling, testing the lines rectifying any leakages or defects etc. complete for soil, waste, rain water, drains, vent pipe, etc. concealed or open at all levels including cost and conveyance of all materials, labour charges, sundries etc complete for external works as directed by the Engineer-in-Charge. 110mm OD(6 kg/cm <sup>2</sup> )	36.00	M	775.00	27900.00
17.03	Supplying, laying, jointing, testing and commissioning of PVC pipes with PVC specials such as tees, bends, door bend, door tee, elbows, unions, etc. with clamps including earth work, refilling, testing the lines rectifying any leakages or defects etc. complete for soil, waste, rain water, drains, vent pipe, etc. concealed or open at all levels including cost and conveyance of all materials, labour charges, sundries etc complete for external works as directed by the Engineer-in-Charge. 75mm OD(6 kg/cm <sup>2</sup> )	12.00	M	507.00	6084.00
17.04	Supplying, laying, jointing, testing and commissioning to the satisfaction of Engineer in charge of PVC pipes with PVC specials such as tees, bends, door bend, door tee, elbows, unions, etc. with clamps including cutting and making good the walls, testing the	12.00	M	843.00	10116.00

	lines rectifying any leakages or defects etc. complete for soil, waste, rain water, drains, vent pipe, etc. concealed or open at all levels including cost and conveyance of all materials, labour charges, sundries etc complete for concealed work as directed by the Engineer- in-Charge. 110mm OD (6 kg/cm <sup>2</sup> )				
17.05	Supplying, laying, jointing, testing and commissioning to the satisfaction of Engineer in charge of PVC pipes with PVC specials such as tees, bends, door bend, door tee, elbows, unions, etc. with clamps including cutting and making good the walls, testing the lines rectifying any leakages or defects, etc. complete for soil, waste, rain water, drains, vent pipe, etc. concealed or open at all levels including cost and conveyance of all materials, labour charges, sundries etc complete for concealed work as directed by the Engineer- in-Charge. 75mm OD (6 kg/cm <sup>2</sup> )	6.00	M	478.00	2868.00
17.06	Supplying, laying, jointing, testing and commissioning to the satisfaction of Engineer in charge of PVC pipes with PVC specials such as tees, bends, door bend, door tee, elbows, unions, etc. with clamps including cutting and making good the walls, testing the lines rectifying any leakages or defects, etc. complete for soil, waste, rain water, drains, vent pipe, etc. concealed or open at all levels including cost and conveyance of all materials, labour charges, sundries etc complete for concealed work as directed by the Engineer- in-Charge. 50mm OD (6 kg/cm <sup>2</sup> )	6.00	M	440.00	2640.00
17.07	Supplying, fixing, testing and commissioning to the satisfaction of Engineer in charge of PVC gully trap of size 160 x 110mm and CI grating 150mm x 150mm size and water tight C.I cover with frames 300mm x 300mm size (inside) the weight of cover to be not less than 4.5kg and frame to be not less than 2.7kg (CI MH cover and frame as per IS:1726) single sealed of size conveying to size the above mentioned items and constructing 30cm x 30cm internal size gully trap chamber and depth upto 60cm, 115 thick brick wall in CM 1:6 on a foundation of PCC 1:4:8. 100mm thick	2.00	No	3261.00	6522.00

	plastering inside with CM 1:3,12mm thick with a neat cement flushing coat and conveying to site,cleaning ,installing and testing approved make PVC gully trap with 160mm outlet (Fabricated), surrounding with CC 1:1.5:3, 150x150mm,top with CI grating above the PVC gulley trap and light duty CI cover and frame over the chamber including cost of all materials, etc complete as per approved drawing and as directed by Engineer-in- Charge.				
17.08	Constructing brick masonry manhole in cement mortar 1:4 ( 1 cement : 4 coarse sand) with R.C.C. top with 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size), foundation concrete 1:4:8 mix ( 1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size,) inside plastering 12 mm thick with cement mortar 1:3 ( 1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 ( 1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size ) finished with a floating coat of neat cement complete as per standard design: Inside size 60x60 cm and depth varying from 30 cm to 60 cm including C.I. cover with frame (medium duty) 500 mm diameter with frame, total weight of cover and frame to be not less than 116 kg :With common burnt clay F.P.S. (non modular) bricks of class designation 7.5	No	5.00	8980.00	44900.00
17.09	Providing and laying non-pressure NP3 class (medium duty) R.C.C. pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 ( 1 cement : 2 fine sand) including testing of joints etc. complete. 300 mm dia R.C.C. pipe	30.00	M	961.00	28830.00
17.10	Constructing brick masonry chamber for underground C.I. inspection chamber and bends with bricks in cement mortar 1:4 (1 cement : 4	2.00	No	8185.13	16370.26

	coarse sand) C.I. cover with frame (light duty) 455x610 mm internal dimensions, total weight of cover with frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg), R.C.C. top slab with 1:1.5:3 mix (1 cement : 1.5 fine sand : 3 graded stone aggregate 20 mm nominal size), foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size), inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand), finished smooth with a floating coat of neat cement on walls and bed concrete etc. complete as per standard design: Inside dimensions 500x700 mm and 45 cm deep for pipe line with one or two inlets :With common burnt clay F.P.S. (non modular) bricks of class designation 7.5				
17.11	Supplying and fixing of Centrifugal Monobloc pump with cover, with CI construction, CI impeller complete with motor, base plate, foundation bolts, nuts, pressure guage and all accessories. and working with 415V, 3ph and 50 Hz frequency . head-12m, Discharge-167lpm	2.00	No.	9394.00	18788.00
17.12	Supplying and fixing GM foot valve with all accessories including cost and conveyance of all materials, labour charges etc., complete as directed by the Engineer -in - charge at all levels. 50 mm dia.	2.00	No.	2591.00	5182.00
17.13	Providing and fixing gun metal non-return valve of approved quality (screwed end) :50 mm nominal bore: Horizontal.	2.00	No	1217.00	2434.00
III	<b>PART-C ELECTRICAL WORKS</b>				
18.00	<b>CABLES AND CABLING</b>				
18.01	Supply of following 4C 16 Sq.mm size 1.1 KV grade XLPE insulated, PVC sheathed, armored Aluminum conductor cable conforming to IS 7098 (Part 1) amended upto date.	170.00	M	125.00	21250.00
18.02	Supply of following 4C 1.5 Sq.mm size 1.1 KV grade XLPE insulated, PVC sheathed, armoured copper conductor cable conforming to IS 7098 (Part 1)	30.00	M	96.00	2880.00

	amended upto date				
18.03	Supply of following 3C 4 sqmm size 1.1 KV grade XLPE insulated, PVC sheathed, armoured copper conductor cable conforming to IS 7098 (Part 1) amended upto date	20.00	M	151.00	3020.00
18.04	Supply of following 4C 4 sqmm size 1.1 KV grade XLPE insulated, PVC sheathed, armoured copper conductor cable conforming to IS 7098 (Part 1) amended upto date	60.00	M	190.00	11400.00
18.05	Supply of following 2C 4 sqmm size 1.1 KV grade XLPE insulated, PVC sheathed, armoured copper conductor cable conforming to IS 7098 (Part 1) amended upto date	470.00	M	109.00	51230.00
18.06	Supplying and making end termination with brass compression gland and aluminium lugs for following 4C 16 Sq.mm size of PVC insulated and PVC sheathed / XLPE aluminium conductor cable of 1.1 KV grade as required.	2.00	No	328.00	656.00
18.07	Supplying and making end termination with brass compression gland and copper lugs for following 4C 1.5 Sq.mm size of PVC insulated and PVC sheathed / XLPE copper conductor cable of 1.1 KV grade as required	4.00	M	272.01	1088.04
18.08	Supplying and making end termination with brass compression gland and copper lugs for following 3C 4 sqmm size of PVC insulated and PVC sheathed / XLPE copper conductor cable of 1.1 KV grade as required	4.00	NO	324.16	1296.64
18.09	Supplying and making end termination with brass compression gland and copper lugs for following 4C 4 sqmm size of PVC insulated and PVC sheathed / XLPE copper conductor cable of 1.1 KV grade as required	4.00	NO	328.46	1313.84
18.10	Supplying and making end termination with brass compression gland and copper lugs for following 2C 4 sqmm size of PVC insulated and PVC sheathed / XLPE copper conductor cable of 1.1 KV grade as required.	6.00	NO	319.87	1919.22
18.11	Laying and fixing of one number PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of following Upto 35 sq. mm (clamped with 1mm thick saddle) size on wall or surface as required	90.00	M	34.93	3143.70
18.12	Laying of one number PVC insulated and PVC sheathed armoured power	350.00	M	220.09	77031.50

	cable of 1.1kV grade for the following Upto 35 sq. mm sizes in ground including excavation ,sand cushioning , providing protective covering and refilling the trench etc. as required				
18.13	Laying of one number additional PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of following Upto 35 sq. mm size direct in ground in the same trench in one tier horizontal formation including excavation, sand cushioning, protective covering and refilling the trench etc., as required	70.00	M	154.94	10845.80
18.14	Laying of one number PVC insulated and PVC sheathed / XLPE power cable of 1.1 KV grade of following Up to 35 sq mm size in the existing RCC/ HUME/ METAL pipe as required.	140.00	M	29.22	4090.80
18.15	Laying and fixing of one number PVC insulated and PVC sheathed/ XLPE power cable of 1.1 KV grade of following Upto 35 sq. mm (clamped with 1mm thick saddle) size on cable tray as required.	100.00	M	29.89	2989.00
18.16	Providing, laying and fixing following 50 mm dia G.I. pipe (medium class) in ground complete with G.I. fittings including trenching (75 cm deep)and re-filling etc., as required	150.00	M	376.66	56499.00
18.17	Fabrication, supply and installation of following 150 MM WIDTH X 50 MM DEPTH X 2MM THICK size of perforated GI cable tray including horizontal and vertical reducers, tees, cross members and other accessories as required and duly suspended from the ceiling with MS suspenders and painting etc as required	10.00	M	615.00	6150.00
18.18	Providing, laying and fixing following 100 mm dia RCC pipe NP2 class (light duty) in ground complete with RCC collars, jointing with cement mortar 1:2 (1 cement : 2 fine sand) including trenching (75 cm deep) and refilling etc as required.	15.00	M	438.00	6570.00
18.19	Supply, fabricating and installing MS items such as Tees/ angles/ channels etc. on floor/ ceiling/ wall including necessary civil work such as grouting, finishing etc. and painting with two coats of primer and two coats of synthetic enamel paint as required	350.00	KG	154.08	53928.00
18.20	Supply of ISI marked HDPE pipes with following '110 mm dia (OD) size of 10	15.00	M	505.00	7575.00



	kgf/cm2 conforming to as per IS 4984,1985 PE-100 including all fittings and specials such as tees, elbows, bends, reducers, end caps,complete so as to withstand the internal design pressure of 10 fkg/cm2 as directed by Engineer -in-Charge.				
18.21	Supplying and fixing cable route marker with 10 cm X 10 cm X 5 mm thick G.I. plate with inscription there on, bolted /welded to 35 mm X 35 mm X 6 mm angle iron, 60 cm long and fixing the same in ground as required.	5.00	NO	341.30	1706.50
19.00	<b>WIRING AND ACCESSORIES</b>				
19.01	Wiring for light point/ fan point/ exhaust fan point/ call bell point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable in surface / recessed medium class PVC conduit, with modular switch, modular plate, suitable GI box and earthing the point with 1.5 sq.mm. FRLS PVC insulated copper conductor single core cable etc as required. (Note:The total distance from the switch box to the point will not exceed 5mtr, incase if length increases above 5 metres, the wiring shall be measured under item 3.04.1	14.00	NO	1017.31	14242.34
19.02	Group controlled light point with 1.5 sq. mm wire - Wiring for Group controlled light point (from one point to another point) with 3X 1.5 sq. mm PVC insulated, (FRLS), copper conductor cable in surface/recessed mounted rigid medium class 20mm PVC conduit with all accessories as required. (Note: This item does not include the cost of MCB or 16Amp/ 6Amp one way switches. The total distance from one point to another point will not exceed 5meters. In case if the total length increases 5meters, the additional length shall be measured under item 3.04.1 The distance from DB to 1st point will be measured under point circuit wiring.	6.00	NO	742.45	4454.70
19.03	Wiring for twin control light point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable in surface / recessed medium class PVC conduit, 2 way modular switch, modular plate, suitable GI box and earthing the point with 1.5 sq.mm. FRLS PVC insulated copper conductor single core cable etc as required	2.00	NO	1076.86	2153.72

	(Note:The total distance from the switch box to the point will not exceed 5mtr, incase if length increases above 5 metres, the wiring shall be measured under item 3.04.1				
19.04	Circuit wiring -Wiring for circuit/ submain wiring along with earth wire with the following 2 X 1.5 sq. mm + 1 X 1.5 sq. mm earth wire sizes of FRLS PVC insulated copper conductor, single core cable in surface/ recessed medium class PVC conduit as required.	180.00	M	152.38	27428.40
19.05	Circuit wiring -Wiring for circuit/ sub main wiring along with earth wire with the following 2 X 2.5 sq. mm + 1 X 2.5 sq. mm earth wire sizes of FRLS PVC insulated copper conductor, single core cable in surface/ recessed medium class PVC conduit as required.	100.00	M	165.23	16523.00
19.06	Circuit wiring -Wiring for circuit/ submain wiring along with earth wire with the following 2 X 4 sq. mm + 1 X 4 sq. mm earth wire sizes of FRLS PVC insulated copper conductor, single core cable in surface/ recessed medium class PVC conduit as required.	60.00	M	202.34	12140.40
19.07	Supplying and fixing following 6 pin 15/16 amp socket outlet with modular plate & cover on surface or in recess, including proving and fixing suitable size GI box,inter connection etc as required complete.	1.00	NO	155.94	155.94
19.08	Supplying and fixing following 15/16 amp switch with modular plate & cover on surface or in recess, including proving and fixing suitable size GI box,inter connection etc as required complete.	1.00	NO	106.52	106.52
19.09	Supplying and fixing following Telephone socket outlet with modular plate & cover on surface or in recess, including proving and fixing suitable size GI box,inter connection etc as required complete.	2.00	NO	104.22	208.44
19.10	Supplying and fixing following Bell push with modular plate & cover on surface or in recess, including proving and fixing suitable size GI box, inter connection etc., as required complete	2.00	NO	142.99	285.98
19.11	Supplying and fixing call bell/ buzzer suitable for single phase, 230 volts, complete as required.	2.00	NO	69.29	138.58
19.12	Supplying and fixing suitable size GI	2.00	NO	433.13	866.26

	box with modular plate and cover in front on surface or in recess, including providing and fixing 6 pin 5/6 & 15/16 amps modular socket outlet and 15/16 amps modular switch, connection etc. as required.				
19.13	Supplying and fixing suitable size GI box with modular plate and cover in front on surface or in recess, including providing and fixing 3 pin 5/6 amps modular socket outlet and 5/6 amps modular switch, connection etc. as required. (For light plugs to be used in non-residential buildings).	2.00	NO.	361.94	723.88
19.14	Supply & fixing Computer points with 3 nos 3 pin 5/6A socket with 2no.5/6A switch with modular front plate and cover on surface/recess, including proving and fixing suitable size GI boxes, its interconnections etc as required complete. (Note: 2 nos 5/6A socket fixed at 60cm above FFL and 2 nos 6A switch with 1no 5/6A socket at 1m above FFL)	2.00	NO	878.10	1756.20
19.15	Supply, fixing of Network point, UTP RJ45, CAT 6 modular type socket with modular plate & cover on surface or in recess, including proving and fixing suitable size GI box, inter connection etc as required complete.	2.00	NO	815.68	1631.36
19.16	Supplying and fixing modular blanking plate on the existing modular plate & switch box excluding modular plate as required.	5.00	NO	30.08	150.40
19.17	Supplying and fixing of following 20 mm sizes of medium class PVC conduit along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required.	20.00	M	99.61	1992.20
19.18	Supplying and fixing of following 25 mm sizes of medium class PVC conduit along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required.	30.00	M	94.19	2825.70
19.19	Supplying and fixing of following 32 mm sizes of medium class PVC conduit along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required	30.00	M	112.26	3367.80
19.20	Supplying and fixing of following 40 mm sizes of medium class PVC conduit along with accessories in surface/recess including cutting the	20.00	M	191.12	3822.40

	wall and making good the same in case of recessed conduit as required.				
19.21	Supplying and fixing of following 25 mm sizes of medium class steel conduit along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required.	20.00	M	135.93	2718.60
<b>20.00</b>	<b>MCB s AND MCB DISTRIBUTION BOARDS</b>				
20.01	Supply, Installation, Testing & Commissioning of Single channel digital time switch with auto-manual option+ 25A power contactor in suitable CRCA steel enclosure duly painted with powder coated finishing on surface including all the mounting accessories, internal wiring etc as required complete. Timer, Modular contactor, Power contactors of approved make	1.00	NO	2351.45	2351.45
20.02	Supplying and fixing of 4 way (8 + 12) ways surface/ recess mounting, vertical type, 415 volts, TPN MCB distribution board of sheet steel, dust protected, duly powder painted, inclusive of 200 amps tinned copper bus bar, common neutral link, earth bar, din bar for mounting MCB's (but without MCB's and incomer ) as required. (Note: Vertical type MCB TPDB is normally used where 3 phase outlets are required.)	2.00	NO	10330.85	20661.70
20.03	Supplying and fixing following way, single pole and neutral, sheet steel, MCB distribution board, 240 volts, on surface/ recess, complete with tinned copper bus bar, neutral bus bar, earth bar, din bar, interconnections, powder painted including earthing etc. as required. (But without MCB/RCCB/Isolator) 12 way, Double door	1.00	NO	4692.35	4692.35
20.04	Supply and fixing of following 4 pole 40 amps. (415 Volts), 100mA sensitivity rating residual current circuit breaker with MCB having earth leakage and overload protection (RCCB+MCB) as per specification as required	1.00	NO	5052.86	5052.86
20.05	Supply and fixing of following 4 pole 25 amps. (415 Volts), 100mA sensitivity rating residual current circuit breaker with MCB having earth leakage and overload protection (RCCB+MCB) as per specification as	1.00	NO	4422.75	4422.75

	required				
20.06	Supply and fixing of following 2pole 25 amps. (240 Volts),30mA sensitivity rating residual current circuit breaker with MCB having earth leakage and overload protection (RCCB+MCB) as per specification as required	1.00	NO	2898.28	2898.28
20.07	Supply and fixing of 6A to 32A, SP, B/C-CURVE following rating, 10 KA, Miniature Circuit Breakers as required.	14.00	NO	251.64	3522.96
20.08	Supply and fixing of 6A to 32A, TP, B/C-CURVE following rating, 10 KA, Miniature Circuit Breakers as required	5.00	NO	1030.88	5154.40
20.09	Supplying and fixing single pole blanking plate in the existing MCB DB complete etc. as required.	5.00	NO	21.02	105.10
20.10	Supply and laying of UPVC cable management system of size 150 mmx 50mm including all accessories such as plastic trucking 150 mmx 50mm, flexible cover, base joint, end cap, flat angles, flat junctions, external angles etc., as required complete.	50.00	M	6070.42	303521.00
20.11	Supply installation, testing and commissioning of outdoor (IP 54 ) DOL starter upto 5 HP, 3ph motor including auxiliary contactors, SPP relay , illuminated pushbuttons, provision for remote operation all the necessary accessories as required complete. The starter enclosure shall be made of powder coated 1.6 mm CRCA sheet.	2.00	NO	3005.15	6010.30
20.12	Supply and fixing outdoor type START/STOP (2way) push button station (IP65) of approved make including all the necessary accessories as required complete with suitable mounting arrangement	2.00	NO	2438.45	4876.90
20.13	Supply and fixing cable end boxes IP43 for 4 way,TPN DB with necessary bolts and nuts etc. as required .	2.00	NO	922.75	1845.50
20.14	Supply and fixing cable end boxes IP43 for 12 way, SPN MCB DB with necessary bolts and nuts etc. as required.	1.00	NO	905.91	905.91
20.15	Supply and fixing of IP 66 junction box for direct access to cables with necessary accessories as required.	22.00	NO	867.92	19094.24
<b>21.00</b>	<b>LIGHT FIXTURES AND FANS</b>				
21.01	Supply of indoor decorative surface mounted LED Batten with Polycarbonate diffuser, along with driver, system wattage of maximum 10Watts,lumen output of luminaire	2.00	NO	293.00	586.00

	greater than 1000, power factor >0.9, rated life of L70 @ 25,000 hours, system efficacy greater than 100 lumen/watt and including all the necessary accessories as required complete.				
21.02	Supply of LED recess mounted down light made of die cast aluminum, along with driver, system maximum wattage of 12 Watts with lumen output of luminaire greater than or equal to 1200 lumens, power factor > 0.95, THD <10% rated life of L70@ 50,000 hours, system efficacy greater than or equal to 100 lumen/Watt and including all necessary accessories as required complete.	2.00	NO	1300.88	2601.76
21.03	Supply of recess mounted LED panel light fixture made of die cast aluminum with corrosion resistance powder coating and with proper diffusers, along with driver, system wattage of maximum 36 Watts with lumen output of fixture greater than or equal to 3600 lumens, power factor > 0.9, rated life of L70 @ 50,000 hours, system efficacy greater than 100 lumen/watt and including all necessary accessories as required complete	2.00	NO	4840.00	9680.00
21.04	Supply of LED high bay Lighting luminaire of, pressure die cast aluminum housing body with optimal heat sink, with system wattage of maximum 60 W with rated life of L70 @ 50,000 hours, CRI greater than or equal to 70 & with system lumens greater than 6600 and system efficacy greater than or equal 110 lumen/watt and including all necessary accessories as required complete..	2.00	NO	14680.00	29360.00
21.05	Supply of 250 mm sweep, 900 rpm light duty exhaust fan in plastic body with self opening louvers working on 230 V AC supply complete with all accessories as required.	2.00	NO	1431.00	2862.00
21.06	Supply of 10w LED Bulkhead fitting with die cast aluminum housing, PC diffuser and IP66 Protection suitable for operation on 230V 50Hz AC, wall / ceiling including giving connections with required length of 16/0.20mm PVC insulated and PVC sheathed 3 core round copper conductor flex wire and making good the surface as required.	8.00	NO	1724.00	13792.00

21.07	Supply of 400 mm size wall mounting oscillating type fan having three speed control, oscillation control at bottom and suitable for operation on single phase 230 volt, 50Hz AC supply complete with continuous duty motor, chrome plated front and rear gaurds and all accessories as required complete, of approved make	2.00	NO	1984.00	3968.00
21.08	Installation, testing and commissioning of pre-wired, fluorescent fitting / compact fluorescent fitting/LED Fitting of all types, complete with all accessories and tube etc. directly on ceiling/ wall, including connection with 1.5 sq. mm FRLS PVC insulated, copper conductor, single core cable and earthing etc. as required.	10.00	NO	163.25	1632.50
21.09	Installation, testing and commissioning of exhaust fan upto 450mm sweep in the existing opening, including making the hole to suit the size of the above fan, making good the damage, connections, testing & commissioning etc as required	2.00	NO	155.81	311.62
21.10	Installation, testing and commissioning of High bay/Mid bay/LED/ FLOOD type fittings on wall/Column/truss/false ceiling using suitable MS clamps, nuts, bolts/ 20mm heavy duty GI chain/ pipe (upto 50cm)etc including connections with 3C 2.5 Sq.mm PVC insulated flexible copper conductor cable as required.	2.00	NO	763.69	1527.38
21.11	Installation, testing and commissioning of LED down lighter fittings on false ceiling with all mounting accessories as required complete including interconnections using 3 core 1.5 sqmm FRLS PVC insulated flexible copper conductor as required.	2.00	NO	230.83	461.66
21.12	Installation, testing and commissioning of LED PANEL type fittings with GI chain and 2x2 adapter - with all accessories etc. on false ceiling including supplying and fixing of GI chain and 2x2 adapter ,hook arrangement, upto 60cm length, and wiring using 3 runs of 1.5 sqmm FRLS PVC insulated stranded copper conductor cable as required.	2.00	NO	796.84	1593.68
21.13	Installation, testing and commissioning of Wall fan, including all the supports as required and	2.00	NO	157.08	314.16

	wiring using 3 runs of 1.5 sqmm FR PVC insulated stranded copper conductor etc complete.				
21.14	Numbering of ceiling fan / exhaust fan/ fluorescent fitting as required	20.00	NO	29.30	586.00
21.15	Supply, installation, testing and commissioning of 5m long Hot dipped GI pole painted with PU coat with built- in control box prewired, with pole suitable for mounting LED luminaire with lamp , concealed wiring with 3Cx 2.5 sq.mm copper wire from the control box to light fixture, and all other accessories. complete including necessary civil foundation. Along with LED Lamp with die cast Aluminium alloy housing and polycarbonate diffuser, inbuilt driver,system wattage maximum system wattage of 25 watts, lumen outputnot less than than 2500 lumen, system efficacy greater than 100 lumen/watt ,power factor >= 0.9, IP 66 compliant including all necessary accessories as required complete. Note:Incoming and outgoing cable at termination box shall be terminated with glands properly. Unique Poles and Light fixture of approved make	18.00	No	14259.74	256675.32
21.16	Supply ,Installation and Testing of Bollard light in range of 0.6m0.8m height, Luminaire made of aluminium. Protection class IP 65.Suitable for operation on 240V, 50Hz single phase ac supply with system Wattage 11+/- 3W and Warm White fixture of Approved make	22.00	No.	4600.00	101200.00
<b>22.00</b>	<b>EARTHING AND SAFETY EQUIPMENTS</b>				
22.01	Earthing with C.I. earth pipe 3 metre long, 100 mm dia including accessories, and providing masonry enclosure with heavy duty CI cover plate of 300X300mm having locking arrangement and watering pipe etc. with 64kg charcoal/ coke and 5kg salt as required. (As per IS 3043 amended up-to-date)	1.00	NO	11891.93	11891.93
22.02	Providing and fixing 25mm X 6mm GI strip on surface or in recess for connections etc. as required.	20.00	M	190.05	3801.00
22.03	Providing and fixing 3.15mm Cu (10 SWG) wire on surface or in recess for connections etc. as required.	20.00	M	81.19	1623.80
22.04	Supplying and laying 25mm X 6mm GI strip at 0.50 meter below ground as	20.00	M	99.83	1996.60



	strip earth electrode, including connection/ terminating with G.I. nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of G.I. nut bolt & spring washer spaced at 50mm)				
22.05	Supplying and laying 3.15mm Cu (10 SWG) wire at 0.50 meter below ground as strip earth electrode, including connection/ terminating with G.I. nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of G.I. nut bolt & spring washer spaced at 50mm)	20.00	M	69.43	1388.60
22.06	Supplying and laying 8 SWG GI strip at 0.50 meter below ground as strip earth electrode, including connection/ terminating with G.I. nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of G.I. nut bolt & spring washer spaced at 50mm)	450.00	M	34.78	15651.00
22.07	Providing and fixing 8 SWG wire on surface or in recess for connections etc. as required.	80.00	M	47.93	3834.40
<b>Total Amount</b>					<b>1,90,00,979.10</b>
<b>Excess/Less (In percentage in two decimals)</b>					
<b>Quoted amount in Figures</b>					

(Quoted amount in Words Rupees .....

**Note:**

- 1) GST as applicable will be paid separately in the Tax invoice.
- 2) Contractor shall file the applicable returns with Tax department in time and submit the same as documentary evidence.

**SIGNATURE OF THE BIDDER**

**(iii) FORM OF TENDER**

NAME OF CONTRACT.....

To

The Chairman  
New Mangalore Port AUTHORITY  
Panambur  
Mangalore - 575 010

Gentlemen,

1. We have examined the Conditions of Contract, Specification, Drawings, Bill of Quantities, and Addenda Nos----- for the execution of the above-named Works, and we the undersigned, offer to execute and complete such Works and remedy any defects therein in conformity with the Conditions of Contract, Specifications, Drawings and Bill of Quantities and Addenda
2. We acknowledge that the Appendix forms part of our Tender.
3. We undertake, if our Tender is accepted, to commence the Works as soon as is reasonably possible after the receipt of the Engineer's notice to commence, and to complete the whole of the Works comprised in the Contract within the time stated in the Appendix to Tender.
4. We agree to abide by this Tender for the period of 120 days from the last date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
5. Unless and until a formal Agreement is prepared and executed, this Tender together with your written acceptance thereof shall constitute a binding Contract between us.
6. We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this \_\_\_\_\_ day of \_\_\_\_\_ 20\_\_

Signature \_\_\_\_\_ in the Capacity of \_\_\_\_\_ duly

Authorized to sign Tenders for and on behalf of \_\_\_\_\_

\_\_\_\_\_

(IN BLOCK LETTERS)

Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Witnesses

1. Signature : \_\_\_\_\_

Name : \_\_\_\_\_

Address : \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. Signature : \_\_\_\_\_

Name : \_\_\_\_\_

Address : \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

## SECTION VII

## SCHEDULE II

(See sub rule (1) of Rule 36)

Sl. No.	Name of the Mineral	Present Rate of Royalty	Royalty to be revised	
			Export	Domestic
1	Ornamental and Decorative Building Stones as defined under clause(m) of Rule 2 A)Dyke Rock (i)Black granites: (a)Chamarajanagar District:	15% of Sale Value or of Average Selling Price on advalorembasis or Rs.4,500 per m3 which is higher.	Rs.1,200 per MT	Rs.600 per MT
	(b)All other Districts other than(a)above	15% of Sale Value or of Average Selling Price on advalorem basis orRs.1,500 per m3 which is higher.	Rs.1700 per MT	Rs.400 per MT
	(ii)Other varieties of dyke other than black granites(Entire State)	15% of Sale Value or of Average Selling Price on advulorembasis or Rs.1,500per m3 which is higher.	Rs.500 per MT	Rs.375 per MT
	(B)(I)Pink and Red Granites (Ilkal Pink Variety) (i) Hungunda and BadamiTaluk of Bagalkot District, Kustagi of Koppal District.	15%of Sale Value or of Average Selling Price on advalorembasis or Rs.1,200	Rs.1,000 per MT	Rs.400 perMT
	(ii) Pink and Red Granites, Gneissess and their structural verities (other	15% of Sale Value or Average Selling Price on advalorem basis or	Rs.600 per MT	Rs.350 per MT

	than Ilkal Pink Variety)	Rs.1,800 Variety) per m <sup>3</sup> which is higher		
	C)Grey and White Granites and their varieties: (i) Very fine grained Grey granite (Siragrey Variety) Price on Chintanmi, Siddlaghattaof ChikkaballapuraDistrict Hoskote of Bangalore District.	15% of SaleValue or of Average Selling Price on advalorembasis or Rs.1,350 per m <sup>3</sup> which is higher.	Rs.500 per MT	Rs.350 per MT
	(ii) Greyand white granites and textural varieties having shades of grey, balckand white colours (other than (i) above Entire State.	15% of SaleValue or of Average Selling Price on advalorembasis or Rs.1,050 per m <sup>3</sup> which is higher.	Rs.375 per MT	Rs.250 per MT
	(iii) Grey granite of DevanahalliTaluk of Bangalore Rural District and ChikkaballapurTaluk of Chikkaballapur District	15% of Sale Value or of Average Selling Price on advalorembasis or Rs.600 per m <sup>3</sup> which is higher.	Rs.300 per MT	Rs.200 per MT
2	Felsite and its varieties suitable for use as Ornamental Stone-Entire State	15% of Sale Value or of Average Selling Price on advalorembasis or Rs.1800 per m <sup>3</sup> which is higher.	Rs.900 per MT	
3	Quartzite and sand stone and their varieties	15% of Sale Value or of Average Selling Price on	Rs.900 per MT	

	suitable for use as Ornamental Stone-Entire State	advalorem basis or Rs.1800 per m <sup>3</sup> which is higher.	
4	Marable and Crystalline Limestone as ornamental Stone-Entire State	15% of Sale Value or of Average Selling Price on advalorem basis or Rs.1800 per m <sup>3</sup> which is higher.	Rs.1000 per MT
5	Bentonite-Entire State	Rs.400 per MT	Rs.500 per MT
6	Fuller Earth-Entire State	Rs.125 per MT	Rs.125 per MT
7	Buff colour (waste) the permits not exceed 20% of permit issued For Fullers Earth	Rs.60 per MT	Rs.70 per MT
8	Limestone under the title "Shahabad Stone"	Rs.70 per 10 Sqmeters or Rs.70 per MT	Rs.50 per 10 Sqmeters or Rs.50 per MT
9	Limestone(non-cement) when used for building stone-Entire State	Rs.25 per MT	Rs.60 per MT
10	Ordinary Building Stone(Entire State as defined under clause(g) of Rule2(1))	Rs.60 per MT	Rs.70 per MT
11	Limeshell-Entire State	100 per MT	120 per MT
12	Lime Kankar(non cement) Entire State	50 per MT	80 per MT
13	Agate, Chalcedony, Flint-Entire State	240 per MT	300 per MT
14	Ordinary Sand-Entire State	60 Per MT	80 Per MT

15	Steatite and sand stone used formakinghousehold utensils / articles-Entire State.	40 Per MT	80 Per MT
16	(i)Murram (All types of soils)-Entire State	20 per MT	40 per MT
	(ii)Clay used for manufacturing tile sand bricks	40 per MT	60 per MT
17	Waste rocks generated in ornamental stone quarry- which is suitable for ornamental purpose Entire State (See explanation under Rule36)	300 per MT or 850 CUM	300perMT
18	Irregular shaped waste rock generated in Ornamental stone quarry, which is not suitable for ornamental purpose (used for making aggregates and m-sand) Entire State.	60 per MT	40 per MT
19	Waste rocks generated in Shahabad stone quarry- Entire State (See explanation under Rule-36)	60 per MT	40 per MT
20	Finished Kerb stones/cubes not exceeding 30 cms each face-Entire State.	110per MT	150 per MT
21	Barytes	6.5% of average selling price or of sale value	400 per MT
	(i) A Grade (Grey colour		300 per MT

	(ii) B Grade (Greycolour) (iii) C, D Grade &Waste	whichever is higher on ad-valorem basis	200 per MT
22	Calcite	15% of average selling price or of sale value whichever is higher on ad-valorem basis	80 per MT
23	China clay and Kaolin (including Ball clay, White shell, Fireclay and white clay) i)Crude/Raw  ii)Processed	8% of average selling price or of sale value whichever is higher on ad-valorem basis.  12% of average selling price or of sale value whichever is higher on ad-valorem basis	80 Per MT  600 per MT
24	Corundum	12% of average selling price or of sale value whichever is higher on ad-valorem basis	15% of Sale Value or of Average Selling Price on ad valorem basis which is higher.
25	Dolomite	Rs.75 per MT	100 per MT
26	Dunite and Pyroxenite	Rs. 30 per MT	60 per MT
27	Felsite (Other than for ornamental purpose)	12% of average selling price or of sale value whichever is higher on ad-valorem basis	120 per MT
28	Gypsum	20% of average selling price or of sale value whichever is higher on ad-valorem basis	150 per MT



29	Jasper	12% of average selling price or of sale value whichever is higher on ad-valorem basis	150 per MT
30	Quartz, feldspar	15% of average selling price or of sale value whichever is higher on ad-valorem basis	100 per MT
31	Mica i. Crude ii. Waste	4% of average selling price or of sale value whichever is higher on ad-valorem basis	1500 per MT 500 per MT
32	Quartzite & Fuchsite Quartzite not suitable for use as Ornamental /Gemstones	12% of average selling price or of sale value whichever is higher on ad-valorem basis	100 per MT
33	Laterite i) /dispatched for use in cement or chemical industries or Abrasive or Refractory purpose (below threshold value as specified by IBM from time to time) ii) For use as building stone (below threshold value as specified by IBM)	Rs.60 per MT	160 per MT  60 per MT
34	Ochre	Rs.24 per MT	60 per MT
35	Pyrophyllite	20% of average selling price or of sale value	200 per MT

		whichever is higher on ad-valorem basis	
36	Shale	Rs.60 per MT	150 per MT
37	Slate	Rs.45 per MT	150 per MT
38	Silica Sand	10% of average selling price or of sale value whichever is higher on ad-valorem basis	100 per MT
39	Steatite or Soapstone (Other than for household articles)	18% of average selling price or of sale value whichever is higher on ad-valorem basis	200perMT
	Talc	--	200perMT
40	All other minerals (which is not specified in schedule-II) Entire State	30% of sale value on ad-valorem basis	30% of Sale Value or of Average Selling Price on ad-valorem basis which is higher.

**SECTION VII****SCHEDULE – B****MINIMUM RATES OF WAGES****ABSTRACT OF MINIMUM RATES OF WAGES FROM RELEVANT NOTIFICATIONS**

MINIMUM RATES OF WAGES APPLICABLE IN THE BEAT OF ALC(C), MANGALORE WITH EFFECT FROM **01.10.2022**

Minimum Wages applicable "Construction or maintenance of roads, runways or in building operations including laying down underground electric, wireless, radio, television, telephone and overseas communication cables and similar other underground cabling work, electric lines, water supply lines and sewerage pipelines"-

<b>Category</b>	Area: A	Area:B	Area:C
Unskilled	711.00	595.00	477.00
Semiskilled/ Unskilled Supervisory	788.00	671.00	557.00
Skilled/Clerical	866.00	788.00	671.00
Highly Skilled	940.00	866.00	788.00

(Kindly Note: Area A: Bangalore (UA), Area B: Mangalore (UA), Mysore (UA), Belgaum (UA), Hubli-Dharwad, Area C: All other places in Karnataka not specified above as per Ministry of Labour and Employment F.No.1/16 (3)/2022-LS-II dated 28.09.2022)

"Employment of Sweeping and Cleaning excluding activities prohibited under the Employment of Manual Scavengers and Construction of Dry latrines (Prohibition) Act, 1933".

<b>Area</b>	<b>Rates of wages Rs.</b>
'A'	711.00
'B'	595.00
'C'	477.00

"Employment of Watch and Ward"-Rates of wages for employees employed in watch and ward – Govt. of India, Ministry of Labour

<b>Area</b>	<b>Without arms</b>	<b>With arms</b>
	<b>Rates of wages Rs.</b>	<b>Rates of wages Rs.</b>
'A'	866.00	940.00
'B'	788.00	866.00
'C'	671.00	788.00

For further details log on to Ministry of Employment.