

PROCUREMENT, FABRICATION, SUPPLY, ERECTION AND COMMISSIONING OF HELIOSTAT REFLECTOR DEVELOPMENT WITH TRACKING AND FLUX MEASUREMENT

Tender Number: 201601525



INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

INDEX

SECTION 1 – INVITATION OF THE BIDS

SECTION 2 – PREQUALIFICATION CRITERIA

SECTION 3 – INSTRUCTIONS TO BIDDERS

SECTION 4 TERMS AND CONDITIONS

SECTION 5 TECHNICAL BID

SECTION 6 – PRICE BID

SECTION 7– ANNEXURES

ANNEXURE 1: INTEGRITY PACT

ANNEXURE 2: EARNEST MONEY DEPOSIT

ANNEXURE 3: PERFORMANCE GUARANTEE BOND

ANNEXURE 4: FORMAT FOR DEVIATIONS / EXCLUSIONS SCHEDULE

ANNEXURE 5: PREVIOUS SUPPLY ORDER FORMAT

SECTION 8 – CHECKLIST

SECTION 1 – INVITATION OF THE BIDS

Tender Details Tender Number: 201601525 Tender Type: Open No. of Covers: 2		Tender Date: -02.03.2017 Form of Contract: Buy	
Payment Instruments Payment Mode Offline		Instrument Type: As per Tender Document	
Covers Information			
Cover No.	Cover Type	Description	Document Type
1	Technical	Tender Document, Pre-qualification responses Tender Fee, EMD, Integrity Pact and Technical Specification	.pdf
2	Commercial	Commercial Bid / Price Bid	.pdf
Tender should be submitted on the schedule to tender and returned with your covering letter in the enclosed form duly signed. Tender should be sent in the sealed cover super scribed with 'Tender Number' and Due Date. Two Bid System : The two bid system will be followed for this tender. In this system bidder must submit their offer in separate sealed envelopes as – Technical Bid and Commercial Bid. Separate technical bid and commercial bid envelopes should be clearly marked as "Envelope No. 1 - Technical Bid" and "Envelope No. 2 - Commercial Bid". Both these sealed covers are to be put in a bigger cover which should also be sealed and duly superscribed with our Tender No. & Due Date and to be submitted to the concern department/section mentioned in tender document. Note: The technical offer should not contain any price information. If the price quoted is submitted in technical bid the tender will be rejected at the sole discretion of IIT Bombay. Initially Technical Bids will be opened and evaluated by the purchase committee. Commercial bids of only Technically qualified bidders will be opened later. Contract/ Purchase Order will be awarded to the lowest bidder(L1) among them.			
Tender Fee Details			
Tender Fee(INR): 500/-		Payable to : The Registrar, IIT Bombay Payable at : Mumbai	
Earnest Money Deposit Details			
EMD Fee (INR): 7,60,000/-		In favour of : The Registrar, IIT Bombay	

EMD Fee Type: Fixed	Payable at: Mumbai		
Item Details			
Item Name	Item Description		
Appointment of vendor for procurement, fabrication , supply, erection and commissioning of Heliostat reflector development with tracking and flux measurement	This Tender document is for 'Heliostat reflector development with tracking and with flux measurement' which includes Development of indigenous heliostat reflector and method for its optical testing. This project will be implemented at NETRA at Greater NOIDA, Uttar Pradesh for testing and performance evaluation. Basic and detailed engineering of the Heliostat has been carried out by IIT B and its engineering consultant. The bidder is expected to carry out the required procurement, fabrication, supply, construction, commissioning work and supply of manpower as per the detailed engineering documents, drawings and BOM.		
Pre Qualification:	As per Tender Document	Bid Validity (Days)	180
Period of Work/			
Delivery Period	24 Weeks	Product Sub Category	N/A
Product Category	Others	Pre Bid Meeting Date &	21.03.2017
		Time	3.30 pm.
Contract Type	Tender		
Location	IIT Bombay Campus &	Pre Bid Meeting	Materials Management
	Greater Noida	Address & Place	Division, IIT Bombay
Pincode	400076		
Critical Dates			
Bid Submission End		Bid Opening Date &	30.03.2017
Date/	30.03.2017	Time	3.00 pm.
Date & Time of	1.00 pm.		
Submission			
Place of Submission	Materials	Bid Opening Place	Materials Management
	Management Division,		Division, IIT Bombay
	IIT Bombay		
Other Condition : Suppliers should mentioned at least two purchase order details in the previous order format and to be enclosed in the technical bid along with the necessary document.			
Warranty : Warranty as per mentioned in technical specifications.			

Technical Clarification Name: Dept: Email: Contact No.	Prof. Shireesh B. Kedare Dept. Of Energy Science & Engg. sbkedare@iitb.ac.in 022-25767835
Tender Inviting Authority Name: Address: Date: -----	Joint Registrar Materials Management Division, IIT Bombay, Powai, Mumbai 400076 Signing Authority: Joint Registrar (MM)

SECTION 2 – PREQUALIFICATION CRITERIA

Pre-qualification criteria and process along with details and format of data to be submitted for selection:

Two bid system will be followed wherein the technical bids will be opened first and evaluated. Bidders whose technical bids are acceptable as per the selection criteria (elaborated below), will be considered for opening of the respective commercial bids. Detailed format for the data to be submitted for the technical bid is given below:

1. Bidder quoting as a consortium of entities shall provide documentary evidences (letter from each entity / MOU / board resolution etc.) of such consortium along with the technical bid. The document forming the basis of the consortium shall explicitly state the division of the various works involved in this bid between the members of the consortium. The bidder shall not make any change in the consortium until successful completion of the contract.
2. The bidder on its own should have successfully executed at least one multidisciplinary procurement, construction and commissioning project of value not less than Rs .100 Lakhs during last 5 (five) years ending 31st Mar 2016 involving mechanical, electrical, instrumentation controls and civil works.
3. The bidder on its own or through its consortium partner / s should have successfully executed minimum 2 projects involving manufacturing of specialized equipment / machinery with high degree of skills and accuracy of millwright fitting (normally expected machine tolerances) for equipment / machinery with large dimensions.
4. The bidder on its own or through its consortium partner / s should have successfully executed minimum 3 projects involving procurement, supply, and installation and commissioning of PLC systems with SCADA.
5. Bidder (including all consortium partner /s) shall submit information sought below of successful completion of the works meeting the criteria stated above and other works executed in the last three years. A purchase committee may also choose to get the feedback from bidder's client to check the fulfillment. Following information / documents shall be provided of the works executed.
 - a. Name of the client with corporate address, site address
 - b. Name of contact person/s and phone/email of the contact person
 - c. Description and scope of job (mechanical, electrical, instrumentation controls and civil works, manufacturing of specialized equipment / machinery with high degree of skills and accuracy of the millwright fitting { normally expected machine tolerances }, procurement, supply, and installation and commissioning of PLC systems with SCADA)
 - d. Order value in Indian Rupees
 - e. Year of start and job completion
 - f. Documentary evidence provided, like copy of POs, reports, appreciation letters, etc.

6. Bidder (including all consortium partner /s) shall submit financial statements such as balance sheets and P&L statements of the last 3 financial years.
7. The decision of the purchase committee on the eligibility of the bidder shall be final and binding on the bidder.

Commercial bid:

All bids qualifying the prequalification criteria will be stand eligible for opening of commercial bid.

Bidder with lowest commercial bid will be awarded the contract.

SECTION 3 – INSTRUCTIONS TO BIDDERS

Preparation and Submission of offers:

- The Quotation MUST BE ENCLOSED IN A SEALED COVER superscribing Tender number / due date & should reach the undersigned on or before due date mentioned in the tender notice. If the quotation cover is not sealed, it will be rejected.
- Tender should be dropped in the tender box kept in the office of concerned Department / Section or to Indenter. No tender is to be handed over to our staff personally unless otherwise specified. All communications are to be addressed to the undersigned only. In case due date happens to be holiday the tender will be accepted and opened on the next working day.
- The bid can be submitted in person or through post/ courier (IIT Bombay shall not be responsible for any postal delays or any other reason for not submitting the bid in the specified time and resulting in disqualification / rejection of any bid) so as to reach on or before the due date and time.
- **Leaflets, catalogue, additional informations, etc. should be sent invariably so that a proper evaluation of the equipment offered is possible.**

Cost of Bidding:

- The Bidder shall bear all costs associated with the preparation and submission of its Bid and the Purchaser shall not be responsible or liable for those costs regardless of the conduct or outcome of the bidding process.

Validity of the Bid:

- 180 Days from the last date of submission of bid.

Amendment of Bidding Documents:

- At any time prior to the deadline for submission of bids, IIT Bombay may, for any reason, whether on its own initiative or in response to the clarification request by a prospective BIDDER may modify the bid document.
- All prospective BIDDERS who have downloaded the bidding document may visit IIT Bombay, website for amendments / modifications which will be binding on them.

Deadline for Submission of Bids

- Bids must be received by IIT Bombay before the due date and time at the address specified in the tender document. In the event of the specified date for the submission of bids being declared as a holiday for IIT Bombay the bid closing deadline will stand extended to the next working day up to the same time.

Late Bids:

- IIT Bombay will not be responsible:

- i) For delayed / late quotations submitted / sent by post / courier etc.
- ii) For submission / delivery of quotations at wrong places other than the mentioned in the tender.
- iii) Fax / Email / Telegraphic / Telex tenders will not be considered.
- iv) Any bid inadvertently received by IIT Bombay after the deadline i.e. due date & time for submission of bids, will not be accepted and returned unopened to the BIDDER.

Supplementary offer /Modification of Original Bid:

- Tender submitted against Notice Inviting Tender (NIT) shall not be returned in case the tender opening date is extended/postponed. BIDDER desirous to modify their offer/terms may submit their revised/ supplementary offer (s) within the extended Tender Opening Date (TOD) by clearly stating to the extent of updation done to the original offer. The purchaser reserves the right to open the original offer along with the revised offer.

Confidentiality:

- Information relating to the evaluation of Bids, and recommendation of Contract award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on Contract award is communicated to all Bidders.
- Any attempt by a Bidder to influence the Purchaser in the evaluation of the Bids or Contract award decisions may result in the rejection of its Bid.
- Notwithstanding, from the time of Bid opening to the time of Contract award, if any Bidder wishes to contact the Purchaser on any matter related to the bidding process, it shall do so in writing.

Deviation, Reservations and Omissions:

- During the evaluation of Bids, the following definitions apply:
 - a) "Deviation" is a departure from the requirements specified in the Bidding Documents;
 - b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Documents; and
 - c) "Omission" is the failure to submit part or all of the information or documentation required in the Bidding Documents.

Correction of Arithmetical Errors:

- Provided that the Bid is substantially responsive, the Purchaser shall correct arithmetical errors on the following basis:
 - (a) if there is a discrepancy between the unit price and the line item total that is obtained by multiplying the unit price by the quantity, the unit price shall prevail and the line item total shall be corrected, unless in the opinion of the Purchaser there is an obvious misplacement of the decimal point in the unit price, in which case the line item total as quoted shall govern and the unit price shall be corrected;
 - (b) if there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and
 - (c) if there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) and (b) above.

Bidders shall be requested to accept correction of arithmetical errors. Failure to accept the correction in accordance with the same, shall result in the rejection of the Bid.

Evaluation of Bid :

- IIT Bombay evaluate technical and commercial acceptable offers on landed net Price basis.
- In case any BIDDER is silent on any clauses mentioned in this tender documents, IIT Bombay shall construe that the BIDDER had accepted the clauses as per the invitation to tender no further claim will be entertained.
- No revision in the terms and conditions quoted in the offer will be entertained after the last date and time fixed for receipt of tenders.

Corrupt & Fraudulent Practices:

- IIT Bombay requires that bidders, suppliers, contractors and consultants, if any, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuit of this policy,
 - (a) The terms set forth below are defined as follows:
 - i) "Corrupt practice" means the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the action of a public official in the procurement process or in contract execution;
 - ii) "Fraudulent practice" means a misrepresentation or omission of facts in order to influence a procurement process or the execution of a contract;
 - iii) "Collusive practice" means a scheme or arrangement between two or more bidders, designed to establish bid prices at artificial, noncompetitive levels; and
 - iv) "Coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the procurement process or affect the execution of a contract;
 - (b) IIT Bombay will reject a proposal for award if it determines that the Bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive or coercive practices in competing for the Contract in question.

Communication for Nonparticipation of Tenders:

- For registered vendors with IIT Bombay, in case you choose not to participate in the tender a regret letter by way of fax/letter/email may be submitted before the due date duly superscribing "Regret" and tender No. If no communication received by the due date and time, it shall be inferred that you are not interested in participation and your name is liable to be removed from the vendor's list.

Cancellation of Tender:

- Notwithstanding anything specified in this tender document, Purchaser / IIT Bombay in his sole discretion, unconditionally and without having to assigned any reasons, reserves the rights:
 - a) To accept OR reject lowest tender or any other tender or all the tenders.
 - b) To accept any tender in full or in part.
 - c) To reject the tender offer not confirming to the tenders terms.
- To give purchase preference to Public Sector undertakings when applicable as per Govt. Policy/ Guidelines.
- Offer which deviates from the vital conditions (as illustrates below) of the tender shall be rejected:
 - d) Nonsubmission of complete offers.
 - e) Receipt of offers after due date and time and or by email / fax (unless specified otherwise).
 - f) Receipt of offers in open conditions.

Price Bid:

- **Bid Prices MUST BE SUBMITTED IN ENCLOSED PRICE BID FORM ONLY.**
- **If the price is not quoted in Price Bid Form provided in tender document then, IIT Bombay will reject bid. If supplier wish to give pricing details may be attached in separate sheet.**
- Any new taxes and duties liable on the subject contract due to change in legislation during the contract period shall be reimbursed subject to the applicability of the said act to the satisfaction of the purchaser and the production of documentary evidence after availing of statutory concession, benefits etc.
- The supplier shall pay and bear all other liabilities, taxes and duties not specifically agreed by the Purchaser in the contract.
- VAT/Other Govt. Taxes : Excise Duty (ED), other taxes, levies, like Service Tax (ST), Education Cess, etc., are to be indicated separately. BIDDER should mention Central and State Sales Tax/VAT Registration, PAN Number are to be necessarily indicated in the offer.
- **We are not authorised to issue any Sales Tax forms like form “C” & “D”.**

Legal Matter:

- All Domestic and International disputes are subject to Mumbai Jurisdiction Only.

Transfer and Subletting:

- The seller shall not sublet, transfer, assign or otherwise part with the acceptance to the tender or any part thereof, either directly or indirectly, without the prior written permission of the Purchaser.

Force majeure:

- Force Majeure will be accepted on adequate proof thereof.

Penalty/ Liquidated Damages:

- Timely delivery is essence of the contract and hence if any consignment be delayed, liquidated damages at the rate 0.5% of the price of the delayed consignment, for each week or part whereof shall be levied and recovered subject to maximum of 10% of total purchase order value.
- IIT Bombay reserves the right to cancel the order in case the delay is more than 10 weeks. Penalties if any will be recovered by forfeiting PBG.

SECTION 4 – TERMS AND CONDITIONS

1. Procurement, Construction and Commissioning (PCC) Contract for “Heliostat Reflector Development with Tracking & Flux Measurement” shall be a FIXED PRICE Lump sum Contract.
2. Bidder shall ascertain all work item quantities in conformity to Tender Drawings and quote FIXED Lump sum PRICE. The price shall be inclusive of procurement, construction, fabrication, erection, erection, testing, commissioning including all labour costs, taxes, duties, charges, loading, unloading, transport, storage, safe-keeping, insurance, statutory payments towards material and labour etc. complete. The bidder shall also submit prices of cost drivers as sought in the price bid. The prices shall remain firm for six months from the date of submission of the bid. For successful bid, the prices shall remain firm for the entire duration of the contract including any extension thereof.
3. The bidder is requested to visit the site before bidding to inspect the site and its surroundings and ascertain and satisfy himself in all respects to understand the site and surroundings, the development necessary by way of site clearing, filling, drainage, access roads, fences, sheds, material required for temporary and / or construction power and water, permits and procedures etc. to estimate all costs related to the work. No extra claims of any nature on any misunderstanding or otherwise shall be allowed. The site visit shall be conducted entirely at bidder's cost.
4. It is not the intent to specify herein all aspects of engineering and construction. The Bidder shall provide all materials, equipment and services, specified or otherwise (unless specifically excluded) which are required to fulfill the intent of ensuring operability and the reliability of the complete system covered under this specification.
5. The bidder shall state construction power in the bid document. The bidder shall arrange for construction and potable water as stated elsewhere in this document.
6. The bidder shall submit Quality Assurance Plan for all items of supply and execution along with the bid document. However, such plan shall not be limiting / binding on the client for the bidder's supplies / work to meet the stated / required quality of work and shall be duly extended as per instructions and requirements to ensure compliance with the requirements and specifications.
7. The bidder shall not state any clarifications, assumptions in the offer. Clarification, if any required, shall be obtained by the bidder before submission of the bid.
8. Security of all materials at site for the project shall be in the bidder's scope.
9. Any failure on the part of the bidder to progress with / complete the work / rectify work defects including those informed during pre-commissioning (refer pre-commissioning section above) as per schedule will entitle the client / DEC to deploy resources as required to complete the work and recover all such costs towards deployment of the resources at twice the cost incurred by the client from pending bills or the security deposits of the contractor. The decision of the client in this regard shall be final and binding on the contractor.
10. Since the project is a solar based power plant, there might be a chance that the solar component cannot be operates/ tested owing to weather condition. During that phase the manpower required for solar component requires demobilization till the next sunny months as, would be informed by DEC. The bidder must arrange for demobilization and subsequent remobilization of manpower at site depending on the requirement.
11. All drawings issued for this tender shall not be reproduced in any manner and shall only be used for the purpose of bidding. All the drawings shall be returned by unsuccessful bidders for refund of their bid security amount / EMD. The drawings shall be collected from the project office of IITB.
12. Bidder shall also furnish Item Rates and amount against all “Cost Driver Items of Price Bid”. This shall form basis to arrive at compensation towards additional work ordered / reduction for deleted work, if any.

Detailed phased payment schedule linked to the deliverables along with expected time line is mentioned below.

Delivery linked payment schedule:

PCC Contractor can raise one invoice per calendar month, as per Delivery / Site Activity Linked Payment Schedule

Delivery / Site Activity Linked Payment Schedule			
Sr. No	Key Deliverables	Payment (%)	Delivery in Weeks from PO Date
1	Completion of Heliostat Foundations	10.0 %	6
2	Completion of RCC Work of Receiver Tower Building	10.0 %	8
3	Site Delivery Of Fabricated & Inspected Structural of Receiver Tower Building	10.0 %	8
4	Site Delivery Of Heliostat Drive Mechanism, duly Inspected	20.0 %	7
5	Site Delivery Of Fabricated & Inspected Structural of Heliostat	7.5 %	6
6	Electrical & Controls Items: Site Delivery Of Inspected Goods	7.5 %	9
7	Erection & Testing of Heliostats	2.5 %	12
8	Completion of Civil Work Finishes at Receiver Tower Building	5.0 %	10
9	Dummy Receiver & Focus Fixtures: Site Delivery Of Inspected Goods	1.0 %	9
10	Dummy Receiver & Focus Fixtures: Erection, Testing & Commissioning	0.5 %	11
11	Cleaning Mechanism: Site Delivery ,Assembly , Testing & Commissioning at Site	4.0 %	11
12	Completion of “ All Supply and Site Construction Work ” including “ General Civil & Structural Work ”	6.0 %	11
13	Installation, commissioning and Successful Testing of Heliostats with Tracking Mechanism, Optical Configuration, Tower and Dummy Receiver, Cleaning Mechanism and Controls	6.0 %	13
14	Commissioning and Testing of Heliostat System with Actual Receiver	5.0 %	16
15	Project Handover	5.0 %	19

The bidder should quote in the above schedule, the period of Delivery from PO Date for Key Deliverables Listed so as to fit within an overall delivery period not exceeding 20 weeks from the date of Letter of intent / PO whichever is earlier. The overall delivery period shall be inclusive of design (bidder scope items – see scope matrix), procurement, fabrication, construction, erection, testing, pre-commissioning, commissioning, documentation, training etc. complete.

SECTION – 5 TECHNICAL BID

Project Brief:

This project of Indian Institute of Technology, Bombay, is targeted towards development and setup of indigenous 3.5 MWe x 24 hour/day Solar Thermal Power Plant.

Setting up of the above mentioned indigenous Solar Thermal Power Plant now requires development and testing of prototypes of various CSP components conceptualized till now and experimented with. This prototype development and testing is being taken up as three R&D projects mentioned below;

1. Linear Fresnel Reflector (LFR) based collector development with receiver and steam storage.
2. Molten salt loop with central receiver, salt storage and heat exchanger.
3. Heliostat reflector development with tracking and flux measurement.

These three R&D projects are being taken up in parallel.

The heliostat project, to which this tender document pertains, is caters to the development and set up of 8 nos. heliostats and central receiver tower. The heliostats will track the sun and reflect the beam radiation onto the receiver supported on the central tower. The manufacturing and installation of the heliostats will require high level of precision. The design details of the project will be provided by the Design & Engineering Consultant M/s. Clique Consultants Pvt. Ltd., appointed by Indian Institute of Technology, Bombay. The scope of the project is the procurement, construction, fabrication, erection, testing and commissioning of the heliostat foundations, heliostats (including reflectors etc), central tower, instrumentation and controls as per the directions, designs, documents and instructions of IITB through its consultant.

The 3 projects will be integrated at the end of successful commissioning and testing of each project independently. Subsequently, the entire system of the 3 projects is expected to deliver turbine quality steam.

The project is to be executed at NTPC-NETRA, Greater Noida, Uttar Pradesh.

Scope of work:

The scope shall include all the structures and units as shown in the overall layout in the attached drawing **C529/TND/GA/A0/903-P2** and all other drawings and details as per this tender.

Note:

Hard copies of all tender drawings mentioned in this tender document will be supplied separately on request by the interested bidder. Please, email us your intention of applying to this tender in-order to get the drawings.

Email ID for correspondence: heliostat.iitb@gmail.com

The work includes:

- a. Civil work including foundation, roads etc.
- b. Structural steel work for heliostats (and parts thereof) and receiver tower etc.
- c. Handling, assembly etc. of reflectors.
- d. Electrical system including PV system, battery etc.
- e. Instrumentation and controls including PLC etc.
- f. Control room, interiors, furnishings, furniture etc.
- g. Safety signage, displays, safety equipment, etc.

In general the inclusions of the scope will include items and activities described in the following sections:

1. Heliostat civil foundations
2. Heliostat structure
3. Heliostat drive mechanism
4. Heliostat tracking and control
5. Reflector optics
6. Receiver Tower and foundations
7. Dummy Receiver
8. Reflector Cleaning Mechanism
9. Instrumentation.
10. Electrical systems

11. Pavings, Roads, Pathways and drains
12. Supply of mandatory tools, tackles, spares
13. Construction of temporary office for IITB and DEC.
14. Construction stores
15. Pre-commissioning including heliostat testing
16. Commissioning
17. Special notes
18. Scope matrix.

The above sections are elaborated below:

Heliostat civil foundations:

The foundation shall be of Reinforced cement concrete of M25 grade of concrete with Fe500 reinforcement as per drawings and details issued by the DEC (refer drawing list).

Heliostat Structure:

Configuration:

The platform to support the mirrors (Heliostat structure) shall be a flat top structure made up of Structural Steel. It will support the mirror frames and if required, the cleaning mechanism. Each Heliostat shall have an aperture area of about 100 sqm and overall shape shall be square.

Coating:

All the structural components shall be spray galvanized as per specifications

The General arrangement Scheme is shown in the attached drawing **C529/TND/GA/A1/905-P2**

Heliostat Drive Mechanism:

Configuration:

The mechanism shall be designed to suit the purpose and specifications defined in the specification sheet stated later in this section. The horizontal axis shall be rotatable from a horizontal to near vertical position. The vertical axis shall be rotatable 100 deg. each towards East and West from the mean position towards the tower.

Design:

As described above, the mechanism shall be designed for a wind velocity of 15 m/sec during its operation and shall have a provision to park and lock automatically during the velocities greater than 10 m/s. Survival wind speed shall be 50 m/s with the heliostat parked and locked.

The design and selection of the components of the mechanism shall be such that the required tracking accuracy and parking within the time period as per specifications.

The whole mechanism shall be well supported by a steel platform which shall have the provision to lock both the mechanisms during stormy wind conditions. The locks shall be operated automatically on sensing the wind velocity crossing the limiting value.

The whole drive mechanism shall be assembled at workshop and tested for a smooth operation (devoid of undue noise, rattling, abrupt resistance to movement etc. as may be detected in manual trials and measurement of electrical power consumption etc. The accuracy and performance parameters as defined in the technical specifications of the mechanism shall be demonstrated by the bidder.

The Conceptual drawing is attached drawing **C529/TND/GA/A1/906-P1**.

Please refer specification sheet in the technical specification section (refer index).

Heliostat tracking & Controls

The logic for tracking will be by developed by others. The hardware and software for the same shall be as per the specifications **C529/I&C/SP/A4/517**.

The centralized Programmable Logic Controller (PLC) based control system is envisaged for the Heliostat Controls. The overall system architecture shall be as detailed in the specifications

Reflector optics

Mirrors shall be free issue at site. The mirrors shall be handled with care to ensure that there is no breakage during the entire assembly process. In case of any breakage / damage to the mirror and coating thereof rendering the mirror useless for the intended purpose while handling, storage etc. after the issue to the bidder, it will be the bidder's responsibility to arrange for replacement of the mirrors of identical specifications. All interim storage arrangements from issue of the mirrors to installation on the structure and for any rework will be in the scope of the bidder. Each mirror shall be placed in a steel frame and pasted to it using Industrial adhesive as stated in the drawings and details as directed by the EIC. The mirror frames shall be placed on the supporting structure as per drawings, details and instructions of the EIC.

Testing

After placing the mirror frames, on top of the supporting structure, further work of fixing etc. will be carried out by others with labour supplied by the bidder. The estimated quantum for labour required to be provided by the bidder is estimated as unskilled, 70 man days. The bidder shall supply a one no. truck / tractor mounted aerial access platform as per specifications stated in cost drivers (price bid mechanical items).

Receiver Tower:

Concept

The central tower in a Heliostat project supports the receiver on top of it at a height of about 33 m. It shall be placed on the South of the solar field. It shall also support a focus plate (calibration screen), dummy receiver, focus fixture and other fixtures on it. Additionally, it will also house some thermal equipment and the central Control Room.

Material of Construction:

The structure shall be of Mild steel fabricated as per IS: 800 using steel conforming to IS: 2062. It shall be painted as per the specifications.

Foundations shall be of reinforced concrete using M25 concrete mix and reinforcement for the same shall be FE500 conforming to IS 1786.

All concrete work shall be painted with a painting system so as to protect the same for its 25 years of life.

In addition suitable protection is to be provided to the parts of the building directly exposed to the concentrated sun light from the heliostats.

The General Arrangement Scheme is shown in the attached drawing **C529/AR/GA/A1/132 P0-**.

Dummy Receiver:

Configuration:

The dummy receiver consists of an assembly of 121 receiver plates with K type thermocouples fixed on the rear side with thermocouple clamping plates bolted to the receiver plates. A column of 11 receiver plates will be fixed to one end of pipe supports which will be fixed to a single cooling pipe at other end. 11 such cooling pipes will be attached 2 horizontal headers at both ends (top and bottom). The complete assembly of the 121 receiver plates, 121 thermocouples, 121 thermocouple clamping plates, 11 vertical

cooling pipes and 2 horizontal headers shall form the dummy receiver. The dummy receiver will be mounted on the central tower in front of the actual receiver. On completion of testing, the bidder shall obtain written approval from the client. The scope also includes dismantling the dummy receiver after successful completion of testing, lowering to ground, dismantling as directed, including disconnection and removal of thermocouples etc. and handing over to stores as directed by EIC

The General Arrangement Scheme is shown in the attached drawing **C529/TND/GA/A1/172- P0**.

Mobile Reflector cleaning system:

Configuration:

It is a semiautomatic system. The cleaning arrangement will consist of cleaning brushes mounted on a rotating horizontal cantilever shaft reaching the centre of the heliostats. One end of the shaft will be fixed with drive on a rotating column mounted on a 5 MT diesel operated truck. The cleaning arrangement will also consist of water jets along the length of the shaft. The jets will be supplied with water from a pump mounted and operated from the truck. The Entire construction of the mobile reflector cleaning system shall be as per drawings and details issued by the DEC.

Instrumentation:

The contractor shall supply following items:

Sr.no.	Items	Specification reference (Annexure)
1	PLC system	C529/I&C/SP/A4/517
2	Image processing server based system along with camera units and mounting, controller, interfacing hardware	C529/I&C/SP/A4/508
3	Instrumentation cables	C529/I&C/SP/A4/502
4	Set of pyranometers	C529/I&C/SP/A4/504
5	Set of anemometers	C529/I&C/SP/A4/505
6	Proximity sensors	C529/I&C/SP/A4/506
7	Ambient temperature sensor	C529/I&C/SP/A4/507
8	instrument junction box	C529/I&C/SP/A4/510
9	instrument cable glands	C529/I&C/SP/A4/511
10	instrumentation cable tray	C529/I&C/SP/A4/512

Sr.no.	Items	Specification reference (Annexure)
11	instrument tubing and fittings	C529/I&C/SP/A4/513
12	Software	as defined in the instrumentation section

Electrical system:

All electrical system for the project shall be provided as per specifications stated in this tender and annexure thereto.

Pavings, Roads, Pathways and drains:

Pavings, Roads, Pathways and drains shall be constructed as per attached drawing **C529/TND/GA/A2/908-P1** and specifications attached.

Supply of Spares:

Within the cost quoted, the contractor shall supply mandatory spares, tools and tackles as per annexures.

Construction office for IITB and DEC:

The contractor shall, within the cost quoted, provide a site office for the IITB and DEC representatives in portable container / porta-cabin construction, air conditioned, thermally insulated, furnished with 8 nos 4' x 2' tables, steel structure with laminated plywood top, reclining, fabric covered cushioned chairs with PU arms-rest and castors, electrical connections with 3 x 5 amp x 3 pin switch socket at each table for computers etc., main MCB DB, 2 nos wall mounted / ceiling mounted fans, 6 sliding aluminum glazed tinted windows with curtains, heavy aluminum partially glazed door with door spring, lock etc. including temporary power supply to the office as required, earth pits etc. complete. All maintenance of the office and the internals including electrical etc. provided by the contractor shall be in the contractor's scope for the entire duration of the project.

The above construction office shall be besides the contractor's own requirement of office space, fabrication yard, stores etc. which shall be constructed including land development, within the site.

The construction office shall be withdrawn by the contractor from the site on completion of the project or as directed by EIC.

Construction stores:

The bidder shall, within the overall cost quoted, develop and construct a 120 sqm (about 8m x 15m) covered and enclosed space for storage of the mirrors and for all work related to assembly on mirror frames etc.as per drawings and details **C529/AR/GA/A1/021-P1**.

The above space shall be besides the contractor's own requirement of office space, fabrication yard, stores for work in progress items etc. which shall be constructed including land development, within the site.

Testing and Pre-commissioning

- a. System testing / start-up (pre-commissioning) for the various systems in the plant would be carried out under the supervision of the consultant. The contractor shall furnish, as part of his work at no additional cost, on round the clock basis, skilled personnel and supervision, to carry out the same. The number and category of skilled personnel to be deployed by the contractor shall be decided by the Engineer-in-charge in advance and the contractor shall provide such personnel as and when required by him.
- b. System testing would include drive mechanisms, PV systems, PLC systems, radiation sensors, anemometers, battery charging system and all such systems and equipment in the scope of supply of the contractor.
- c. Pre-commissioning will also include sequential testing of heliostats with focus checking structure as well as dummy receiver at tower with dummy receiver cooling system for a period of at least about 2 months of good solar period (March to May, both months included).The contractor may be permitted on request to demobilize manpower if good solar period is not available immediately (on completion of all other work) after written approval from engineer in charge. The contractor shall remobilize manpower upon intimation of good solar period. However, the contractor will not be entitled to make any claim for extra amount for demobilization / remobilization on any account whatsoever.
- d. All tools, tackles (except some special tools) shall be provided by the contractor along with skilled personnel.
- e. Defects noted during these tests shall be rectified by the contractor at his own cost, if the defects are attributable to the contractor's work.
- f. After completion of system startup (pre commissioning) shall be commenced and any defects noticed in the plants, which are attributable to the contractor shall be attended to by the contractor at his own cost, as and when they are brought to his notice by the owner. The owner shall have the right to have these defects rectified at the risk and cost of the contractor if he fails to attend to these defects immediately. After the operating conditions

are fully achieved in all the plants and the requirements stated elsewhere in this Contract are fulfilled, the contractor would be eligible for applying for completion certificates.

Commissioning:

- a. Entire system will be commissioned as per directions of the Engineer-in-charge
- b. The contractor will provide required assistance with required manpower including engineers, technicians, labourers etc. as described in pre-commissioning.

Scope matrix:

Sr. no.	Work	Responsibility		
		Bidder	Client	Consultant
A	Overall, detailed, weekly planning schedule, safety and statutory compliances, site supervision and management	R ¹	A ²	A
B	QA for all supplies and work including documentation	R	A	A
C	Clearing site of grass, dirt, debris and disposal outside premises	R	A	A
D	Site office for client, consultant			
1	General description and requirement statement	-	A	R
2	Design, procurement, erection, furnishing, dismantling, removal, reinstatement of clear land	R	A	I ³ , A
E	Temporary cement godown, design, procurement, construction, erection, dismantling, removal, reinstatement of clear land	R	-	I, A
F	Stores for client supplies, items covered under scope of supply (excludes bidder's stores) – design, procurement, construction, erection, dismantling, removal, reinstatement of clear land	R	A	I, A

¹ R - Responsible for the activity / document
² A - Has the approving / acceptance authority
³ I - Inspection (only at site)

Sr. no.	Work	Responsibility		
		Bidder	Client	Consultant
G	Bidder's site office, stores - design, procurement, construction, erection, dismantling, removal, reinstatement of clear land	R	-	A
H	Heliostat foundations			
1	Layout drawing and RC details	-	A	R
2	Survey, setting out, marking etc.	R	-	S ⁴ , I, A
3	Procurement, Construction, completion	R	A	S, I, A
4	Cube tests, slump tests etc.	R	-	W ⁵ , A
I	Heliostat structure			
1	Design, Fabrication drawings, BOM, specifications	-	A	R
2	Procurement, fabrication, finishing, assembly, finishing, erection	R	-	S, I, A
3	Material sampling, testing, documentation	R	-	W, I, A
J	Heliostat drive mechanism			
1	Design, Fabrication drawings, BOM, specifications	-	A	R
2	Procurement, fabrication, finishing, assembly, finishing, erection	R	-	S, I, A
3	Testing, precommissioning, commissioning	R	W, A	S, I, A
4	Material sampling, testing, documentation	R	-	W, I, A
K	Reflector optics			
1	Supply of mirrors	-	R	-
2	Receiving, storing, handling, security etc. of mirrors	R	-	I
3	Procurement, fabrication, finishing	R	-	S, I, A
4	Assembly of reflector with mirrors	R	-	S, I, A

⁴ S - Consulting / Monitoring supervision (only at site), Site supervision on day-to-day basis for all purposes by bidder

⁵ W – Witness

Sr. no.	Work	Responsibility		
		Bidder	Client	Consultant
5	Reflectors erection and assembly with heliostat	R	A	S, I, A
6	Labour supply for alignment, testing etc.	R, L ⁶	-	S, I, A
L	Receiver Tower and foundations			
1	Layout drawing and RC details of foundations	-	A	R
2	Survey, setting out, marking etc.	R	-	S, I, A
3	Procurement, Construction, completion	R	A	S, I, A
4	Cube tests, slump tests etc.	R	-	W, A
5	Design, Fabrication drawings, BOM, specifications	-	-	R
6	Procurement, fabrication, finishing, assembly, finishing, erection	R	-	S, I, A
7	Material sampling, testing, documentation	R	-	W, I, A
M	Dummy Receiver			
1	Design, Fabrication drawings, BOM, specifications	-	A	R
2	Procurement, fabrication, finishing, assembly, finishing, erection	R	-	S, I, A
3	Testing, precommissioning, commissioning	R	A	S, I, A
N	Reflector cleaning system			
1	Design, Fabrication drawings, BOM, specifications	-	A	R
2	Procurement, fabrication, finishing, assembly, finishing, erection	R	-	S, I, A
3	Testing, precommissioning, commissioning	R	A	S, I, A
O	Instrumentation			
1	Detailed specifications of PLC, Heliostat Remote Unit, instruments, I/O list, cables, trays, etc., cables schedule, termination schedule, indicative BOM, instrument list, layout, location plan, hookup plan	-	A	R

⁶ L – Labour supply only to make fine adjustments with hand tools

Sr. no.	Work	Responsibility		
		Bidder	Client	Consultant
2	Detailed Engineering of PLC system, enclosure, instruments, etc.	R	-	A
3	Detailed Engineering of Camera system etc.	R	-	A
4	Procurement, supply, fabrication, assembly of panels, consoles, hardware, development software, other software etc.	R	-	I, A
5	Procurement, supply of image processing system	R	-	A
6	FAT, documentation of PLC system and instruments (as-built drawings, datasheets, test certificates, inspection certificates, warranty certificates, type test certificates etc.)	R	I, A	I, A
7	Logic development for PLC system	Sup ⁷	A	R
8	Procurement, installation, certification of instruments, cables, loop testing,	R	-	I, A
9	Procurement, installation, erection of cable trays, glands, etc.	R	-	I, A
10	Testing, pre-commissioning, commissioning	R	W, A	S, I, A
11	Equipment manuals, documentation	R	A	A
P	Electricals			
1	Detailed specifications of PV system, heliostat local panel, battery charger, cables, trays, heliostat drive motors, etc., cables schedule, termination schedule, indicative BOM, layout	-	A	R
2	Detailed Engineering of Heliostat local panel, battery charger, etc.	R	-	A
3	Procurement, supply, fabrication, assembly, commissioning of PV systems, panels, hardware, battery charging system, spare batteries etc.	R	-	I, A
4	FAT, documentation of Heliostat local panels, battery charger etc. (as-built drawings, datasheets, test certificates, inspection certificates, warranty certificates, type test certificates etc.)	R	A	I, A

⁷

Sup – support of PLC application specialist of PLC manufacturer, as required

Sr. no.	Work	Responsibility		
		Bidder	Client	Consultant
5	Procurement, installation, termination etc. of cables, cable trays, glands, etc.	R	-	I, A
6	Testing, precommissioning, commissioning	R	W, A	S, I, A
7	Equipment manuals, documentation	R	-	A
Q	Roads, pavings, pathways, drains			
1	Design / construction details	-	A	R
2	Survey, setting out, marking etc.	R	-	S, I, A
3	Procurement, Construction, completion	R	A	S, I, A
4	Cube tests, slump tests etc.	R	-	W, A
R	Stores			
1	Layout drawing and RC / construction details	-	-	R
2	Survey, setting out, marking etc.	R	-	S, I, A
3	Procurement, Construction, completion	R	A	S, I, A
4	Cube tests, slump tests etc.	R	-	W, A
S	Pre-commissioning	R	-	S, I, A
T	Commissioning	R	A	S, I, A
U	Spares	R ⁸	A	I, A
V	Handover of all work entrusted to the bidder vide this document to consultant	R	A	I, A
W	Final Documentation: Documentation of all supplies & services which are entrusted to the bidder. This document to be submitted to the consultant.	R	A	I, A

⁸ -The bidder shall provide spares as stated in the spares list (Annexures2). Special note needs to be made by the bidder to ensure supply of requisite spares related to the heliostat drive mechanisms defined in the technical specifications (C529/ME/DS/A4/302) of the drive mechanism

In case of drive mechanism where the mechanism has been procured by the bidder, the testing, pre-commissioning and commissioning will be carried out by the bidder (to the satisfaction and acceptance of the DEC). The testing shall demonstrate the parameters stated in the specifications of the mechanism by measurement and quantification. Bidder is not expected to design the drive mechanism.

Technical Deviations:

- a. Any deviation or variation from the scope, requirement and/or intent of this specification shall be clearly defined under Deviation Schedules of the relevant Bid forms irrespective of the fact that such deviations/ variations may be standard practice or a possible interpretation of the specification by the Bidder.
- b. Except for those deviations/ variations covered under Deviation Schedules which are accepted by the Owner / IITB / DEC before the award of the Contract, it will be the responsibility of the bidder to fully meet the intent and the requirements of the specification within the quoted price.
- c. Before submitting his bid, the bidder should inspect and examine the site and its surroundings and should satisfy himself in all respects. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the Employer.
- d. In case of any conflicts / contradiction among various sections / annexure / chapters / appendices / tender drawings of bid documents, the same shall be referred to the Employer for clarifications whose decision shall be final and binding. No extra claims shall be allowed on this account.

Technical specifications – Civil work

Earthwork in roads and building works

1.0 SCOPE

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

2.0 APPLICABLE CODES

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

- | | |
|-------------|--|
| a. IS -783 | -Code of Practice for laying of concrete pipe. |
| b. IS -1200 | -Method of Measurement of Building Works |

- c. IS -3764 -Safety code for excavation work
- d. IS -6313 (Part II) - COP for anti-termite measures in buildings

3.0 GENERAL

- 3.1 CONTRACTOR shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, anything and everything necessary, whether or not such items are specifications stated herein, for completion of the job in accordance with specification and requirements.
- 3.2 CONTRACTOR shall carryout survey of the site before commencing excavation and set properly all lines and establish levels for various works such as earthwork in excavation for foundations, plinth filling, roads, drains, cable trenches, pipelines, etc. Such survey shall be carried out by studying thoroughly the drawings for the existing plant and modus operandi shall be discussed with ENGINEER. Ground levels shall be taken and properly recorded by the CONTRACTOR and shall be checked and certified by ENGINEER. If required, grown shrubs etc. have to be cut to take levels at no additional cost.
- 3.3 The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night to ensure safety.
- 3.4 The work shall also include for dumping of excavated materials in required heaps, riprap with regular slope as directed by ENGINEER, within the lead specified and leveling the same so as to provide natural drainage. Soil excavated shall be stacked properly as directed by ENGINEER. As a rule, a softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top.
- 3.5 Potable and construction water: The contractor shall make his own arrangement for potable and construction water at site. The raw water available from bore well is not suitable for the use, hence use thereof for construction etc. will not be permitted. The contractor shall make his own arrangements by obtaining potable water from outside including provision of suitable water tank, pumps, hoses, temporary piping etc.
- 3.6 Construction Power : The contractor shall furnish his construction power requirement along with the bid. The contractor shall arrange for drawing the construction power from the single point source allocated by NTPC to the site in an approved manner with all statutory and safety compliances by the contractor.

4.0 CLEARING:

The area to be excavated, and/or filled shall be cleared of fences, plants, bushes, vegetation, slush, etc. and other objectionable matter. The materials so removed shall be disposed off as directed by ENGINEER. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/material before fill commences.

5.0 EXCAVATION:

5.1 All excavation work shall be carried out manually or by mechanical equipment, as directed by ENGINEER.

5.2 Excavation for permanent work shall be taken out to such widths, lengths, depths, and profiles of P.C.C. as are shown on the drawings or such other lines and grades as may be specified by ENGINEER. Initially excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final excavation, if so instructed by engineer, and shall be carried out just prior to laying the P.C.C.

5.3 CONTRACTOR may, to facilitate his work or for similar to the reasons excavate and also backfill later, if so approved by ENGINEER, at his own cost, outside the lines shown on the drawings or directed by ENGINEER. Should any excavation be taken below the specified elevation, CONTRACTOR shall fill it up, with concrete of the grade specified on drawings, up to the required elevation. No extra shall be paid to CONTRACTOR on this account.

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

5.5 Excavation shall be carried out with such tools, tackles and equipment as described here in before.

6.0 FILL AND BACKFILLING:

6.1 GENERAL: A fill material will be subject to Engineer's approval. If any material is rejected by ENGINEER CONTRACTOR shall remove the same forthwith from the site at no extra cost to the OWNER. Surplus fill material shall be deposited/ disposed off as directed by ENGINEER after the fill work is complete.

No earth fill shall commence until surface drain have been properly intercepted, or otherwise dealt with, as directed by ENGINEER.

6.2 MATERIAL: Only selected excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed

6.3 If any selected fill material is required to be borrowed, CONTRACTOR shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of ENGINEER. The approved borrow pits area shall be cleared of bushes, plants, rubbish, etc. Topsoil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be disposed off, as directed by ENGINEER

6.4 FILLING IN PITS AND TRENCHES AROUND FOUNDATIONS OF STRUCTURES, WALLS ETC.: As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc. shall be cleared of all debris and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of ENGINEER. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless ENGINEER is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to proper profile, as directed by ENGINEER and/or shown on the drawings

6.5 PLINTH FILLING

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

6.6 SAND / MURUM FILLING IN PLINTH AND OTHER PLACES: At places backfilling shall be carried out with local sand/ murum if directed by ENGINEER. The sand/ murum used shall be clean medium grained and free from impurities. The filled-in-sand/ murum shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand/ murum under flooded condition shall be to CONTRACTOR'S account. The

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

6.7 FILLING IN TRENCHES:

- 6.7.1 Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and approved by ENGINEER. The back-filling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.
- 6.7.2 Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centerline of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm.
- 6.7.3 In case of excavation for trenches, the filling up to a level 30 cm above the top of the pipe shall be done with fine materials, such as earth, sand, murum, etc. The filling up to the level of the centerline of the pipe shall be done by hand compaction in layers not exceeding 8 cm. Whereas the filling above the centre line of the pipe shall be done by hand compaction or by approved means in layers not exceeding 15 cm. The filling from a level 30 cm. above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods, as directed by ENGINEER.
- 6.7.4 Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

7.0 MEASUREMENT:

- 7.1 All excavation shall be measured net. Dimensions for the all purposes shall be reckoned on the horizontal area of the P.C.C. at the base for foundations of the walls, columns, footings, tanks, rafts, or other foundations/structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings and duly recorded ground levels. Excavation in side slopes will not be considered extra. CONTRACTOR may make such allowance in his quote to provide for excavation in side slopes keeping in mind the nature of the soil and safety of excavation for fixing shuttering etc.
- 7.2 Backfilling as per specifications as specified and directed for the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches, etc. with excavated material will not be considered separately. It shall be clearly understood that quoted value of work shall

include stacking of excavated material, if required, within specified lead, backfilling with selected earth in layers of 150 mm, compacting, etc. and transporting the surplus excavated material outside plot limits.

7.3 Filling inside trenches, plinth or similar filling with selected excavated material will be included in the cost. Cost of all other operations shall also be deemed to have been included in the quoted value of work. The site shall be surveyed before quoting for this purpose.

7.4 Actual quantity of consolidated filling shall be measured as per the levels before and after filling and paid for in cubic meters.

7.5 Contractor's quoted value shall include the cost of shoring, strutting, and de-watering, if required.

8.0 ANTI-TERMITE TREATMENT:

8.1 GENERAL:

The formation of the chemically treated soil barrier shall be accomplished in stages as the building construction work progresses and due care shall be exercised to ensure that each stage of treatment is well integrated with that previously applied so that no unprotected avenues of termite entry are left open.

8.2 CHEMICALS:

The chemicals used for the soil treatment shall conform to IS Codes. The only allowed type is Chlorophyrisphos.

8.3 COMMENCEMENT OF TREATMENT:

The treatment shall commence after the construction has reached the plinth level and before the rubble packing or sand bed over the filled earth in the plinth area is laid. Treatment shall also be given to all the faces of pits excavated for footings.

8.4 TERMITE PROOF BARRIER AT DPC LEVEL:

- a. Where a Damp Proof Course is provided, the CONTRACTOR shall apply chemical emulsion, as specified above, on the surface of the DPC when the concrete is yet green, at the rate of 5 liters per sq. meter of DPC surface, ensuring that the emulsion gets soaked into the concrete.
- b. Where no DPC is provided, the mortar used for two consecutive courses of masonry just below the plinth filling shall be made with emulsion, as specified above, instead of water. These two operations are intended to create a termite

proof barrier in the plinth was preventing subterranean termites from infiltrating through voids in the masonry into the superstructure.

8.5 TREATMENT OF TOP SURFACE OF PLINTH FILLING: After the earth filling is completed in the plinth areas and before the dry rubble packing or sub-grade is laid, the entire surface of the filled earth shall be treated with the chemical emulsion at five liters per sq. meter. Light rodding may be carried out in the soil surface to facilitate absorption of the emulsion.

The above application is intended to prevent entry of termites through the floor structure.

8.6 TREATMENT AT JUNCTION OF COLUMNS / WALLS AND FLOOR:

Rodding shall be carried out among the junction of the columns/ walls and earth filling at 150 mm, intervals down to or slightly lower than the DPC or the chemical barrier described above. Emulsion shall be spread along the wall junction at the rate of one liter per linear meter so that it mixes with the broken up soil and seeps to the DPC level or chemical barrier, thus establishing continuity of the anti-termite layer. The disturbed earth shall be tamped back in place after the treatment.

8.7 TREATMENT OF SOIL ALONG EXTERNAL PERIMETER:

Finally the earth around the external perimeter of the building up to a depth of 50 mm shall be treated at the rate of five liters per running meter of the plinth wall. To facilitate this treatment, solid M.S. Rods shall be driven into the soil as close as possible to the plinth wall at intervals of 150 mm and the rods moved backward and forward in a direction parallel to the wall to break up earth so that chemical emulsion mixes intimately with the soil.

8.8 TREATMENT OF SOIL SURROUNDING PIPES, WASTES & CONDUITS:

When pipes, Waste pipes, conduits, etc. enter the soil inside the area of the foundation, the soil surrounding the point of entry must be loosened around each such pipe, for a distance of 150 mm and up to a depth of 75 mm before treatment is commenced, when they enter the soil, external to the foundations. They shall similarly be treated unless, they stand clear of the walls of the building by about 75 mm, for a distance of every 300 mm.

8.9 SPRAYING EQUIPMENT:

A pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemical into the earth.

8.10 PRECAUTIONS DURING MONSOON:

No spraying shall be carried out when it rains. Treatment shall be repeated in plinth areas if it rains immediately after a spraying operation and before the emulsion has soaked into the earth.

8.11 The treatment shall carry a guarantee for a minimum period of ten years.

8.12 The work shall be carried out to suit other relevant civil works.

9.0 MEASUREMENT: The quantity of work to be measured for under this item shall be calculated by taking the plan area of a horizontal surfaces treated and area of a vertical and inclined faces treated, after making a necessary deductions for openings. Quantity of anti-termite treatment shall be measured in sqm. Anti-termite treatment shall be done as per relevant working drawings or as per the direction of ENGINEER. Vendor to keep a record for consumption of Anti Termite chemical used & get it certified by EIC.

Cement concrete and allied works

1.0 SCOPE: This specification covers the general requirements for concrete to be used on jobs using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing & testing of concrete, and also requirements in regard to the quality, storage, bending and fixing of reinforcement. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing curing, protecting, repairing and finishing of concrete.

2.0 APPLICABLE CODES AND SPECIFICATIONS: The following specification, standards and codes shall form a part of this specification. All standards, tentative specifications, codes of practice, referred to herein, shall be the latest editions including all applicable official amendments and revisions. In case of discrepancy, if any between this specification and those referred to in the following, the latter shall govern.

APPLICABLE I.S. SPECIFICATIONS AND CODES OF PRACTICE:

Code no.	Description
I.S. 12330	Specification for sulfate resisting cement
I.S. 12269	Specification for High Strength Ordinary Portland Cement Grade 53
I.S. 8112	Specification for High Strength Ordinary Portland Cement Grade 43
I.S. 1489	Specification for Portland Pozzolona Cement
I.S. 383	Specification for coarse and fine aggregates from natural source for concrete
I.S. 2386	Method of test for aggregates (Part I to VIII) for concrete

I.S. 516	Method of test for strength of concrete
I.S.1199	Method of sampling and analysis of concrete
I.S. 3025	Method of sampling and test (Physical and chemical) for water & waste water
I.S. 432	Specification for mild steel (Part I & II) and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
I.S. 1139	Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement
I.S. 1566	Specification for hard drawn steel wire fabric for concrete reinforcement
I.S. 1786	Specification for TMT (thermo-mechanically treated) Steel bars for concrete reinforcement
I.S. 2645	Specification for integral cement waterproofing compound
I.S. 456:2000	Code of practice for plain and reinforced concrete
I.S. 3370	Code of practice for concrete (Parts I-IV) structures for storage of liquids
I.S. 2502	Code of practice for bending and fixing of bars for concrete reinforcement
I.S. 2571	Code of practice for laying in situ cement concrete flooring
I.S. 3696	Safety code for scaffolds and (Part I & II) ladders
I.S.1200	Method of measurement of building & civil engineering works.

3.0 GENERAL:

3.1 The quality of materials & method and control of manufacture and transportation of a concrete work irrespective of mix, whether reinforced or otherwise, and shall conform to the applicable portions of this specifications.

3.2 ENGINEER shall have the right to inspect the source of material, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work.

4.0 MATERIALS FOR STANDARD CONCRETE: The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland cement, clean sand, natural coarse aggregate, clean water, and admixtures, if specially called for on drawings and/or specifications.

4.1 CEMENT:

- 4.1.1 Unless otherwise specified cement shall be OPC/ PPC of approved make in 50 kg bags. The use of bulk cement will be permitted only with the approval of ENGINEER. Changing of brands or type of cement within the same structure will not be permitted.
- 4.1.2 CONTRACTOR shall make his own arrangements for the storage of adequate quantity of cement. If supplies are arranged by OWNER, cement will be issued in quantities to cover work requirements of one month or less, as deemed fit by the ENGINEER and it will be the responsibility of CONTRACTOR to ensure adequate and proper storage. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulin will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from ground & walls, and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be approved by ENGINEER. Consignment of cement shall be stored as received and shall be consumed in the order of their receipts at site. Cement will be tested as per schedule of testing given in the tender document & manufacturer's test certificate alone will not suffice.
- 4.1.3 Cement held in storage for a period of ninety (90) days or longer shall be tested. Should at any time ENGINEER have reasons to consider that any cement is defective, then irrespective of its origin, date of manufacture and/or manufacturer's test certificate, such cement shall be tested immediately at Contractor's cost at a National Test Laboratory / approved laboratory and until the results of such tests are found satisfactory, it shall not be used in any work. CONTRACTOR shall not be entitled to any claim of any nature of this account.

4.2 AGGREGATES:

4.2.1 Definitions

"Aggregate" in general designates both fine and coarse inert materials used in the manufacture of concrete.

"Fine Aggregates" are aggregates most of which pass through 4.75 mm IS sieve.

"Coarse aggregates" are aggregate most of which retain on 4.75 mm IS sieve.

- 4.2.2 A fine and coarse aggregate proposed for use in the work shall be subject to Engineer's approval and after specific materials have been accepted, the source of supply of such materials, shall not be changed without prior approval of ENGINEER.

- 4.2.3 Aggregates shall, except as noted above, consist of natural sands, crushed stone and

gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and/or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength & consistency that will work readily into position without segregation and shall be based on test on concrete as specified later in this group.

4.2.4 SAMPLING AND TESTING: Samples of the aggregates for determination of suitability shall be taken under the supervision of ENGINEER and delivered to the laboratory well in advance of the scheduled placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregate shall be furnished to ENGINEER in advance of the work for use in determining the aggregate suitability. The costs of all such tests, sampling, etc. shall be borne by CONTRACTOR.

4.2.5 STORAGE OF AGGREGATES: A coarse and fine aggregate shall be stacked separately in stock piles in the material yard near the work site to avoid intermixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into the mixer. Rakers shall be used for lifting the coarse aggregates from stock piles. Coarse aggregates shall be piled in layers not exceeding 1.20 meters in height to prevent coning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after remixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

4.3 SPECIAL GRAVITY: Aggregates having all specific gravity below 2.6 (saturated surface dry basis) shall not be used without special permission of ENGINEER.

4.4 FINE AGGREGATES: Fine aggregate, except as noted above, shall consist of natural or crushed sand conforming to IS: 383. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coatings, clay, alkali, organic matter, mica, salt, or other deleterious substances which can be injurious to the setting qualities/strength/durability of concrete.

5.0 SAND :

5.1 MACHINE MADE SAND: Machine made sand will be acceptable, provided the constituent rock gravel composition shall be sound, hard, dense, inorganic, un-coated and durable against

weathering.

5.2 SCREENING AND WASHING: Sand shall be prepared for use by such screening or washing or both, as necessary, to remove any objectionable foreign matters while separating the sand grains to the required size fraction.

5.3 FOREIGN MATERIAL LIMITATIONS: The percentage of deleterious substances in sand delivered to the mixer shall not exceed the following:

Sr. no.	Deleterious substance	Percent by Weight			
		Fine Aggregates		Coarse Aggregates	
		Uncrushed	Crushed	Uncrushed	Crushed
i	Material finer than 75 micron I.S. sieve -	3.00	15.00	3.00	3.00
ii	Shale	1.00	--	--	--
iii	Coal and Lignite	1.00	1.00	1.00	1.00
iv	Clay lumps	1.00	1.00	1.00	1.00
v	Total of all above substances including items (i) to (iv) for uncrushed sand and items (iii) & (iv) for crushed sand.	5.00	2.00	5.00	5.00

5.4 GRADATION: Unless otherwise directed or approved, the grading of sand shall be within the limits indicated hereunder:

S.no.	I.S. Sieve Designation	Percentage passing for			
		Grading Zone-I	Grading Zone-II	Grading Zone-III	Grading Zone-IV
1	10.00 mm	100	100	100	100
2	4.75 mm	90 - 100	90 - 100	90 - 100	95 - 100
3	2.36 mm	60 - 95	75 - 100	85 - 100	95 - 100
4	1.18 mm	30 - 70	55 - 90	75 - 100	90 - 100
5	600 µm	15 - 34	35 - 59	60 - 79	80 - 100
6	300 µm	5 - 20	8 - 30	12 - 40	15 - 50
7	150 µm	0 - 10	0 - 10	0 - 10	0 - 15

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron I.S. sieves, by total amount not exceeding 5 %, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron I.S. Sieves or to percentage passing any other sieve size on the coarser limit of Grading Zone I or conforming to Grading Zone IV shall be used. Sand used for preparing concrete shall belong to Grading Zone-II.

5.5 FINENESS MODULUS: The sand shall have a fineness modulus of not less than 2.2 nor more than 3.2. The fineness modulus is determined by adding the cumulative percentages retained on the following I.S. Sieve (4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.

6.0 COARSE AGGREGATES: Coarse aggregates for concrete, except as noted above, shall conform IS: 383. This shall consist of natural or crushed stone & gravel and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

6.1 SCREENING AND WASHING: Natural gravel and crushed rock shall be screened and/ or washed for the removal of dust coating, if so demanded by ENGINEER.

6.2 GRADING:

6.2.1 The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminate pieces, mica and shale, if present, shall be only in such quantities that will not, in the opinion of ENGINEER, affect adversely the strength and/or durability of concrete. The maximum size of coarse aggregates shall be specified on relevant drawings. The maximum size of coarse aggregates shall in no case be greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. Plums above 150 mm and up to any reasonable size can be used in plain mass concrete work of large dimensions up to a maximum limit of 20% by volume of concrete when specifically approved by ENGINEER. For heavily reinforced concrete members, the nominal maximum size of the aggregates shall be 5 mm less than the minimum clear distance between the reinforcing main bars, or 5 mm less than the minimum cover to the reinforcement, whichever is smaller. The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per IS: 2386. After 24 hours immersion in water, previously dried sampled shall not have gained more than 10% its oven dry weight in air, as determined by I.S. 2386.

6.3 FOREIGN MATERIAL LIMITATIONS: The percentages of deleterious substances in the aggregate delivered to the mixer shall not exceed the following:

Sr.no.	Description	Percentage by weight	
		Uncrushed	Crushed
i.	Material finer than 75 micron I.S. sieve	3.00	3.00
ii.	Coal and lignite	1.00	1.00
iii.	Clay lumps	1.00	1.00
iv.	Soft fragments	3.00	-

v.	Total of a the above substances	5.00	5.00
----	---------------------------------	------	------

7.0 WATER:

Water used for both mixing and curing shall be free from injurious amounts of deleterious materials.

Potable waters are generally satisfactory for mixing and curing concrete.

8.0 REINFORCEMENT:

8.1 SUPPLY:

The reinforcement shall be TMT bars conforming to IS: 1786-1985

Substitution of reinforcement will not be permitted except upon written approval from ENGINEER.

8.2 STORAGE: The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like.

If the reinforcing rods/ bars have to be stored for a long duration, they shall be coated with cement wash before stacking and/or be kept under cover or stored as directed by ENGINEERS. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed, unless approved by ENGINEERS.

8.3 LAPS: Laps and splices for reinforcement shall be as shown on the drawings. Splices in adjacent bars shall be staggered and the locations of a splices, except those specified on the drawings, shall be approved by ENGINEER. The bars shall not be lapped unless the length required exceeds the maximum available length of bars at site.

8.4 BENDING: Reinforcing bars, supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done in cold and without damaging the bars. This is considered as a part of reinforcement bending fabrication work and contractor's rates are deemed to include this work.

All bars shall be accurately bent according to the sizes and shapes shown on the detailed working drawings. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent in a manner that will injure the material; bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25 mm in diameter which may be bent hot if specifically approved by ENGINEER. Bars which depend for their strength on cold working, shall not be bent hot. Bars bent hot shall not be

heated beyond cherry red color (not exceeding 84°C) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and re-bending is such as shall not, in the opinion of ENGINEER, injure the material. No reinforcement shall be bent when in position in the work without approval, Whether or not it is partially embedded in hardened concrete. Bars having kinks or ends other than those required by designed shall not be used.

8.5FIXING: Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the drawings by the use of blocks, spacers and chairs as per IS 2502 to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with 16 gauge annealed soft iron wire (shall be included in the rate of reinforcement itself). The vertical distances required between successive layers of bar in beams or similar members shall be maintained by the provisions of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

8.6 COVER: Clear concrete cover for reinforcement shall be as stated on drawings. Correct cover shall be maintained by cement mortar blocks or other approved means. Reinforcement for footings, grade beams and slabs on subgrade shall be supported on precast concrete blocks as approved by ENGINEER. The use of pebbles or stones will not be permitted. Cost of such blocks etc. shall be included in the cost of concreting work.

8.6.1 The 28 days crushing strength of cement mortar cubes/precast cover blocks shall be at least equal to the specified strength of concrete in which these cubes/blocks are embedded. The minimum clear distance between reinforcing bars shall be in accordance with IS 456:2000, or as shown in drawings.

8.7 INSPECTION:

8.7.1 Erected and secured reinforcement shall be inspected and approved by ENGINEER prior to placement of concrete.

8.8 PAYMENT: For payment of work done under this item shall be made as per Special Terms & conditions. The price quoted shall include all wastage, binding wire, etc. for which no separate payment shall be made. Laps as shown on drawings or as approved by ENGINEER and minimum number of chairs and spacer bars to keep the reinforcement in place and approved by ENGINEER shall be deemed included in the price.

9.0 STEEL SHAPES ENCASED IN CONCRETE:

Structural steel columns, beams, girders and bracings to be encased in concrete shall be unpainted. The encasing shall be done in concrete with 10 mm maximum size aggregate. The steel

member will have a minimum cover of 50 mm unless otherwise indicated on the drawings. Where the clean cover to steel is more than 75 mm, mild steel bar and concrete with 20 mm coarse aggregate shall be used.

10.0 MIXING:

Concrete shall be mixed in mechanical mixer (with hopper). The mixer should comply with IS 1791 and IS 12119. The mixer shall be fitted with water measuring devices. The mixing shall be continued until there is a uniform distribution of the material and the mass is uniform in color. If there is segregation after unloading from the mixer, the concrete should be remixed. For guidance, the mixing time shall be at least 2 minutes. For concrete of grades M20 or lower, "Nominal Mix Concrete" as specified in IS: 456:2000 is to be used. Whether reinforced or otherwise, a concrete to works to be carried out under this specification shall be divided into the following classification.

Minimum compressive strength of 15 cm cubes in N/mm ² at and 28 days after mixing, conducted In accordance with IS: 516					
Sr. no.	Grade	Works Test		Maximum Size of aggregate in mm	
		At 7 days	At 28 days		
1	M25	17.0	25.0		As indicated on drawing
2	M20	13.5	20.0	20	
3	M15	10.0	15.0	20	
4	M10	7.0	10.0	40 or 20	

Mix Proportioning and Cement Consumption For Concrete: as per the IS 456 – 2000

Min and Max cement content will be as per IS 456:2000.

11.0 SAMPLING AND TESTING CONCRETE IN THE FIELD:

11.1 Facilities required for sampling materials and concrete in the field, shall be provided by CONTRACTOR at no extra cost.

11.2 SAMPLING AND TESTING CONCRETE IN THE FIELD: Test cubes of each grade of concrete shall be made as specified in IS: 456:2000. Such samples shall be drawn on each day, for each grade of concrete & during each concreting operations. Of each set of 6 cubes, three shall be tested at 7 days age and three at 28 days age. The laboratory test results shall be tabulated and furnished to ENGINEER. ENGINEER will accept the concrete according to 'Acceptance Criteria' specified in the IS: 456:2000.

11.3 CONSISTENCY: Slump tests shall be carried out as often as demanded by ENGINEER invariably from the same batch of concrete from which the test cubes are made. Slump test shall be done immediately after sampling.

12.0 ADMIXTURE:

12.1 WATERPROOFING COMPOUND: Where specified and approved by ENGINEER, waterproofing compound conforming to IS: 2645, shall be added in quantities recommended by manufacturer and specified by ENGINEER.

13.0 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL, INSPECTION AND APPROVAL.

13.1 Before the concrete is actually placed in position, the inside of the formwork shall be inspected to see that they have been cleaned and oiled. Non-staining oil shall be used as approved by ENGINEER. Temporary opening shall be provided to facilitate inspection, especially at bottom of columns and wall forms, to permit removal of sawdust, wood shavings, binding wire, rubbish, dirt, etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be later suitably plugged.

13.2 The various trades shall be permitted ample time to install drainage and plumbing lines, floor and trench, drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedments to be cast in the concrete as indicated on the drawings or as is necessary for the proper execution of the work. CONTRACTOR shall co-operate fully with all such agencies and shall permit the use of scaffolding, formwork, etc. by other trades at no extra cost.

13.3 All embedded parts, inserts, etc. supplied by OWNER or CONTRACTOR shall be correctly positioned and securely held in the forms to prevent displacement during placing and vibrating of concrete.

13.4 All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by ENGINEER. The use of all such templates, fixtures shall be deemed to be included in Contractor's rates.

13.5 Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.

13.6 Prior to concrete placement a work shall be inspected and approved by ENGINEER and, if found unsatisfactory, concrete shall not be poured until after all defects have been rectified at Contractor's cost.

13.7 Approval by ENGINEER of any or all materials and works required herein shall not relieve CONTRACTOR from his obligation to produce finished concrete in accordance with the drawings and specifications.

13.8 RAIN OR WASH WATER: No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rains shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete placed. To guard

against damage which may be caused by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulated on the surface the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitable drains and sumps shall be provided.

- 13.9 BONDING MORTAR: Immediately before concrete placement begins, prepared surfaces except formwork, which will come in contact with the concrete to be placed, shall be covered with the bonding mortar.
- 14.0 CLEANING OF EQUIPMENT: All equipment used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipelines & other equipment shall be thoroughly cleaned after each period of placement.
- 15.0 PROCEDURE FOR PLACING OF CONCRETE:
- 15.1 ENGINEER'S APPROVAL OF EQUIPMENT & METHOD: Before any concrete is placed, the entire placing program consisting of equipment, layout, proposed procedures and methods shall be submitted to ENGINEER for approval, if so demanded by ENGINEER and no concrete shall be placed until Engineer's approval has been received. Equipment for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.
- 15.2 TIME INTERVAL BETWEEN MIXING AND PLACING: Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer, and once compacted, it shall not be disturbed.
- 15.3 AVOIDING SEGREGATION : Concrete shall, in a cases, be placed as near as practicable directly in its final position, and shall not be re-handled or caused to flow in a manner which will cause segregation loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible, and in narrow forms, CONTRACTOR shall provide suitable drop and "Elephant Trunks" to confine the movement of concrete. Special care shall be exercised when concrete is dropped from a height, especially if reinforcement is in the way, particularly in columns and thin members.
- 15.4 PLACING BY MANUAL LABOUR: Except when otherwise approved by ENGINEER, concrete shall be placed in the shuttering by shovels or other approved equipment. It should be handled in a manner to preclude segregation. Care should be taken to avoid displacement of reinforcement or movement of formwork. As a general guidance, the maximum permissible free fall of

concrete may be taken as 1.5m.

16.0 COMPACTION

16.1 Concrete shall be compacted during placing, with approved vibrating equipment until the concrete has been consolidated to the maximum possible density, is free of pockets of coarse aggregates, and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms or against hardened concrete at joints is free from voids and cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised to not over vibrate the concrete to the point that segregation results, and water appears on the top surface.

16.2 Use of vibrators: The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibration at the top of a lift e.g. in a column or wall.

16.3 Penetration of Vibrator: immersion vibrator shall penetrate the layer being placed and also the layer below while the under layer is still plastic, to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

16.3.1 Vibration against reinforcement: Care shall be taken to prevent contact of immersion vibrator with reinforcement steel and/or embedded parts. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms of finished surfaces.

16.4 STONE POCKETS AND MORTAR PONDAGES: The formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for thorough bonding, as directed by ENGINEER.

16.5 PLACING CONCRETE THROUGH REINFORCING STEEL: When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position.

16.6 BLEEDING: Should bleeding of free water on top of concrete being placed into the form occur, the conditions causing this defect shall be corrected before further concreting is resumed.

17.0 CONSTRUCTION JOINTS AND KEYS:

- 17.1 Concrete shall be placed without interruption until completion of the part of the work between predetermined construction joints, as specified hereinafter. Time lapse between the pouring of adjoining units shall be as specified on the drawings or as directed by ENGINEER.
- 17.2 If stopping of concreting become unavoidable anywhere, a properly formed construction joint shall be made where the work is stopped. Joint shall be either vertical or horizontal unless otherwise shown on drawings. In case of an inclined or curved member, the joint shall be at the right angles to the axis of the member. Vertical joints in walls shall be kept to a minimum. Vertical joints shall be formed against a stop board; horizontal joints shall be level and wherever possible, arranged so that the joint lines coincide with the architectural features of the finished work. Battens shall be nailed to the formwork to ensure a horizontal line, and if directed, shall also be used to form a grooved joint. For water storage tank walls and similar work, joints shall be formed as per IS: 3370. Concrete that is in the process of setting shall not be disturbed or shaken by traffic either on the concrete itself or upon the shuttering. Horizontal and vertical construction joints and shear keys shall be located and shall conform in detail to the requirements of plans, unless otherwise directed by ENGINEER. Where not described, the joint shall be in accordance with the following:
- 17.2.1 COLUMN JOINTS: In a column, the joint shall be formed 75 mm below the lowest soffit of the beams including haunches, if any. In flat slab construction, the joint shall be 75 mm below the soffit of column capital. At least 2 hours shall elapse after depositing concrete in columns, piers or wall s, before depositing in beams, girders or slabs supported thereon.
- 17.2.2 BEAM AND SLAB JOINTS: Concrete in a beam/girder shall be placed throughout without a joint, however, if provision of a joint is unavoidable, the joint shall be vertical and between quarter and third points of the spans unless otherwise shown on drawings. Where a beam intersects a girder, the joint in the girder shall be offset a distance equal to twice the width of the beam and additional reinforcement provided for shear, if required. the joints shall be vertical throughout the full thickness of the concrete member. A joint in a slab shall be vertical and para el to the principal reinforcement. Where it is unavoidable at right angles to the principal reinforcement, the joint shall be vertical and at the middle of the span.
- 17.3 JOINTS IN LIQUID RETAINING STRUCTURE: Vertical construction joints in watertight construction will not be permitted unless indicated on the drawings. Where a horizontal construction joint is required to resist water pressure, special care shall be taken in a phases of its construction to ensure water-tightness.
- 17.3.1 DOWELS: Dowels for concrete work, not likely to be taken up in the near future, shall be

encased in concrete as per drawings and as directed by the ENGINEER.

18.0 TREATMENT OF CONSTRUCTION JOINTS ON RESUMING CONCRETING:

18.1 A stiffer mix shall be used for the top lift of horizontal pours to avoid laitance. A laitance and loose stones shall be thoroughly and carefully removed by wire brushing / hacking and surface washed. Just before concreting is resumed, the roughened joint surface shall be thoroughly cleaned and loose matter removed and then treated with a thin layer of cement grout of proportion specified by ENGINEER and worked we into the surface. The new concrete shall be we worked against the prepared surface before the grout mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joints/plane.

19.0 CURING, PROTECTING, REPAIRING AND FINISHING:

19.1 CURING: All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated covering of sacking, canvas, hessians or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even-textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

19.2 CURING WITH WATER: Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying concrete. The curing of horizontal surface exposed to the drying winds shall however begin immediately after the concrete surface within 1 hour after concrete has set. Water shall be applied to formed surface immediately upon the removal of forms. Quantity of water applied shall be controlled so as the prevent erosion of freshly placed concrete.

19.3 CONTINUOUS SPRAYING: Curing shall be assured by use of an ample water supply under pressure in pipes, with a necessary appliance of hose, sprinkle and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by ENGINEER.

19.4 CURING EQUIPMENT:

19.5 All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

20.0 PROTECTING FRESH CONCRETE: Fresh concrete shall be protected from the element, from

defacement & damage due to construction operations by leaving forms in place for an ample period as specified later in this specification. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun & winds. Steps as approved by ENGINEER shall also be taken to protect green concrete from damage by debris, excessive loading, vibration abrasion or contact with other materials, etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that workman enter the area of freshly placed concrete, ENGINEER may require that bridges be placed over the area.

21.0 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE:

21.1 Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defective areas called to the attention of ENGINEER who may permit patching of the defective areas, by CONTRACTOR, or also reject the concrete unit, either partially or in its entirety, at no additional expenses to OWNER. Holes left by form bolts, etc. shall be filled up and made good with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm I.S. sieve after removing any loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of the concrete. Concrete surfaces shall be finished as described under the relevant items of work.

21.2 Superficial honeycombed surfaces and rough patches shall similarly be made good immediately after removal of shuttering, in the presence of ENGINEER and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by ENGINEER, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove the fine or other irregularities, care being taken to avoid damage to the surface. Surface irregularities shall be removed by grinding.

21.3 If reinforcement is exposed or honeycombing occurs at vulnerable positions, e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of ENGINEER shall be final in this regard. If only patching is necessary, the defective concrete shall be cut out till sound concrete is reached (or to a minimum depth of 25 mm) the edges being cut perpendicular to the affected surface or with small undercut, if possible. Anchors, tees or dovetail slots shall be provided, whenever necessary, to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surface of the repaired voids shall be saturated with water for 24 hours immediately before the patching material is placed.

21.4 USE OF EPOXY: The use of epoxy for bonding fresh concrete used for repairs will be permitted

upon written approval of ENGINEER. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

- 21.5 METHOD OF REPAIR: Small size holes having surface dimensions about equal to the depth of hole, holes left after removal of form bolts, grout insert holds and slots cut for repair of cracks shall be repaired as follows. The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops.

21.5.1 A 5 mm thick layer of grout of equal parts of cement and sand shall be brushed into the surface to be patched, followed immediately by the patching concrete which shall be consolidated with a wooden float & felt slightly protruding of the surrounding surface. The concrete shall be built up in 10 mm thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian, using a steel trowel for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired although reduction in the maximum size of the coarse aggregates maybe necessary and the mix shall be kept as dry as possible, as directed by ENGINEER.

21.5.2 Mortar filling by air pressure (grouting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the color and textures of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by ENGINEER, so match the shade of patch with the original concrete. No payment whatsoever shall be made to the CONTRACTOR on account of repair work.

- 21.6 CURING OF PATCHED/REPAIR WORK: The patched areas shall be covered immediately with an approved non-staining, water saturated material such as gunny bags, etc. as stated earlier which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter the patched area shall be kept wet continuously by fine sprayer sprinkling for not less than 14 days.

22.0 FORMWORK:

- 22.1 The formwork shall consist of shores, bracings sides of beams and column, bottom of slabs, etc. including ties, anchors, hangers, inserts, etc. complete which shall be properly designed and planned for the work. False work shall be so constructed that vertical adjustments can be made to compensate for take up and settlements. Wedges maybe used at the top or bottom of timber props, but not at both ends, to facilitate vertical adjustment or dismantling of the formwork.

22.2 DESIGN OF FORMWORK: The design and engineering of the formwork as well as its construction shall be the responsibility of CONTRACTOR. If so instructed, the drawings and/or calculations for the design of the formwork shall be submitted to ENGINEER for approval before proceeding with work, at no extra cost to OWNER. Engineer's approval shall not, however, absolve the CONTRACTOR of his full responsibility for the design and construction of the formwork. The design shall take into account all the loads, vertical as well as lateral, that the form would be carrying, including live and vibration loadings.

22.3 TOLERANCES: Tolerance is a specified permissible variation from lines, grades or dimensions given on drawings. No tolerances specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerance will be permitted.

Sr.no.	Particulars of structure / part thereof	Tolerance
A	Tolerance for R. C. Buildings:	
1	Variation from the plumb:	
a	In the lines and surfaces of columns, piers, walls and in arises	5 mm per 2.5 m or 25 mm whichever is less
b	For exposed corner columns and other conspicuous lines	
i	In any bay of 5m maximum	5 mm
ii	In 10 m or more	10 mm
2	Variation from the level or from the grades indicated on the drawings:	
a	In slab soffits, ceilings, beam soffit, and in arises	
i	In 2.5 m	5 mm
ii	In any bay or 5m maximum	8 mm
iii	In 10 m or more	15 mm
b	For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines	
i	In any bay or 5 m maximum	5 mm
ii	In 10 m or more	10 mm
3	Variation of the linear building lines from established position in plan and related position of columns, walls and partition	

Sr.no.	Particulars of structure / part thereof	Tolerance
a	In any bay or 5 m maximum	10 mm
b	In 10 m or more	20 mm
4	Variation in cross-sectional dimensions of columns and beams and in the thickness of slab and walls	-5mm / + 10mm
a	Footings	
i	Variation in dimensions in plan	-5mm / + 10mm
ii	Misplacement or eccentricity	2% of footing width in the direction of misplacement but < 50 mm.
iii	Reduction in thickness	-5% of specified thickness $\leq$ 50 mm
5	Variation of the constructed linear outline from established position in plan	
a	In 5 m	10 mm
b	In 10 m or more	15 mm
6	Variation of dimensions to individual structure features from established positions	
a	In 20 m or more	25 mm
b	In buried construction	50 mm
7	Variation from level or grade indicated on drawings in slab, beams, soffits, horizontal grooves and visible arise	
a	In 2.5 m	5 mm
b	In 7.5 m or more	10 mm
c	In buried construction	Twice the above amounts
8	Variation in cross-sectional dimensions of columns beams, but tresses, piers and similar members	-5mm / + 10mm
B	Tolerances in other Concrete Structures	
1	Variation in the thickness of slabs, walls, arch sections and similar members	-5mm / + 10mm
2	Footing for columns, piers, walls, but-tresses and similar	-10mm / + 50 mm

Sr.no.	Particulars of structure / part thereof	Tolerance
	members Variation of dimensions in plan	
3	Misplacement or eccentricity	2% of footing width in the direction of misplacement but < 50 mm
4	Reduction in thickness	5% of specified thickness subject to a max. of 50 mm
C	Tolerances in fixing bolts shall be as follow	
a	Anchor bolts without sleeves	$\pm 1.5\text{mm}$ in plan.
b	Anchor bolts with sleeve	$\pm 5.0\text{ mm}$ in elevation
c	For bolts up to and including 28 mm dia	$\pm 5\text{mm}$ in all directions
d	For bolts 32 mm dia and above	$\pm 3\text{mm}$ in all directions
e	Embedded parts	$\pm 5\text{mm}$ in all directions

22.4 TYPE OF FORM WORK: Formwork may be of timber, plywood, metal, plastic or concrete. For special finishes the formwork maybe lined with plywood, steel sheets, oil tempered hard board, etc. Sliding forms and slip forms may be used with the approval of ENGINEER.

22.5 FORM WORK REQUIREMENTS: Forms shall conform to the shapes, lines, grades and dimensions, including camber of the concrete as called for on the drawings. Ample studs, walers, braces, ties, straps, shores, etc. shall be used to hold the Forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit the removal of forms. Forms shall be strong enough to permit the use of immersion vibrators. The shuttering shall be close boarded. Timber shall be we seasoned free from sap shakes, loose knots, wormholes, warps or other surface defects in contact with concrete. Faces coming in contact with the concrete shall be free from adhering grout, plaster, paint projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete.

22.5.1 Plywood shall be used for Exposed Concrete surfaces, where called for Sawn and wrought timber may be used for unexposed surfaces. Inside faces of forms for concrete surfaces which are to be rubbed finished shall be planned to remove irregularities or unevenness in the face. Formwork with linings will be permitted.

22.5.2 A new and used material for lumber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness and cleanliness of surfaces.

Form lumber unsatisfactory in any respect shall not be used and, if rejected by ENGINEER, shall be removed from the site.

22.5.3 Formwork, during any stage of construction showing signs of distortion or distorted to such a degree that the intended concrete work will not conform to the exact contours shown on the drawings, shall be repositioned and strengthened. Poured concrete affected by the faulty formwork, shall be removed in its entirety and the formwork corrected, as directed by ENGINEER, prior to placing new concrete.

22.5.4 Excessive provision of camber to compensate for shrinkage settlement, etc. that may impair the structural strength of members will not be permitted.

22.5.5 Forms for substructure concrete may be omitted when, in the opinion of ENGINEER, the open excavation is firm enough to act as the form. Such excavation shall be slightly larger than that required by the drawings to compensate for irregularities in excavation and to ensure concrete cover and the design requirements.

22.5.6 Forms shall be so designed and constructed that their removal will not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conform to the architectural features of the structure as to location of joints and be as directed by ENGINEER.

22.5.7 When exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the resulting concrete surfaces require a minimum finish.

22.6 BRACINGS, STRUTS AND PROPS:

22.6.1 Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men, equipment and other materials. Bamboos shall not be used as props or cross bearers.

22.6.2 The shuttering for beams and slabs shall be so erected that the shuttering on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.

22.6.3 If the shuttering for a column is erected for the full height of the columns, one side shall be left open and built up in sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m or, as

directed by ENGINEER.

22.7 MOULD OIL:

22.7.1 Care shall be taken to see that the faces of formwork coming in contact with concrete are perfectly cleaned and two coats of mould oil or any other approved material applied before fixing reinforcement and placing concrete (Burnt lube oil will not be allowed). Such coating shall be insoluble in water, non-staining and not injurious to the concrete. it shall not become flaky or be removed by rain or wash water. Reinforcement and / or other items to be cast in the concrete shall not be placed until coating of the forms is complete. Adjoining concrete surfaces shall also be protected against contamination from the coating material.

22.8 CHAMFERS AND FILLETS: A corners and angles exposed in the finished structure shall be formed with moldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 20 mm x 20 mm. Care shall be exercised to ensure accurate molding. The diagonal face of the molding shall be planed or surfaced to the same texture as to form to which it is attached.

22.9 VERTICAL CONSTRUCTION JOINT CHAMFERS: Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above except where not permitted by ENGINEER for structural or hydraulic reasons.

22.10 WALL TIES: Wire ties passing the walls shall not be allowed. in their place bolts passing through sleeves shall be used.

22.11 REUSE OF FORMS: Before reuse, all forms shall be thoroughly scrapped, cleaned, nails removed, holes that may leak, suitably plugged and joint examined and when necessary, repaired and the inside retreated to prevent adhesion to the satisfaction of ENGINEER. Warped lumber shall be resized. CONTRACTOR shall equip himself with enough shuttering to complete the job in the stipulated time.

22.12 REMOVAL OF FORMS:

22.12.1 CONTRACTOR shall record on the drawing or a special register, the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed therefrom.

22.12.2 Under no circumstances shall forms be struck until the concrete reaches strength of at least twice the stress due to self-weight and any construction/erection loading to which the concrete maybe subjected at the time of striking formwork, as directed by ENGINEER.

22.12.3 In normal circumstances (generally where temperatures are above 20 °C), forms maybe struck after expiry of the following periods, where ordinary Portland cement is used and adequate curing is done:

Sr. no.	TYPE OF FORMWORK	MIN. PERIOD BEFORE STRIKING FORMWORK
a.	Walls columns and vertical sides of beams.	6 - 24 hours as directed by the ENGINEER.
b.	Slabs (Props left under)	
c.	Beam soffits (Props left under)	3 days
d.	Removal of props under slabs:	
i.	Spanning upto 4.5 m.	7 days
ii.	Spanning over 4.5	14 days

22.12.3.1 Striking shall be done slowly with utmost care so to avoid damage to arises and projections and without shock or vibration, by gently easing the wedges. If after removing the formwork, it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

22.12.4 Reinforced temporary openings shall be provided as directed by ENGINEER to facilitate removal of formwork which otherwise maybe inaccessible.

22.12.5 Tie rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures, shall be loosened not sooner than 24 hours nor later than 48 hours after the concrete has been deposited. Tiles, except those required to hold forms in place, may be removed at the time. Ties withdrawn from walls and grade beams shall be pulled towards the inside face. Cutting ties back from the faces of walls and grade beams shall not be permitted.

22.12.6 For liquid retaining structures, to sleeves for through bolts shall be used, nor shall through bolts be removed as indicated in 24.12.5. The bolts, in this case, shall be cut at 25 mm depth from the surface and then the hole shall be made good by sand cement mortar of the same proportion of the concrete, just after striking the formwork.

23.0 FOUNDATION BEDDING, BONDING AND JOINTS:

23.1 All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering, as indicated on the plans or as directed by the ENGINEER, to meet the various situations encountered in the work.

23.2 Soft or spongy areas shall be cleaned out and backfilled with either a soil-cement mixture, lean concrete or clean sand, till compacted to minimum density of 90% Modified Proctor,

unless otherwise mentioned in Schedule of Quantities.

23.3 PREPARATION OF EARTH STRATA OF FOUNDATIONS:

23.3.1 All earth surfaces upon or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soil shall be removed and replaced with suitable earth, sand or murrum well compacted as directed by ENGINEER. Where specified, lean concrete shall be provided on the earth stratum for receiving concrete. The surface of absorptive soils, against which concrete is to be placed, shall be moistened thoroughly so that no moisture will be drawn from the freshly placed concrete, and later shall help to cure the concrete.

23.4 PREPARATION OF CONCRETE SURFACES: The preparation of concrete surfaces upon which additional concrete is to be placed later, shall preferably be done by scarifying and cleaning, while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet as directed by ENGINEER. Utmost care shall be exercised in performing this work to avoid removal of too much mortar and the weakening of the surface by loosening of aggregates.

23.4.1 When it is not practicable to follow the above method, it will be necessary to employ compressed air to remove laitance and roughen the surface.

23.4.2 The final required result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

23.5 BONDING TREATMENT (MORTAR):

23.5.1 After rock or concrete surface upon which new concrete is to be placed have been scarified, cleaned and wetted, as specified herein, they shall receive a bonding treatment, immediately before placement of the concrete.

23.5.2 The bonding medium shall be a coat of cement-sand mortar. The mortar shall have the same cement-sand proportions as the concrete which shall be placed thereon. The water-cement ratio shall be determined by site conditions and as approved by ENGINEER.

23.5.3 Bonding mortar shall be placed in sufficient quantity to completely cover the surface about 5 mm thick for concrete surfaces. It shall be brushed or boomed over the surface and worked thoroughly into all cracks, crevices and depressions. Accumulations or puddles of mortar shall not be allowed to settle in depressions and shall be brushed out to a satisfactory degree, as approved by ENGINEER.

23.5.4 Mortar shall be placed at such a rate that it can be brushed over the surface just in advance of placement of concrete. Only as much areas shall be covered with mortar as can be covered with concrete before initial set in the mortar takes place. The amount of mortar that will be permitted to be placed at any one time, or the area which it is required to cover, shall be in accordance with Engineer's directions.

23.6 CLEANING AND BONDING FORMED CONSTRUCTION JOINTS: Vertical construction joints shall be cleaned as specified above or by other methods as approved by ENGINEER. In placing concrete against formed construction joints, the surfaces of the joints, where accessible, shall be coated thoroughly with the specified bed-joint bonding mortar immediately before they are covered with concrete, or by scrubbing with wire brooms dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint, by careful puddling and spading with aid of vibrators and suitable tools.

23.7 EXPANSION AND CONTRACTION JOINTS: Provision shall be made for expansion and contraction of concrete by use of special type joints located as shown on the drawings. Construction joint surfaces shall be treated as per specifications, drawings or as directed by ENGINEER.

24.0 HOT WEATHER REQUIREMENT:

24.1 All concrete work performed in hot weather shall be in accordance with IS: 456 : 2000, except as herein modified.

24.2 Admixture may be used only when approved by ENGINEER.

24.3 Adequate provisions shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyors to direct sunlight, the use of reflective paint on mixers, etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38 °C.

24.4 Consideration shall be given to providing shade aggregate stockpiles from direct rays of the sun and spraying stockpiles with water, use of cold water when available and burying, insulating shading and/or painting white the pipe lines & water storage tanks.

24.5 In order to reduce loss of mixing water, the aggregates, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces shall be wetted prior to concreting. Placement and finishing shall be done as quickly as possible.

24.6 Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot

winds for a period of at least 12 days immediately after concrete has set and after which normal curing procedures may be resumed.

25.0 PRECAST CONCRETE:

25.1 Precast concrete shall comply with IS:456 : 2000 and also with following:

25.1.1 All precast units shall be cast on a suitable bed or platform with firm foundation and free from wind. CONTRACTOR shall be responsible for the accuracy of the level or shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

25.2 STRIKING FORMS: Side shutters shall not be struck in less than 24 hours after placing concrete and no precast unit shall be lifted until the concrete reaches a strength of at least twice the stress to which the concrete maybe subjected to at the time of lifting, as directed by ENGINEER.

25.3 PRECAST UNITS: The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before, lifting and removal takes place, CONTRACTOR shall satisfy ENGINEER or his representative that the methods he proposes to adopt for these operations will not overstress or otherwise affect the strength of the precast units. The reinforced side of the units shall be distinctly marked.

25.4 CURING:

25.5 All precast work shall be protected from the direct rays of sun for at least 14 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits. Otherwise curing practice as given earlier shall be followed.

26.0 SLOTS, OPENINGS ETC.: Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the positions indicated in the drawings or as directed by ENGINEER. Any deviation from the approved drawings shall be made good by CONTRACTOR at his own expense without damaging any other work. Sleeves, bolts, inserts, etc. shall also be provided in concrete work where so specified.

27.0 GROUTING:

27.1 STANDARD GROUT:

27.1.1 The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be as specified on drawings and as directed by ENGINEER.

- a. Sand shall be such as to produce a flowable grout without any tendency to segregate.
- b. Sand, for general grouting purposes, shall be graded within the following limits:

Sr. no.	Sieve size	Percentage
1	Passing IS: 2.36 mm sieve	95 to 100%
2	Passing IS: 1.18 mm sieve	65 to 95%
3	Passing IS: 300 micron sieve	10 to 30%
4	Passing IS: 150 micron sieve	3 to 10%

- c. Surface to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.
- d. Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

Forms around base plates shall be reasonably tight to prevent leakage of the grout.

Adequate clearance shall be provided between forms and base plate to permit grout to be worked into place properly.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate & foundation and to help release entrapped air, link chains can be used to work the grout into plate.

Grouting through holes in base plates shall be by pressure grouting, variations in grout mixes and procedures shall be permitted if approved by ENGINEER.

27.2 SPECIAL GROUT: Special grout, where specified on the drawings, shall be provided in strict accordance with the manufacturer's instructions/specifications on the drawings.

28.0 INSPECTION: All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of ENGINEER.

All materials supplied by CONTRACTOR and all work or construction performed by CONTRACTOR and rejected as not in conformity with the specifications and drawings, shall be

immediately replaced at no additional expense to the OWNER, and to the entire satisfaction of the ENGINEER. Approval of any preliminary materials or phase of work shall in no way absolve the CONTRACTOR from his responsibility of supplying concrete and/or producing finished concrete in accordance with the specifications and drawings.

All concrete shall be protected by the CONTRACTOR against damage until finally accepted by the OWNER or his representative.

- 29.0 CLEAN UP: Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.

All the debris i.e. empty containers, scrap wood, etc., shall be removed daily, as directed by ENGINEER.

The finished concrete surfaces shall be left in a clean condition to the entire satisfaction of the ENGINEER.

- 30.0 PAYMENT:

All work as per the drawings and document is deemed included in the lump sum contract. Measurements will be done only to ascertain compliance.

Brick work

- 1.0 BRICKS:

- 1.1 Bricks used in works shall conform to the relevant Indian Standards. They shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, table molded, deep red, cherry or copper colored, of regular shape and size and shall have sharp & square edges and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing unground particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Over burnt or under-burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 Kg/sq.cm., unless otherwise noted on drawing / BOQ. The classes and quality requirements of bricks shall be as laid down in IS : 3102.

- 1.2 The size of the brick shall be approx. 230 x115 x75/100 mm unless otherwise specified, but tolerance up to plus 3 mm in each direction shall be permitted. However, bricks conforming in size to IS : 1077 could be used. Bricks shall be provided with frogs. Only full size bricks shall be used for masonry work. Brickbats shall be used only with the permission of the ENGINEER to make up required wall length or for bonding. Sample bricks shall be submitted to the ENGINEER for approval and bricks supplied and used in works shall conform to the approved samples. Brick samples shall

be got tested as per IS -3495 by the CONTRACTOR at no extra cost to OWNER. Bricks rejected by ENGINEER shall be removed from the site of works within 24 hours.

1.3 Specification of sand used for brick work shall be the same as that specified for concrete work and shall belong to Grading ZONE-II.

1.4 MORTAR:

1.4.1 Mortar for brick masonry shall be prepared as per IS: 2250. Mix for cement mortar shall be as specified in the respective items of work. Gauge boxes for sand shall be of such dimensions that one complete bag of cement containing 50 kgs. of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER. If so directed by the ENGINEER, it shall be thoroughly washed till it is free of any contamination.

1.4.2 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. The mortar shall be thoroughly mixed of required consistency. The mortar shall be thoroughly mixed and the same shall be used within 25 minutes of mixing. Mortar left unused in the above specified period shall be rejected.

1.4.3 The CONTRACTOR shall arrange for test on mortar samples if so directed by the ENGINEER. Re-tempering of mortar will not be permitted.

1.4.4 Quantity of mortar required for brick work shall be calculated assuming consumption rate of 0.24 Cu.M.per Cu.M. of brick work.

CEMENT CONSUMPTION FOR MORTAR:		
Sr. no.	Mortar proportion	Cement Consumption (Kgs./Cu.M.)
1	1:1	1020 (20.4 Bags)
2	1:2	680 (13.6 Bags)
3	1:3	510 (10.2 Bags)
4	1:4	380 (7.6 Bags)
5	1:5	310 (6.2 Bags)
6	1:6	250 (5.0 Bags)
7	1:1:6 (Cement : Lime : Sand)	250 (5.0 Bags)
Note: The above table is applicable for mortars used in all items of work.		

1.5 WORKMANSHIP:

- 1.5.1 All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. The work of 115 mm thickness shall be laid with stretchers. For laying bricks a layer of mortar shall be spread over the full width of the length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.
- 1.5.2 All brick work shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and shall be in line. Horizontal courses shall be levelled. The thickness greater than 230 mm both faces shall be kept in vertical planes. All interconnected brickwork shall be carried out at nearly one level and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS:2212.
- 1.5.3 Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm. and not more than 12 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plaster or pointing to be done. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If the mortar in the lower course has begun to set, the joints shall be raked out to depth of 12 mm before another course laid.
- 1.5.4 All brick work shall be built tightly against columns, floor slabs or other structural members.
- 1.6 Miscellaneous inserts in masonry e.g. sleeves, walls ties, anchors, conduits, structural steel, etc. shall be installed by the CONTRACTOR at no extra cost to the OWNER. Furnishing of any of these inserts by the CONTRACTOR will be paid for separately. Openings, arches, etc. shall be provided as shown on the drawings to receive windows, louvers, door frames, etc. Wall ties and flashings shall be built into the brickwork in accordance with the drawings and specifications. It shall be clearly understood that the rates quoted by the CONTRACTOR include for fixing of inserts, leaving openings, cutting chases in brickwork for various trades, etc.

1.7 FACING BRICKWORK:

- 1.7.1 Facing bricks of the type specified shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks. No facing brickwork shall at any time be more than 600 mm above the backing brickwork.
- 1.7.2 All facing brickwork shall be pointed as the work proceeds and internal faces of the brickwork shall be pointed with neat flush joint to give a fair face.
- 1.7.3 Faced work shall be kept clean and free from damage, discoloration, etc. at all times. The CONTRACTOR shall fill carefully all holes with bricks similar to the surrounding brickwork, point brickwork, as required.
- 1.7.4 For facing brickwork, double scaffolding shall be used and no holes in brickwork for scaffolding shall be permitted.
- 1.7.5 The green work shall be protected from rain by suitable coverings. Bricks shall be kept constantly moist on all the faces for a minimum period of ten days. Brick work shall not be raised more than one meter per day.
- 1.7.6 The rates quoted by the CONTRACTOR shall be exclusive of transoms and mullions. CONTRACTOR shall provide the same as shown or indicated on the drawings. These shall generally be provided only in half and full brick walls.

Dimensions of the transoms and mullions shall conform to the specifications for concrete and shall be grade M15.

- 1.8 MEASUREMENT: Brickwork of all thickness shall unless otherwise stated in the Schedule of Quantities, be paid in units of cu.m. In all cases, the quantities measured and paid for shall be those actually executed after making necessary deductions for openings, etc. Brick masonry for steps and such other mass works and encasement shall be paid on the basis of rates quoted per cu.m.
- 1.9 INSERTS, BOLTS, ETC. Inserts, bolts, etc. shall be provided in masonry works as indicated on the drawings. It is imperative that all inserts bolts, fixtures and fittings shall be provided in their position very accurately. If the ENGINEER directs that such inserts and bolts be fixed by use of templates, the CONTRACTOR shall make arrangements for providing such templates. If as a consequence of negligence on the part of the CONTRACTOR, the inserts, bolts, fixtures, fittings, etc. are out of alignment, the CONTRACTOR shall make arrangements to have the inserts and bolts removed and refixed in their proper position as directed by the ENGINEER at no extra cost to the OWNER.

- 1 MEASUREMENT: Inserts, bolts, etc. shall be measured and paid for as per the Schedule of Quantities.

BRICK ON EDGE PAVING/PITCHING

2.1 Bricks :

Bricks of the specified strength shall be used. These shall conform to the specifications described in Group 3. Broken bricks shall not be used in flooring except for closing the line. The bricks shall be laid on edge.

2.2 Mortar :

The mortar used shall be as specified. In case of dry brick flooring fine sand shall be filled in the joints.

2.3 Sub-Grade :

2.3.1 Flooring shall be laid on concrete sub-grade, where so provided. The sub-grade shall be provided with the slope required for the flooring. Floors in verandahs, kitchens, bath, water-closets and courtyards shall in variably be provided with suitable slopes to drain off washing and rain water. Plinth masonry off-set shall be depressed so as to allow the sub-grade concrete to rest on it.

2.3.2 Where sub-grade is not provided, the earth below shall be properly sloped, watered, rammed and consolidated. Before laying the flooring, it shall be moistened.

2.4 Laying :

2.4.1 The bricks shall be laid on edge in plain, diagonal herring bone bond, or other pattern as specified or directed by the Engineer-in-Charge.

2.4.2 Bricks shall be laid on edge on 12 mm thick mortar bed, and each brick shall be properly bedded and set home by gentle tapping with handle trowel or wooden mallet. Its inside faces shall be buttered with mortar, before the next brick is laid and pressed against it.

2.4.3 On completion of a portion of flooring the vertical joints shall be fully filled from the top with mortar. The surface of the flooring during laying, shall be frequently checked with a straight edge at least 2 M long, so as to obtain a true plain surface with the required slope.

2.4.4 Dry brick flooring shall be laid on a bed of 12 mm thick mud mortar laid to required slope.

2.5 Joints :

Brick shall be so laid that all joints are full of mortar. The thickness of joints shall not exceed 1.0 cm for brick work with bricks of any class designation. All face joints shall be raked to a minimum depth of 15 mm by raking tool during the progress of work when the mortar is still green so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. The face of brickwork shall be cleaned on the same day on which brickwork is laid and all mortar droppings removed promptly.

2.6 Measurements :

The measurement of Brick on edge flooring/paving will be done on Cu.m.basis or as specified otherwise. The actual measurements of length, breadth and height will be taken for calculations.

2.7 Rate :

The price quoted shall include the cost of all materials and labour involved in all the operations described above, including application of cement slurry on sub-grade or R.C.C. slab and leveling, cleaning of sub-grade.

Flooring works

5.1 APPLICABLE CODES AND SPECIFICATIONS

The following codes, standards and specifications are made a part of this specification. All standards, specifications, codes o practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

In case of discrepancy between this specification and those referred to herein, the specification shall govern.

IS:777 : Glazed Earthenware files

IS:2114 : Code of Practice for laying in situ terrazzo floor finish

IS:2571 : Code of Practice for laying in situ concrete flooring.

IS:4860 : Specification for acid resistant bricks

IS:5491 : Code of Practice for laying in granolithic floor topping

5.2 GRANOLITHIC (IPS) FLOORING

5.2.1 GENERAL

Base Slab :The surface of the structural base slab shall be finished at a level not less than 1 inch below the required finished grade. The floor finish shall generally conform to IS:5491.

5.2.2 MATERIALS

1) Portland Cement

Portland cement shall be of approved quality and shall conform to IS:269.

2) Aggregates

Fine aggregate shall consist of clean, hard, sand and / or crushed stone screening, free from dust, clay, loam or vegetable matter and shall be graded from coarse to fine to meet the following requirement.

Sr. no.	Sieve particulars	Percent
1	Passing 3/8" in sieve	100
2	Passing No. 4 sieve	95 to 65
3	Passing No. 16 sieve	45 to 65
4	Passing No.50 sieve	5 to 15
5	Passing No.100 sieve	0 to 5

Coarse aggregate shall consist of clean, hard gravel or crushed stone free from dust, clay, loam or vegetable matter, and from coating which will tend to weaken the bond. It shall contain no soft, flat or elongated fragments and shall be graded to meet the following requirements.

Sr. no.	Sieve particulars	Percent
1	Passing 1/2" in sieve	100
2	Passing 1/8"sieve	95 to 100
3	Passing No. 4 sieve	40 to 60
4	Passing No. 8 sieve	0 to 5

3) MIXTURES

The nominal mixture shall be 1 part of Portland cement, 1 part of the fine aggregate and 2 parts of coarse aggregate by volume. This nominal mix may be slightly varied, depending upon the local

conditions as directed. If the aggregate is very coarse, the gravel or stone may be reduced, but in no case shall the volume of the coarse material be less than 1.5 times the quantity of sand.

The mixtures shall be determined and once established shall not be changed except upon written order from the OWNER / CONSULTANT.

Not more than 4 gal. Of mixing water, including the moisture in the aggregate, shall be used for each 50 kg bag of Portland cement in the mixtures when floating is done by machine.

The mixing of the concrete shall continue for at least 1.5 minutes after all ingredients are in the mixer.

4) CONSISTENCY

The concrete shall be of the direst consistency and shall be possible to work it with a sawing motion of the strike-off board on straight-edge. Changes in consistency shall be obtained by the adjusting of proportions of fine and coarse aggregate within the limits specified. In no case shall the specified amount of mixing water be exceeded.

5) PLACING AND COMPACTING

Water and laitance which rise to the surface of the base slab shall be removed before applying the wearing course. After concrete in the base slab has set sufficiently so that water does not rise to the surface, but within 2 hours of placing, the wearing course shall be applied and brought to the established grade with straight-edge, after striking off the wearing course to the established grade it shall be compacted by rolling or tamping and then floated with a wood float or power floating machine. The surface shall be tested with a straight edge to detect high and low spots, which shall be eliminated.

Following additional points shall also be observed.

- i) Before placing the topping, a slurry coat of cement and water mixed to the consistency of thick paint shall be thoroughly broomed into the wet surface of base slab.
- ii) The topping shall be placed immediately before the slurry coat dries. Excess water and grout puddles shall be swept away.
- iii) Concrete shall be spread over the surface and not heaped to prevent segregation.

6) FINISHING BY TROWELING

Floating shall be followed by steel troweling after the concrete has hardened sufficiently to prevent

excess fine material from working to the surface. Floating shall be finished normally within about 3 to 3.5 hours of laying the topping. The finish shall be brought to a smooth surface free from defects and blemishes. No dry cement nor mixture of dry cement and sand shall be sprinkled directly on the surface of the wearing course to absorb moisture or to stiffen the mix. After the concrete has further hardened, additional troweling may be required. This shall be done as may be directed. Surface to be ground shall be swept with soft brooms, after rolling to remove any water and surplus cement paste which may be brought to the surface. The wearing course shall then be floated and lightly troweled, but no attempt shall be made to remove all trowel marks. The edges of the panels of topping shall be rounded off at proper time, by edging tool, before the concrete finally sets.

7) CURING AND PROTECTION

All freshly placed concrete shall be protected from the elements and from all defacement due to building operations. The CONTRACTOR shall provide and use tarpaulins when necessary to cover completely or enclose all freshly finished concrete.

As soon as the concrete has hardened sufficiently, to prevent damage, it shall be covered with at least 25 mm of wet sand or other satisfactory covering and shall be kept continuously wet by sprinkling with water for at least 3 days when using high early strength Portland cement. In lieu of other curing methods, the concrete may be covered with a colourless curing compound or with asphalt impregnated, waterproofed paper. All seams of such paper shall be over-lapped and sealed with tape.

5.3 ABRASION RESISTANT FLOORS

5.3.1 Floors using metallic Hardeners

Unless otherwise specified, one part of Ironite and four parts of ordinary Portland cement by weight shall be mixed dry thoroughly on a clean and dry platform. This dry mixture shall be mixed with stone grit 6 mm and down size in the ratio of 1:2 (Ironite cement mixture : 2stone grit) by volume and well mixed over, just enough water shall be added to this dry mix before laying.

Laying

Over first layer of 38 mm thick M-15/M-20 grade (as in B.O.Q.) concrete 12 mm thick Ironite topping shall be laid. The topping shall be laid true to line to provide uniform and even surface. It shall be firmly pressed into bottom concrete so as to have a good bond with it. After the starting of initial setting the surface shall be finished smooth and true with steel floats. The laying as usual shall be done in rectangular or square panels, using wooden strips of height equal to the specified

thickness of the floor finish. No dimension of a panel shall exceed 2M and the area of panel shall not be more than 2 sqm.

Curing shall be done for period of 7 days by ponding the finished area.

5.4 FLOORS USING NON-METALLIC HARDENER

Wherever industrial flooring using non-metallic hardener is specified, the same shall essentially be composed of thermo setting polymers reinforced with minerals and fibres suitably coupled and compounded with organo functional sealants. (Refer to Data Sheet 'B' for recommended Vendor / brand information).

5.4.1 Laying

The standard thickness shall be 12 mm, 15 mm and 20 mm. The thermal rating shall be 60°C continuous with max. permissible operating temperature of 110°C. The material chosen shall withstand acidic, alkaline or a combination of acidic and alkaline conditions and shall be laid as per manufacturers specification.

4.4.2 Physical properties

Typical physical properties of the material used shall be as per following details:

Sr. no.	Property	Value
1	Compressive strength	1100 to 1500 kg/cm ²
2	Tensile strength	220 to 350 kg/ cm ²
3	Coefficient of thermal Conductivity	0.08 to 2 Kcal/m.hr.°C

Laboratory or field tests in order to check conformity with above specifications, if ordered by the Engineer, shall be performed by the Contractor without any extra payment.

5.5 TERRAZZO (MOSAIC) TILE FLOORING

Terrazzo tile shall be 20 mm thk. of approved shade and size, conforming in all respect to IS:1237 (Refer to Data Sheet 'B' for Vendor / brand information).

Laying

The bedding for the tiles shall be of cement mortar 1:3 (1 cement : 3 sand) mix. The average thickness of bedding mortar shall be 20 mm and the thickness at any place shall not be less than 13

mm. Cement mortar bedding shall be spread, tamped and corrected to proper levels and allowed to harden for a day before the tiles are set.

Over this bedding neat cement slurry of honey like consistency shall be spread at the rate of 5 kg. cement per square metre. Tiles shall be soaked in water for 20 minutes and allowed to drain out for 20 minutes before laying. Tiles shall be laid in the mortar bedding from center to outwards to obtain a symmetrical pattern, each tile being gently tapped with wooden mallet till it is properly bedded and is in level. Laying shall be frequently checked with a straight edge at least 2m long so as to obtain true surface with required slope. Fractional tiles shall be used where full tiles cannot be used. If the extra space left out is less than 25 mm it shall be filled with coloured terrazzo to match the tile pattern and finished to match tiled floor.

Joints

The joints shall be uniform and as thin as possible and run in straight lines or to suit the required pattern.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 13 mm under the plaster, skirting or dado. The junction between wall plaster and tile work shall be finished neatly and without wavings.

After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleaned off.

Curing, Polishing and finishing

On the day after the tiles are laid, all joints shall be cleaned with wire brush to the depth of 5 mm and all dust and loose mortar removed. Joints shall then be grouted with grey or white cement, mixed with or without pigment to match the shade of the topping of the wearing layer of the tiles. Pigment shall conform to IS:59.

However, this may be noted that the properties may vary slightly depending upon the individual manufacturers. Manufacturer's specifications, prior approval from Engineer shall be followed.

The floor shall then be kept wet for minimum period of 7 days. The surface thereafter be ground evenly to the satisfaction of the engineer with machine grinders in 3 phase with grade stones from coarse to fine grade. The surface shall receive wash of neat cement mixed with or without pigment and cured before every grinding operation. After final polish, surface shall be cleaned and oxalic acid shall be dusted over the surface at 35 gm/sqm. sprinkled with water and rubbed hard with pad

of wooden fags and wiped, with soft cloth. Finally, the finished Terrazzo surface is to be rendered with turpentine or similar approved material. The surface after polishing shall be hand polished. In all other respects the process shall be similar as per machine polishing.

Tests to determine Transverse strength, water absorption, abrasion etc. may be ordered by Engineer for checking with IS requirements. Contractor shall perform all tests without any extra payment.

5.6 PVC TILE FLOORING

PVC (vinyl) tiles shall be 3 mm thick. These shall be of approved make conforming to IS:3461 or 3462.

Laying

A course of approved base binding agent shall be applied evenly over the bedding which shall be finished even and smooth. The tiles shall be sufficiently dried before fixing to the floor. The tiles shall be jointed with binding agent. After allowing it to become sufficiently dry, the tiles shall be pressed down with even pressure until it adheres well to the bed material. In case the binding agent rises from the joints it shall be removed. The tile floor shall be cleaned with the tile finish wax and polished with the muslin cloth. The binding material shall be from approved manufacturer.

The pattern and colour arrangement for the flooring and dado shall be as indicated on the drawings or as specified by the Engineer. The contractor shall assume full responsibility for any failures and defects in the tile finish work.

The tiles shall be laid in accordance with approved manufacturer's directions.

All flooring shall be thoroughly cleaned up to full satisfaction of the Engineer.

5.7 ANTI-SKID VITRIFIED,VITRIFIED,CERAMIC / GLAZED TILES

Tiles shall conform to IS: 777 in all respect and shall be of approved type, make, colour, shade, quality and make.

These shall be flat, true to shape and of uniform shade. These shall also be free from cracks, spots, chipped edges and corner. Thickness of tiles shall be 6 mm, unless otherwise specifically mentioned in drawings or schedule of items.

Preparation of Surface and Laying

Base course concrete or RCC slab on which tiles are to be laid shall be well cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar 1:3 as specified. The average thickness of the bedding shall be not less than 10 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 also to enable the mason to place wooden plank across and to sit on it for the work.

Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread, at the rate of 3.3 kg per square metre, over an area such that approximately 20 tiles can be accommodated. Tiles shall be washed cleaned and fixed on this mortar one after another, each tile being gently tapped with a wooden mallet till it is properly bedded in level with adjoining tiles.

Joints shall be uniform and as thin as possible.

Curing, Pointing and Finishing

The joints shall be cleaned off, the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed. Joints shall then be pointed with white cement.

Flooring shall be kept wet for 7 days. The tiled surface shall then be finished with a 3% solution of oxalic acid duly waxed and polished as directed by the Engineer.

The troweling operation should not take place before the concrete has hardened enough to carry the machine, i.e. the troweling blades will not leave any marks on the concrete. Repeated troweling, with intervals between the passes should be adopted. At least two passes are recommended for floors which are not to be covered.

Tests to determine water absorption, crazing, impact strength, chemical resistance etc. may be ordered by Engineer for checking with IS requirements. Contractor shall perform all tests without any extra payment.

5.8 KOTAH STONE FLOORING

Kotah stone shall be obtained from reputed suppliers as approved by the Engineer.

The stone shall have natural split non slip surface and non-porous. As the stones are natural and driven, material supplies may not be in a particular thickness. The range of thickness shall be 12-15

mm, 16-24 mm and 25-37 mm. The standard size shall be 600 mm x 600 mm. The bedding mortar will be either 1:2 cement sand or chemically resistant mortar as per duty conditions shown on the drawing. The tiles will have hand pitched edges.

5.9 TREMIX CONCRETE FLOORS

5.9.1 General

The contractor shall improve the quality of all concrete floor slabs by placing concrete according to the Tremix system as indicated on the contract drawings and as specified herein.

5.9.2 Technical Assistance / Training of Labour

During the placement of concrete, the Contractor shall have a minimum of one person present at all times who has been adequately trained by a representative of the equipment and shall direct all concrete dewatering work performed. The contractor shall provide the services of a representative from the manufacturer of the vacuum dewatering equipment on site. The manufacturer's representative shall provide technical assistance for the vacuum dewatering process on the initial day of operation (Refer to Data Sheet 'B' for Vendor / brand information).

5.9.3 Equipment for Compaction, Placing, Vacuum Processing & Finishing of Slab

All process equipment to be used shall be of proven design, and shall be subject to the approval of the Engineer. Equipment shall be Tremix or approved equal. The system shall have demonstrated five years history of performing such work. The vacuum pumps shall be able to generate a minimum vacuum of 609 mm (24 inches) of mercury (0.80 atmospheres) in actual operation using the maximum number and size of suction mats required for this work.

The contractor shall have at the job site sufficient, equipment (vacuum pumps, mats, filter pads and accessories) to ensure that the vacuum dewatering process continues uninterrupted till completion.

5.9.4 Mix Design

The contractor will be responsible for the mix design of the class as called for on the Contract Drawings and must conform with the mix proposed for use in the Contract before any work is started. All mix parameters must conform to the values specified in Tremix recommendations and preferably be tested with Trevac Meter.

The contractor shall utilize knowledgeable and experienced concrete technicians for the design and production of mix, meeting all the requirements of the specifications.

5.9.5 Quality Control

The contractor has the responsibility for achieving the quality of concrete specified by controlling the concrete mixes, placing, vacuum process finishing and curing. The concrete technician in charge must be present at the site when work is in progress.

The contractor shall be responsible for mix adjustments, performing necessary tests, correcting deficiencies and trouble shooting in general.

The contractor shall be required to maintain control charts showing individual test results for aggregate gradation, slump, air content, cement content and compressive strength.

5.9.6 Planning of Placing

The contractor shall submit for review shop drawings for floor slabs detailing the location of all construction joints and the sequence of slab placement, and manufacturer's literature describing the equipment to be used. In addition to the shop drawings, the Contractor shall indicate the quantity of each dewatering equipment that will be located at the construction site and shall include the dimensions of all suction mats.

Before concreting, the work should be planned with a view to determine areas to be placed daily, the required amount of equipment, size of vacuum mats, length of vacuum hoses, arrangement of rails, if any, or screeds etc. Placing, vibration, vacuum treatment and floating to follow immediately behind each other. The planning shall be approved by the Engineer.

Cement

Portland cement of normal grinding fineness, which corresponds to a specific surface of 2600 – 3500 sqcm/gm is required in Tremix concrete. Cement of higher grinding fineness, e.g. rapid-hardening Portland cement of larger specific surface/g shall be avoided.

5.9.7 Equipment Specification Tremix System

Poker vibrator with frequency preferably 335 hz (20,000 vibr/min.) dia. 25 to 40 mm.

Surface vibrator type double beam with beam spacing 300 mm. Preferably one-piece beam in full length exceeding bay width within 20 to 60 cm. Beam should easily be adjusted to absolute straightness and controlled every morning before placing of concrete starts.

Suction mat 100% light plastic material weight 650 gram/sqm. Width same as bay size and length 6

M for capacity and flexibility.

Filter pad weight 600 sq/sqm. width 1.2M, length bay width minus 20 cm.

Vacuum pump with 10 HO engine and specially designed pump unit with heavy duty chrome housing and sealing. Adjustable vacuum by valve on top of tank for ease of operation with different mix designs.

Skim floater with disc, which allows direct floating of dewatered concrete. Weight maximum 90 kg. for 1000 mm. Finishing is done with blades only and is normally done with 30 minutes intervals between passes.

The above equipment specified should be used for the production of quality concrete floors according to the Tremix System. Interchangeability of equipment is not recommended.

5.10 EXECUTION OF TREMIX SYSTEM

5.10.1 General

The work shall be planned and executed so that there is no delay between the placement, screeding, dewatering and floating of the concrete. Concrete to be vacuum dewatered shall be handled and placed carefully so as to prevent segregation. The concrete shall be properly vibrated prior to screeding.

5.10.2 Levelling

Immediately following placement, the concrete shall be leveled with a vibrating screed running on a true surface, set at the proper elevation required to provide the specified finished elevation. The concrete surface shall be screeded high by 2% of the slab's thickness to compensate for the compaction caused by the vacuum dewatering process. The vibrating screed shall be moved forward as rapidly as proper consolidation allows. The proper surcharge of concrete must be maintained in front of the leading edge of the screed.

5.10.3 Vacuum

Immediately after leveling, the concrete shall be covered with filter pads and suction mats in strict accordance with the recommendation of the manufacturer to have slab fully dewatered. The suction mat shall extend 10 cm beyond the edge of the filter pad on all sides. The pads shall extend to within 10 cm of the edge of concrete slab, and the mats shall cover entire slab. Before connecting the hose on the suction mat to the vacuum pump, the edges of the mat shall be smoothed to

enable an airtight seal to be created. Vacuum shall then be applied to the mat.

The vacuum shall be maintained for at least 12 minutes per 10 cm of concrete thickness at 0.80 atmospheres (Where aggregate hardeners are specified, sufficient moisture shall be maintained to meet manufacturer's requirements). The suction mats and filter pads shall then be removed and moved to the next section in a leapfrog manner.

Stop the vacuum dewatering when light footprints only are left in the concrete when stepped upon. A suitable suction time can also be checked with a Proctor apparatus, which should show 1-5-2 kg/sqm. pressure.

5.10.4 Floating

On removal of the suction mats and filter pads, the concrete surface shall be power-floated without delay until all imprints from the vacuum process are removed. If crusting occurs, the floating operation must be delayed.

Higher speed is recommended for the floating operation. Two passes with the floating disc should be made in the junction of two mats in order to avoid risk for cracking.

5.10.5 Finishing

The waiting time after the floating operation depends on concrete temperature and humidity and varies from 10 minutes to 2 hours.

The troweling operation should not take place before the concrete has hardened enough to carry the machine i.e. the troweling will not leave any marks on the concrete. Repeated troweling, with intervals between the passes should be adopted.

At least two passes are recommended for floors, which are not to be covered.

5.10.6 Curing

Vacuum dewatered concrete should be cured like any other quality concrete in order to achieve a good final result using curing compounds, plastic sheets or wet burlap.

5.11 **MAGNESIUM OXYCHLORIDE FLOORS**

Magnesium oxychloride flooring shall be laid generally as per recommendation of IS: 657 and IS: 658.

5.11.1 Application

Preparation of the base shall be sound, rigid, free from rising damp and not unduly porous. The base may be of cement concrete, or timber. Highly absorbent materials such as pumice concrete; breeze or clinker concrete and aerated concrete shall not be used unless a layer of damp proof course is laid between the base and the main floor.

New Cement concrete base

The base or screed should have a true and even surface, which has been slightly coarsened by means of a stiff broom or wire brush and should be free from ridges and hollows. A steel troweled finish is not desirable.

The levels of the base should be such that the specified thickness of magnesium oxychloride can be applied uniformly. It is of particular importance to ensure that there is a minimum cover of at least 25 mm of impervious uncracked dense concrete or a screeded bed over any base containing reinforcement either as rods or in filler joints. Any magnesium chloride solution gaining access to the reinforcement may cause serious damage. New concrete to which oxychloride composition is to be applied directly should be allowed to age for at least 28 days before the application of oxychloride composition. No hardening agent other than water shall be used in the concrete. No lime admixture shall be allowed in the concrete where oxychloride is to be applied directly to the concrete.

Existing concrete base

This should be checked for absorption. The existing cement concrete base should be roughened to suitable degree by tooth chiseling, picking or by any other suitable process before oxychloride composition is laid.

Timber base

A suitable mechanical key should be provided between the timber base and the floor finish such as dove tailed wooden battens or galvanized wire netting firmly secured to the base at approximately 200 mm centers with galvanized clout nails driven home at joints of the mesh. An equal number of galvanized clout nails should be used at 200 mm centers and be left proud of the base.

The moisture content of the timber base shall not exceed the limits specified for the corresponding zones given in IS:287.

5.11.2 Preparation of Floor Finish Mixture

Magnesium Chloride Solution – Magnesium chloride both before and after it has been dissolved should not be allowed to come into contact with any floors or walls. Whenever possible, the work of breaking up and dissolving the solid material or diluting the solution should be performed outside the building. Where the work has to be done inside, adequate protection should be provided under and around all vessels containing the chloride by means of tarpaulins, trays or other suitable devices. The solid chloride should be broken up and dissolved in a water tight vessel by covering the same with clean water, that is, clean and free from deleterious acids, alkalis, salts organic material and stirring the same from time to time. The solution should be allowed to stand overnight so that residue, dust, impurities, etc. may settle to the bottom. The clean concentrated solution should be well stirred after each dilution before determining the specific gravity. The solution shall be prepared sufficiently early so that it is cooled to room temperature before use. The specific gravity of the chloride solution should be maintained at a selected value within the limits in Table 1. This value will depend on the type of work, the nature of the base and ambient temperature conditions.

TABLE 1 : SPECIFIC GRAVITY OF MAGNESIUM CHLORIDE SOLUTION

Flooring finish mix (1)	Baume (be)-conc Scale (2)	Specific gravity (3)
Single coat and top coat	20° to 24°	1.16 to 1.20
Bottom coat, coves and skirtings	18° to 20°	1.14 to 1.16

5.11.3 Final mixing

The mixing of the chloride solution with the dry mix should be carried out in trough or box on a bunker and in no case directly on the floor. The quantity of material mixed in any one batch should be such as can be laid easily before initial set begins. The addition of further quantities of chloride solution during laying should not be permitted. If the mix becomes too stiff to be worked, it should be discarded.

5.11.5 Laying the Floor Finish

If the floor finish is to be laid on a concrete base, this should be thoroughly dry before commencement of laying.

The floor finish should not be laid over or near any localized source of heat.

Size of Bay

The floor finish should be laid between battens trued and leveled to ensure that the thickness of each coat complies with the requirements. The optimum size of bay will depend upon the temperature conditions at the time of laying and, generally, the controlling factor would be the time taken to obtain adequate compaction of the floor finish.

Jointing

Where a dimension of floor surface in either direction is 7.5 M or more, joint shall be provided at interval of not more than 5M. These may be in the form of mastic insertions or may consist of strips 5 mm in width of hard wood, vulcanite, non-ferrous metal or other suitable material bedded flush with the surface of the flooring materials. Where the flooring is laid over concrete sub-floor, it is important that any joint in the flooring should be made not to coincide with joint in the sub-floor.

Laying

A concrete base or screed should be damped before laying the floor, finish, but excessive wetting or flooding should be avoided. The damping should be carried out with either:

- a) A solution of magnesium chloride which should be not weaker than 12% - nor stronger than 14% or
- b) A wash composed of at 14% Magnesium chloride solution and magnesia mixed to the consistency of cream and brushed over the base.

5.11.5 Curing

Rapid drying of the floor finish should be avoided for at least the first 24 hours after laying. It should be allowed to set and harden, undisturbed for at least three days before opened to traffic. The setting and hardening process is affected by the surrounding temperature conditions and in cold weather it may be advisable to allow a longer period before the floor is put into use. In any case, some weeks should necessarily elapse before the floor finish is fully dried and hardened and, for this reason, it should not be exposed to abnormally heavy traffic during this period.

Protection of the Surface

During laying and until the floor finish has hardened, it should not be exposed to extremes of heat or cold. The surface should be protected from the direct rays of the sun and rain.

5.11.6 Magnesium Chloride

Chemical Requirements

The composition of calcined magnesite when tested in accordance with the method given in IS:10032 shall be as specified in Table 2.

TABLE 2 : CHEMICAL REQUIREMENTS OF CALCINED MAGNESITE

Sr.No.	Characteristic	Requirements
i	Magnesium oxide (MgO) percent by mass	87 Min.
ii	Calcium oxide (CaO), percent by mass	2.5 max.
iii	Carbon dioxide (CO ₂), percent by mass	2.5 max.
iv	Loss on ignition (Carbon dioxide & water), percent by mass	8 max.
v	Total contents of MgO, CaO, Al ₂ O ₃ , SiO ₂ and loss on ignition, percent by mass	99.5 min

5.11.7 Physical requirements

The physical requirements of calcined magnesite when tested in accordance with the method given in IS:10032 shall be as specified in Table 3.

Sr.No.	Characteristic	Requirements
1	Bulk density, Kg/1	0.65 to 0.85
2	Fineness	
a	Percent by mass passing through 150 micron IS Sieve.	97 min.
b	Percent by mass passing through micron IS Sieve	95 min.
3	Setting time, hours	
a	Initial	3 to 6 hrs
b	Final	7 to 15 hrs.
4	Modules of rupture N/sqm.	
a	At 7 days	7 min.
b	At 28 days	10.5 min.
5	Linear change, percent: The average change in length	
a	Duration expansion	0.15 max.
b	Duration contraction	0.25 max.

5.12 **MODE OF MEASUREMENT (IS:1200)**

16.1 Flooring and Dado Finishes

The work shall be measured on basis of finished area. The rate shall include all materials, labour, tools and tackles, curing, cleaning, wastages etc. complete as specified.

5.12.1 Skirting

The measurement shall be in RM basis. The rate shall include all materials, labour, curing etc. complete as specified.

Water Bound Macadam

1. Scope

This specification covers the general requirements for construction of Water Bound Macadam (WBM)

2. Description

It is the intent of this specification that the water bound macadam road be constructed first. This shall then be opened to traffic, as directed by Engineer. After such period of time as decided by Engineer, preferably when the major construction work and/or erection activities within plant boundary are over, Contractor shall rectify all defects, wear and tear etc. of WBM road. Before taking up rigid pavement work required service crossings such as storm water drains, electrical crossings, piping etc. shall be completed. The contractor shall then only commence concrete pavement works as specified hereunder.

3. Materials

3.1. General

All materials shall be obtained from local sources and shall be subject to Engineer's approval prior to use.

3.2. Stone Aggregate/Metal

Coarse aggregate and screenings shall consist of natural or crushed stone, clean, hard, tough, durable and free from excess of flat, elongated, soft and disintegrated particles, clay, dirt, salt, alkali, vegetable matter, adherent coatings, organic and other objectionable matter, and shall conform to the physical requirements given in Tables 1 or 2 hereunder, as applicable.

Table 1 : Physical Requirements of Coarse Aggregate for Water Bound Macadam

(Sub Base / Base Course)

Sr.No.	Test	Requirements	Test Method
1.	Los Angles Abrasion Value ^a or	40 percent (max.)	IS:2386 (Part-4)
	Aggregate Impact Value ^a	30 percent (max.)	IS:2386 (Part-4) or IS :5640
2.	Flakiness Index ^b	15 percent (max.)	IS:2386 (Part-1)

a) Aggregate may satisfy requirements of either of two tests.

- b) Requirements of flakiness index shall be enforced only in case of crushed/ broken stone.
- c) Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact Value under wet conditions in accordance with IS: 5640.

The coarse aggregate for water bound macadam shall conform to one of the grading given in Table 2

Table 2 : Grading Requirements of Coarse Aggregates for Water Bound Macadam

Grading No.	Size Range	IS Sieve Designation	Percent by Weight Passing the Sieve
1.	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5
2.	63 mm to 45 mm	90 mm	100
		63 mm	90-100
		53 mm	25-75
		45 mm	0-15
		22.4 mm	0-5
3.	53 mm to 22.4 mm	63 mm	100
		53 mm	95-100
		45 mm	65-90
		22.4 mm	0-10
		11.2 mm	0-5

3.3. Screenings for Water Bound Macadam

Screenings to fill voids in the coarse aggregate shall consist of the same materials as the coarse aggregate. However, where permitted, predominantly non-plastic material such as murrum or gravel (other than river borne rounded material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent. Screenings shall conform to the grading set forth in Table 3. Screenings of Type A in Table 4 shall be used with coarse aggregate of grading 1 in Table 2. Screenings of Type A or B, as directed, shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3. The use of screening shall be omitted in the case of soft aggregates such as kankar, laterites etc. as they are likely to get crushed to a certain extent under rollers.

Table 3- Grading For Screenings :

Grading Classification	Size of Screenings	IS Sieve Designation	Percent by Weight Passing the Sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95-100
		5.6 mm	15-35
		180 micron	0-10
B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 micron	15-35

3.4. Binding Material

Binding material shall comprise of a suitable material approved by Engineer, having plasticity index value of less than 6 as determined in accordance with IS: 2720 (Part- 5). Application of binding material may not be necessary, when the screenings used are of crushable type such as murrum or gravel.

Murrum/Kankar/Gravel/Sand Murrum shall contain low plasticity binder material mixed with hard granular particles such as sand and/or gravel. Murrum shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free from all impurities. Large lumps shall be broken at the quarry and murrum delivered at site must pass in every direction through a 63-mm ring. Murrum shall not contain more than 5% to 8% of fines passing a 75-micron sieve.

Gravel shall be composed of large, coarse, siliceous grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense and shall not contain particles bigger than 12 mm and more than 10 percent silt. Sand used for blinding the bituminous road surface, shall be coarse, sharp, gritty, clean, granular material. Only material passing through 4.75 mm sieve and retained on 75 micron sieve shall be used.

4. Construction Sequence

4.1. Earthwork Excavation

4.1.1. Clearing the site:

Clearing the site before earthwork shall be done. The area coming under cutting and refilling shall be cleared off shrubs, vegetation, grass, brush wood trees and saplings and such other things and rubbish as directed by the Engineer.

4.1.2. Limits of excavation:

The contractor shall perform excavation to the given lines and levels as directed by the Engineer. The bottom and sides of excavation shall be dressed to proper levels, slopes, camber etc. as directed by the Engineer by removing high spots and filling up hollows. Excavation be taken below the specified levels the contractor shall at his own expense fill up with suitable earth duly consolidated to the satisfaction of the Engineer. After excavation the excavated surface should be rolled by minimum four passes of 10T smooth wheeled vibratory roller.

4.1.3. Earthwork in Excavation

The entire Earthwork in excavation shall be done as per. relevant clauses of Technical Specification for Earthwork Profiles of road excavation shall be checked & verified at every 50 m intervals to conform to the required alignment, sections, grades and side slopes and the lines of cuts & all these shall be clearly marked.

CONTRACTOR shall on no account excavate beyond the slopes or below the specified grade level unless so directed by the ENGINEER in writing. If excavation is done below the specified level or outside the section, it shall not be paid for and the CONTRACTOR shall be required to fill up at his own cost such extra excavation with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for the sub grade.

The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections and side slopes as shown in the drawings or directed by ENGINEER.

4.2. Earthwork in Embankment

The embankment shall be formed of earth obtained from approved source. The ground over which embankment is to be formed shall be cleared of all brushwood, loose stones, vegetation, bushes, stumps, and all other objectionable matter and materials so removed shall be burnt off or disposed off as directed by ENGINEER. The cost of this clearing, burning and disposal shall be included in the unit rates quoted for embankment construction. Profiles of embankment shall be set up with stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 m on straight portions. Toe line may be marked with pick marks. Before placing any embankment material the top 150 mm of soil strata receiving it shall be scarified and watered and compacted with 8-10 T roller so as to achieve minimum dry density of 95% as per IS: 2720 (Part 8). Embankment material shall be placed in successive horizontal layers so as to achieve compacted thickness of 200 mm extending to the full width of the embankment including the slopes at the level of the particular layer and 300 mm more on both sides to allow compaction of the full specified section. Before placing the next layer the

surface of the under-layer shall be moistened and scarified with pick axes or spades to provide a satisfactory bond with the next layer. The extra loose stuff at the edges shall be trimmed later after completion of the bank work at no extra cost leaving the correct section fully compacted. When boulders, broken stones and similar hard materials are mixed up with the embankment materials, care shall be taken to see that they are distributed uniformly into the bank and that no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, leveled, and compacted as specified before the succeeding layer is placed. The surface of the embankment shall at all times during construction be maintained at such a cross fall as will shed water and prevent ponding.

If the bank material contains less than the optimum moisture, water shall be added to the loose layers of the embankment to bring the moisture uniformly up to the requirement. If the material contains more than the required moisture, it shall be allowed to dry until the moisture is reduced to the required extent.

The moistened/dried loose layers shall be compacted with a power roller of 10 to 12 tones. The roller shall pass at least twice over the same area, once in the forward move and the second time in backward move. Each layer shall be thoroughly compacted to achieve minimum dry density of 95% as per IS: 2720 (Part 8). To allow for subsequent settlement, the finished level of the embankment shall be kept higher than the specified level by one centimeter for every meter of the height of the bank. Embankment shall be finished and dressed smooth and even to conform to the alignment, levels, cross sections, and dimensions shown on drawings with due allowance for shrinkage. Any damage caused by rain, or any other reason shall be made good in the finishing operation.

5. Preparation of Subgrade

In general earthwork in sub grade shall be done as per relevant clauses of Technical Specification for Earthwork.

Immediately prior to the laying of the sub base/base coarse the sub grade shall be cleaned of all foreign substances, vegetation etc. Any ruts or soft yielding patches that appear shall be corrected and the sub grade dressed off parallel to the finished profile. The camber of sub grade shall conform in shape to that of the finished road surface. Camber boards shall be used to get the required section. The prepared sub grade shall be lightly sprinkled with water, if necessary, and rolled with power roller of not less than 10 tones, till the soil is evenly consolidated to 95% of Proctor density with 2% variation in optimum moisture content. Roller shall pass minimum 5 runs on the sub grade. Rolling shall commence at the edges and progress towards the centre longitudinally. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass.

Any undulations in the surface that develop due to rolling shall be made good with approved earth and sub grade re-rolled.

6. Water Bound Macadam

Over the sub grade the coarse aggregate shall be spread uniformly and evenly in the required quantities in layers as specified below: The aggregate shall be spread uniformly by using templates placed across the road 6m apart.

6.1. Base Coarse

Base course (Layer I) for WBM of specified thickness shall be provided using 63 – 40mm (Grade II) hard broken granite metal over sub grade, where specified in the Schedule of Quantities. The coarse aggregate for this shall conform to physical requirements and grading as specified in the above. The total consolidated thickness of the sub-base course shall be as specified in the Schedule of Quantities/drawings.

6.2. Water Bound Macadam

WBM layer (Layer II) of specified thickness shall be provided using 50mm IRC metal over a base coarse as per the Schedule of Quantities. The coarse aggregate for this shall normally conform to physical requirements and grading as specified in the above table. The total consolidated thickness of the WBM course shall be as specified in the Schedule of Quantities/drawings.

6.3. Spreading Coarse Aggregate

The coarse aggregate of size as specified in the schedule of quantity shall be spread uniformly and evenly upon the prepared surface in such quantities that specified the compacted thickness of each layer is obtained. The spreading shall be done from stockpiles by raking the stacks with rakes so as to leave behind mud and dust. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted sub-grade / sub-base be permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved plan. The coarse aggregate shall not normally be spread in lengths exceeding 3 days' average work ahead of the rolling and bonding of the proceeding section.

6.4. Rolling

Following the spreading of the coarse aggregate, rolling shall be started with vibratory roller of approved type of minimum 10tonnes capacity. Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges and gradually progress towards the centre. First the edge/edges shall be firmly compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width. In case of sub-base course, rolling shall be continued until the coarse aggregate has been thoroughly keyed and forward movement of stones ahead of the roller is no longer visible. In case of base course, rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub grade is soft or yielding or when it causes a wave-like motion in the sub grade or sub-base. The rolled surface shall be checked transversely and longitudinally with templates and all undulations shall be corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions. Material, which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates. It shall be ensured that shoulders are also built-up simultaneously along with water bound macadam course.

6.5. Application of Screenings

After the coarse aggregate of the sub-base course/ base course has been rolled in accordance with relevant Clause, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by spreading motion of hand shovels or by mechanical spreaders or directly from trucks. Trucks shall be so driven as not to disturb the coarse aggregate. Screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall screenings be applied so fast and thick as to form cakes and ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate. Spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road, which could be completed within one day's operation.

6.6. Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the sub-grade or sub-base or base does not get damaged due to the addition of excessive quantities of water during construction. In case the sub grade or sub-base gets damaged, the Contractor shall, without additional cost to OWNER, rectify the damaged portion.

6.7. Application of Binding Material

After the application of screenings over the surface of sub-base course / base course, in accordance with relevant Clauses, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate, in the same way, as the screenings are applied. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled, during which water shall be applied to the wheels of the rollers, if necessary, to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

6.8. Setting and Drying

After the final compaction of sub-base course / base course, the same shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the base course has set. Should the sub-grade at any time become soft or churned up with the sub-base metal or the water bound macadam course, the contractor shall without any additional cost to OWNER remove the mixture from the affected portion, reshape & compact the sub-grade and replace the removed section in accordance with the foregoing requirement.

7. Measurements and Rates

The measurements shall be made for the finished work in sq. m. for the area covered in plan. Length and width shall be measured correct to a cm. for the water bound macadam surface unless otherwise specified in the Schedule.

The price quoted shall cover carrying out works as specified above and include the cost of all materials, labor, plant and equipment involved in the works.

Finishing works

1.0 CEMENT PLASTERWORK:

- 1.1 All joints in masonry shall be raked to a depth of 12mm. with a hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material grease, etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall shall not be too wet but not damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall. Prior to plastering necessary treatment etc. shall be done to remove efflorescence, at no extra cost to client.
- 1.2 The proportion of the mortar shall be as specified under the respective items of work. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be all as per I.S. Standards. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to stand for more than 25 minutes after mixing with water. Sand used for plastering work shall belong to Grading Zone II specified in Group 2.
- 1.3 Curing of plaster shall be started as soon as the applied plaster has hardened enough so as to be damaged. The decision as to when the plaster has hardened will be given by the ENGINEER. Curing shall be done by continuous applying water in a fine spray and shall be carried out for at least 7 days.
- 1.4 Whenever the specification or the item of work calls for water-proofing, the CONTRACTOR shall provide the percentage of water-proofing compound as specified in the items of work, or as per the recommendations made by the manufacturer.
- 1.5 Where lath plaster is specified, it shall be paid for at the same rate as for plaster work without metal lath except that separate payment for metal lath will be made.
- 1.6 Ceiling plaster shall be applied before wall plaster and wall plaster shall commence at top and work downwards.
- 1.7 **INTERIOR PLASTER:**

- 1.7.1 Interior plaster shall be laid in a single coat of specified thickness. The mortar shall be dashed on the

prepared surface with a trowel and finished smooth by trawling on the surface with neeru (lime cream). Neeru shall be properly slaked fat lime. The standard of finish expected shall conform to IS: 2394. Interior plaster shall be carried out on jambs, lintel and still faces, top, undersides, etc. as shown on the drawings or as directed by the ENGINEER. Rate quoted for plaster work shall be deemed to include plastering of all those surfaces. However, if the item of work includes plaster finish, no separate payment would be made under 'plastering work'. Sand used for interior plastering work shall be fine sand obtained from Grading Zone-III & shall pass through 1 mm sieve.

- 1.8 EXTERIOR SAND FACED PLASTER: Exterior plaster work shall be carried out in two layers, the first layer being 12 mm. thick and the second layer being 8 mm. thick. The first layer, or scratch coat, as described above, shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise directed by the ENGINEER. The scratch coat shall be cured for at least 7 days.

The second coat shall be 8 mm. thick and it shall not be applied until at least 10 days have elapsed after the application of the scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation and without joints, finish shall be straight, true and even. The mortar proportions of this coat shall be as specified under the respective item of work. Only approved white sand shall be used for the second coat and for finishing work. Sand for finish work shall be the second coat and for finishing work. Sand for finish work shall be obtained from Grading Zone-III & passing through 1 mm sieve and shall be dashed on surface and sponged, thoroughly over the plastered surface.

- 1.9 EXTERIOR ROUGH CAST PLASTER: The external rough cast plaster shall be applied in two coats. The coat, or the scratch coat shall be approximately 12 mm. and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item of work. The scratch coat shall be cured for at least 7 days. Coarse sand conforming to Grading Zone-II shall be used for first coat.

The second coat shall be 8 mm, thick and shall consist of one part of cement, one part of well graded sand conforming to Grading Zone-II & one part of gravel of size varying from 3 mm to 6 mm, and it shall not be applied until at least 10 days have elapsed after the application of the scratch coat. Before application of the second coat, the scratch coat, shall be evenly damped. This coat shall be applied from top to bottom in one operation and without joints, finish shall be straight, true and

even.

- 1.10 MEASUREMENT: The quantity of work to be paid for under this item shall be calculated by taking the projected surface of the area plastered after making necessary deductions for openings, door, windows, fan openings, etc. as per IS: 1200 (Part XII). The actual plaster work carried out on jambs of doors, windows, openings, etc. shall be measured as per IS: 1200 (Part XII) and added. However, for purposes of payment under this category of work, plaster work carried on surfaces for the items of work, which has for plaster finish, shall not be taken, measured and paid for.

WHITE/COLOUR WASHING, PAINTING AND DISTEMPERING OF WALLS, WHITE WASH:

- 2.1.1 Walls to be thoroughly cleaned before white wash is applied. Whitewash shall be of ordinary fat lime and of good quality. It shall be slaked with excess water with creamlike consistency and allowed to remain under water for 2 days. It shall then be screened through a cloth and 2 kg. of clean gum added for every cubic metre of lime ready for white washing.
- 2.1.2 Each coat shall be applied with a brush. It shall be laid with a stroke of the brush from the top downwards, another from bottom upwards over the first stroke and similarly, one stroke from the right and another from the left over the first brush before it dries. Three such coats shall be applied.
- 2.2 COLOUR WASH: Colour wash shall be applied in the same way as white wash. Necessary and approved coloring matter shall be added to the white wash which has been stained. Only wash sufficient for the day's work shall be prepared each morning. If the finished surface is powdery and comes off easily or the general appearance is streaky, the work shall be rejected and work repeated to the entire satisfaction of the ENGINEER and at no extra cost to the OWNER.

2.3 PAINTING:

- 2.3.1 Paint to be used for the various items of work should be of approved make and colour. It is imperative that the CONTRACTOR shall obtain Engineer's permission in regard to the make and colour of paint that he proposes to the use for the various items of work. The painting work shall be carried out as directed by the ENGINEER, keeping however, in view the recommendations of the manufacturer.

2.4 DISTEMPERING:

- 2.4.1 Distemper shall be of well-known brands of approved make. It shall be applied with broad stiff brush in 2 coats over a coat of primer. The first and second coats shall be applied only after the primer coat has thoroughly dried. first coat shall be of lighter tint. The shade of the distemper shall

be got approved by the ENGINEER. Water bound and oil bound distemper shall conform to the requirements of IS 427 and IS 428 respectively.

3.0 CEMENT PAINTING:

3.1 Materials: The cement paint shall conform to IS:5410 of approved brand and colour.

3.2 Scaffolding:

Same as detailed in Whitewash.

3.3 Preparation of Surface:

The surface shall be thoroughly cleaned of all mortar droppings, dirt, dust, algae, grease and other foreign matter. The surface shall be thoroughly wetted with clean water just before the painting is commenced.

3.4 Preparation of Mix:

Cement paint shall be mixed with water in two stages. In the first stage, two parts of cement paint and one part of water stirred thoroughly shall be allowed to stand for five minutes (Cement paint shall be gradually added to water and not vice versa). In the second stage, further one part of water shall be added to obtain a liquid of workable and uniform consistency. Cement paint which can be used within an hour of its mixing shall be prepared.

3.5. Application :

The cement paint shall be applied on wetted surface with brushed on spraying machine. The solution shall be kept we stirred during application, Care shall be taken that the direct heat from the sun of the surface is avoided. The completed surface shall be watered after the day's work. The second coat shall be applied only after the first coat has set for at least 24 hours. Before application of second or subsequent coats, the surface of the previous coat shall not be wetted.

3.6 Precautions:

The cement paint shall not be applied on surfaces already treated with whitewash, colour wash, distemper, varnish, etc.

Technical specification - Structural Steel work

1.0 SCOPE:

This specification covers the general requirements for supply of steel material, where specified, fabrication and delivery at site of structural and miscellaneous steelwork.

2.0 APPLICABLE CODES AND SPECIFICATIONS:

a) MATERIALS:

- | | | |
|---|--------------|--|
| 1 | IS: 226/2062 | -Structural Steel (Standard Quality). |
| 2 | IS: 808 | -Rolled Steel Beam, Channel and Angle Sections. |
| 3 | IS:814 | -Specifications for Covered Electrodes for Metal Arc Welding for Structural Steel. |
| 4 | IS: 1161 | -Specification for Steel Tubes for structural purpose. |
| 5 | IS:2074 | -Ready Mixed Paint, Red Oxide Zinc Chromate and Priming. |
| 6 | IS: 823 | -Code of Procedure for manual metal arc welding of mild steel. |
| 7 | IS: 919 | -Recommendations for limits & fits for engineering (Part I & II). |

b) CODES OF PRACTICE:

- | | | |
|---|---------|--|
| 1 | IS: 800 | -Code of Practice for Construction In Steel. |
| 2 | IS: 816 | -Code of Practice for use of Metal Arc Welding for General Construction in mild steel. |

STEEL SUPPLIED BY THE CONTRACTOR:

3.1.1 The CONTRACTOR shall furnish to the ENGINEER duplicate copies of all mill orders covering the material ordered by him for this project and the test reports received from the Mills for the Engineer's check and information.

3.1.2 It is not the intention of the OWNER that all the steel materials to be supplied by the CONTRACTOR for the work shall be specifically purchased from the rolling mills. Steel shall be from reputed manufacturers. Rolled sections may be allowed only for sizes below 50mm. The Contractor's stock material may be used, provided he satisfactorily demonstrates, the specified grade and quality by furnishing test certificates. The OWNER shall have the right to test all / random samples from the steel materials proposed to be used for work, by the CONTRACTOR at the Contractor's cost. All steel materials supplied by the CONTRACTOR shall be in sound condition, of recent manufacture, free

from defects, loose mill scale, slag intrusions laminations, pitting, flaky rust, etc. and be of full weight and/or thickness specified. The lengths/sizes of steel sections and plates shall be as supplied by the steel mills.

- 3.1.3 Unidentified stock material may be used, only with the prior permission from the ENGINEER in writing, for short sections of minor importance or for small unimportant works and connections where, in the opinion of the ENGINEER, the quality of such materials would not adversely affect the strength and/or durability of the structure. The ENGINEER may also permit use of such materials for other works, if adequate random samples taken out and tested demonstrate conformity with specification and requirement for the work for which these materials are proposed to be carried out to the requirement for this work. He is, however, not to commence plumbing, water supply and drainage work unless drawings for such work or parts thereof are officially released as "Released for Construction". Revisions to drawings and any new drawings made to include additional work by the CONTRACTOR shall be considered as part of this specification and contract. CONTRACT shall be responsible for obtaining approval of the drawings from local authorities, if required, and he shall not be entitled for any extra payment on this account.

4.0 SUBSTITUTIONS:

- 4.1 Wherever the CONTRACTOR, in order to accommodate his/other materials in stock, desires to substitute structural steel or plates for the sizes shown on drawings, such substitutions shall be made only after authorization in writing is given by the ENGINEER.
- 4.2 The ENGINEER may also direct the substitution to be made, when he considers that such substitutions are necessary.

5.0 DRAWINGS PREPARED BY THE ENGINEER:

- 5.1 Checked and approved design drawings will be furnished to the CONTRACTOR for execution of the work and these shall form a part of this specification. The CONTRACTOR shall study these drawings, when made available, in detail for all information contained therein, which pertains to, and is required for his work. Contractor shall also prepare fabrication drawings showing all details as required for fabrication work & submit the same to CCPL for approval prior to starting the work. The drawings shall be approved & returned to the contractor within 20 days from the day of receipt of the same. Discrepancies, if any, shall be brought to the notice of the ENGINEER.
- 5.2 The ENGINEER reserves the right to make changes. Revisions to drawings, even after release of shop drawings, are very likely to be made to reflect additional data/details received and more updated

requirements. Revisions to drawings and any new drawings made which include additional work required to be carried out by the CONTRACTOR shall be considered part of this specification and contract and the OWNER shall entertain no extra claims on this account.

- 5.3 Unless otherwise specified, the drawings and specifications are intended to include everything obviously requisite and necessary for the proper and entire completion of the work and the job shall be carried out accordingly for completeness as required and as directed by the ENGINEER.

Fabrication

- 6.1 GENERAL: All workmanship and finish shall conform to IS: 800. All materials shall be finished straight as per the tolerance limits as specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portion of work exposed to view shall be neatly and accurately done and finished. Material in the shop shall be kept clean and shall be protected from weather.

6.2 CONNECTIONS:

- 6.2.1 Shop connections shall be effected either by welding, or bolting, as specified on the drawings. Bolts shall be in accordance with specifications.

- 6.2.2 However standard M.S. bolts conforming to IS:1363 may be used for field connections for light members such as purlins, girts, staircase stringers, hand railings, landings beams, etc.

- 6.2.3 Where necessary, tapered washers or flat washers or spring washers shall be used with bolts. The length of the bolt shall be such that at least one thread of the bolt project beyond the nut.

- 6.2.4 In all cases where bearing is critical, the unthreaded bolt shall bear on the members assembled. A washer of required thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

- 6.2.5 All connections and splices shall be designed for full strength of members or loads indicated, unless otherwise approved. Column splices shall be designed for the full tensile strength of the minimum cross-section at the splice.

- 6.2.6 All members likely to collect rain water shall have drain holes provided.

- 6.2.7 Not more than one shop splice shall be provided to make up the full length of a member.

- 6.3 Straightening: Rolled material, before being worked, shall be straightened. If straightening or flattening is necessary, it shall be done by methods that will not injure the material. Long plates

shall be straightened by passing through a mangle or levelling rolls and structural shapes by the use of mechanical or hydraulic bar/section straightening machines. Heating and/or forging shall not be resorted to without the prior approval of the ENGINEER in writing.

6.4 Cutting:

6.4.1 Cutting may be carried out by shearing, cropping, sawing or machine flame cutting, if permitted by the ENGINEER. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Sheared or cropped edges shall be dressed to a neat workman like finish flame and shall be free from distortion and burrs. The cutting machine flame cut edges shall be removed.

6.4.2 Hand flame cutting shall be undertaken only if so permitted by the ENGINEER and shall be carried out by an expert in such work. Hand flame out edges shall be ground smooth and straight.

6.4.3 Edge planning of sheared, cropped or gas cut edges is not intended unless the sheared, cropped or gas cut edges are such as to warrant it or is specifically called for.

6.5 Punching and drilling:

6.5.1 Holes in secondary members such as purlins, girts, lacing bars, etc., may be punched full size through material not over 12 mm thick. Holes must be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerance, such parts shall first be assembled tightly clamped together and drilled through.

6.5.2 Sub-punching may be permitted before assembly, provided the holes are punched 3 mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of materials punched shall not exceed 16 mm.

6.5.3 When batch-drilling is carried out in one operation through two or more separable parts, these parts shall be separated after drilling and the burrs removed.

6.5.4 Holes for turned and fitted bolts shall be drilled to slightly smaller diameter and reamed to a diameter of the shank or barrel subject to H 8 tolerance specified in IS : 919.

6.5.5 Where reamed members are taken apart for shipping or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted. Poor matching, over-drilling, and orality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

6.6 Welding:

- 6.6.1 Electrodes for shielded-arc manual welds shall comply with the requirement of IS: 814 and shall be of approved make only. Approved makes are Advani Oerlikon, D&H&ESAB.
- 6.6.2 The Electrodes for manual arc welding shall be suitable for use in the position and type of work, as laid down in the above specifications and type of work, and as recommended by the manufacturers. Electrodes classification group 1 and 2 as given in IS:814 shall be used for welding steel conforming to IS:226.
- 6.6.3 Welding plant and accessories shall have capacity adequate for the welding procedures laid down and shall satisfy appropriate standards and be of approved make and quality. The CONTRACTOR shall maintain all welding plants in working order. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided.
- 6.6.4 All weld shall be made only by welders and welding operators who have been properly trained and previously qualified by tests and to perform the type of work required as prescribed in the relevant applicable standards.
- 6.6.5 All welds shall be free from defects like blow holes, slag inclusions, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show uniform sections, smoothness of weld metal, feather edges without overlap and freedom from porosity.
- 6.6.6 Fusion faces and surfaces adjacent to the joint for a distance of at least 50 mm on either side shall be absolutely free from grease, paint, loose scales, moisture or any other substance which might interfere with welding or adversely affect the quality of the weld. Joint surfaces shall be smooth, uniform and free from fins, tears, laminations, etc. Preparations of fusion faces shall be done in accordance with the approved fabrication drawings by shearing, chipping, machining or machine flame cutting except that shearing shall not be used for thickness over 8mm.
- 6.6.7 Members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated by more than 6 mm. If the separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation. This shall only apply in the case of continuous welds. The fit-up of joints at contact surfaces which are not completely sealed by welds shall be close enough to exclude water after painting.
- 6.6.8 The separation between facing surfaces of lap joints and butt joints with backing plate shall not exceed 1.5 mm. Abutting parts to be butt welded shall be carefully aligned and the correct root gap

maintained throughout the welding operation.

Misalignments greater than 25 percent of the thickness of the thinner plate, or 3 mm, whichever is smaller shall be corrected and in making the correction the parts shall not be drawn into a slope sharper than 2 degrees (1 in 27.5)

6.6.9 Prequalified welding procedures recommended by appropriate welding standards and know to provide satisfactory weld shall be followed. For non-standards procedures, qualifications, tests etc. as prescribed in IS : 823 shall be made to verify the adequacy of the procedures. Welding procedures shall be prepared by the CONTRACTOR and submitted to the ENGINEER for approval before start of welding. This shall include all details of welding procedure with reference to provisions of IS: 823 and IS: 4353.

Approval of the welding procedure by the ENGINEER shall not absolve the CONTRACTOR of his responsibility for correct and sound welding without undue distortion in the finished structure.

6.6.10 No welding shall be done when the surface of the member is wet nor during periods of high wind, unless the welding operator and work are properly protected.

6.6.11 In joints connected by fillet welds, the minimum sizes of single fillet welds or first runs and minimum full sizes of fillet welds shall conform to the requirements of IS : 816 and IS : 823.

6.6.12 Fillet weld larger than 8 mm shall be made with two or more passes.

6.6.13 A complete penetration butt weld made by manual arc welding, except when produced with the air of backing material or welding in flat position, from both sides in square-edged material not over 8 mm. thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross section.

6.6.14 Each layer of all multiple layer welds, except root and surface runs, may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

6.6.15 Inspection of welds : all welds shall be inspected for flaws by any of the methods described under clause "TEST OF WELDS" the choice of the method adopted shall be determined by the ENGINEER.

6.6.16 The CONTRACTOR shall include the costs of carrying out the tests in the cost of structural steel work itself.

6.6.17 The correction of defective welds shall be carried out as directed by ENGINEER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the ENGINEER shall be used to ensure that the whole of the crack and material up to 25mm. beyond each end of the crack has been removed. Cost of all such test and operations incidental to correction shall be to the Contractor's account.

6.7 TOLERANCES:

The dimensional and weight tolerance for rolled shaped shall be in accordance with IS : 852. The acceptable limits for straightness (slope and camber) for rolled or fabricated members are :

Member	Tolerance
Struts and columns	L/1000 or 10 mm. whichever is smaller
For all other members not primarily in compression such as purlins, girts, bracing and the web members of smaller trusses and latticed girders.	L/500 or 15 mm whichever is

Where 'L' is the length of finished members of such lesser length as the ENGINEER may specify.

6.8 Material testing : Even if mill test reports are available for any steel materials the same shall be got tested by the CONTRACTOR to the Engineer's satisfaction to demonstrate conformity with the relevant specification at a lab approved by DEC.

6.9 DIMENSIONS, WORKMANSHIP & CLEANLINESS : Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown on the approved shop drawings.

6.10 DRILLING HOLES FOR OTHER WORKS :

Holes in members required for installing equipment or steel furnished by other manufactures or other contractors shall be drilled at no extra cost to OWNER, in the Contractor's shop as part of this contract, the information for which will be supplied by the OWNER/ENGINEER before fabrication of the steel.

6.11 HANDRAILS :

6.11.1 Handrails shall be provided on open sides of platform, stairways and around all opening as shown on drawings. Handrails shall be of standard weight mild steel pipe of flush welded construction,

ground smooth, provided with double rail, top rail about 1 metre above platform level and pipe posts spaced as shown on drawings.

6.11.2 Smooth uniform curves and bends shall be provided at stair return and also wherever required/specified. Posts connected to curb plates shall have a neat closure at the bottom and 6 mm thick plate neatly welded to posts for attachments to curb plate. All necessary fittings including inner dowels at splices, brackets, bolts, bends, flanges and chains, where required shall be furnished by the CONTRACTOR. Open ends of the pipe posts shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction change in the handrail.

6.11.3 The rate quoted for handrails shall be per running metre of complete handrails including posts, fitting, etc. It shall be clearly understood that individual lengths of runners, posts, etc. will not be measured for purposes of payment.

7.0 CHEQUERED PLATE :

Chequered plates used shall be as shown on drawings. Chequered plate shall be fixed by 8 mm. diameter cadmium plated MS. screws with counter sunk heads at a maximum spacing of 400 mm. Members supporting the chequered plate shall have matching holes tapped in them. The chequered plate pattern shall be approved by the ENGINEER. Chequered plates may also be required to be welded to the structural steel framing. The decision in this regard will be given by the OWNER/ENGINEER.

8.0 MARKING OF MEMBERS :

8.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall legibly be painted and stamped there on. The erection mark shall be stamped with metal dye with figures at least 20 mm high and to such optimum depth to be clearly visible, even after a member is galvanized.

8.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt hole. The markings shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy identification.

8.3 Erection marks on like pieces shall be at identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

8.4 In addition, colour code marking, wherever specified, shall be clearly painted on the member in the manner specified.

8.5 Separate colour code or identification marks, shall be adopted for members fabricated from steel supplied by the OWNER and the CONTRACTOR.

9.0 ERRORS:

Any error in shop work which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the ENGINEER as defective workmanship. All charges incurred by the ENGINEER either directly or indirectly because of the poor workmanship will be deducted from the amount due to the CONTRACTOR before payments made. The amount of such deduction will consist of the sum total of the costs labour direct or indirect, material, plant, transportation, equipment rental and overhead expenses. In case the ENGINEER choose to reject the material because of poor workmanship, the cost of all handling and returning of the material to the CONTRACTOR, if he so desires, shall entirely be to Contractor's account. All the replacement materials shall conform to the same specification as for the original materials, & shall be supplied free and in all such cases, the cost of handling, transport and delivery to site shall be borne by the CONTRACTOR.

Painting :

10.1 All fabricated steel material, except those galvanized, shall receive protective paint coating.

10.2 The surface of steelwork to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter by hand tool cleaning, power tool cleaning, flame cleaning or sand/shot blasting as specified and as directed. In power brushing, sufficient care shall be exercised not to burnish mill scale to a slick finish to which paint may not adhere properly.

10.3 The paint treatment specified shall be applied either by brushing or spraying on the thoroughly cleaned and dry surface. Airless spraying shall be done if so specified. Surfaces inaccessible after assembly shall receive an additional coat of the specified paint prior to assembly.

10.4 Paint shall be stirred frequently to keep the pigment in suspension. All paint delivered to the fabrication shop shall be ready mixed in original sealed containers as packed by the paint manufacturers and no thinners shall be permitted. No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is 50 deg centigrade

or higher.

11 Method of measurement :

11.1 For the purpose of payment, the weight of the actual, completed structures shall be calculated from the approved drawings for different items of work. The CONTRACTOR shall submit to the OWNER relevant materialist containing weight of each item.

11.2 Bolts, washers & nuts shall not be taken into account in calculating the weight of the completed structure. The rates of structural to include the weight of Nuts, bolts & washers etc. No allowances will be permitted for galvanizing, welding or for rolling margins. One ton for the purpose of payment shall mean ONE METRICTON i.e. 1000 kg.

11.3 The weight of all member made out of standard rolled sections such as beam, channels, angles, etc. shall be based on the standard IS book weight of the member, without deducting for holes, notches, bevel cuts, etc. Where a component consist of a cut joint or channels, the full weight of the rolled section shall be considered, only if more than half the depth of the section is used. Otherwise only half the section unit weight shall be considered for calculation of the weight of the component. Deductions shall be made in the weight of gussets/plates for skew cuts and notches of 900 sq.cm. or larger.

11.4 For gussets/plates used in trusses, bracings columns, beams, etc. the area shall be that of the minimum circumscribing rectangle, except as stated in 11.3 above.

11.5 The weight of any built-up member shall be separated into the weight of each component.

12.0 Structural steel work in tubes :

12.1 SCOPE : This specification covers the specific technical requirements for the following.

a) Supply, inspection, and testing at site of tubular structural steelwork.

b) Fabrication, erection and testing at steelwork.

12.1.1 SUPPLY, ERECTION AND TESTING OF MATERIALS:

Materials for tubular steelwork supplied by CONTRACTOR shall conform to IS : 1161. The class of tubes shall be as specified on drawing / BOQ. All materials shall be free from injurious defects.

12.1.2 FABRICATION ERECTION AND TESTING OF TUBULAR STEELWORK:

12.1.2.1 The supply and erection of tubular steelwork shall include inspection, delivery at site, cleaning, cutting, aligning welding connecting and installing a tubular steelwork in position as shown on drawing and as directed by Engineer.

12.1.2.2 Wherever tubes of different thickness are to be butt welded the necessary beveling shall be carried out by the CONTRACTOR at no extra cost to the OWNER.

12.1.2.3 The CONTRACTOR shall be supplied with the drawings for tubular steelwork connections. The tubes shall be cut to the exact shape and welded properly. The thickness of the weld shall be as specified on drawing. Welded joint shall be ground smooth.

12.2 WELDING:

12.2.1 Tack welds used in assembling tubes shall be made by qualified welder (see below), or shall be removed. Tack welds which are not to be removed shall be made with an electrode which is the same as or equivalent to the electrode be used for the first pass.

12.2.2 All welds shall be full penetration, homogenous with no voids. Any cracks or blowholes that appear on the surface of joint shall be removed by chipping

12.2.3 All stipulations for welding work as mentioned in this specification (para 6.6) shall apply for the welding of tubular steelwork, in addition to that mentioned above.

12.2.4 Prior to commencement of welding, welder qualification test shall be taken by the bidder and certificates furnished to the EIC. Only after the welder is approved, he can proceed with the welding.

12.2.5 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.

13.0 STORING AND HANDLING

13.1 Storage of structures shall be preferably be done in such a manner that erection sequence is not affected.

13.2 While storing, care shall be taken so that structures do not come in direct contact with the earth surface and accumulated water. Girders, beams, columns etc. shall be placed and stored in such a manner that during rain, no accumulation of water on the structures takes place.

- 13.3 Stacking of the structures shall be done in such a way that, erection marks are visible easily and handling does not become difficult. Wherever required, wooden sleepers / grilles may be used.
- 13.4 Handling and storage of materials shall be as per IS:7969-1975, ensuring Watch and Ward, Safety, Inventory control.

Galvanizing:

Wherever specified, spray galvanizing shall be carried out as per specifications below:

Sr. no.	Aspect	Specification
A		
1	Surface preparation	Sand blasting (NACE No. 10 /SP10)
2	Quality of Zinc	According to IS : 13229-1991, Min Zinc 98.5%
3	Method of application	Molten Zinc spray
4	Spray interval	Within 4 hrs of sand blasting in dry weather
5	Dry film thickness of zinc coating at any point on the steel surface	85 Micron (Minimum)
6	Overall quality of HDG	Zinc coatings shall be uniform, adherent, reasonably smooth and free from imperfections such as flux, ash, bare patches, black spots, pimples, lumpiness and runs, rust stains, bulky white deposits as per IS 2629 practice
B	Tests & Inspection	Zinc purity and quality report. Uniformity of coating DFT measurement on various sections/parts
C	Documentation	As per tests and inspection

List of recommended makes / manufacturers for steel and mechanical

General:

The makes and manufactures shall be preferably from the following list. In case some of the items not available in the market or some of the particular products are not producing by the following manufacturer or incase of change in trade name etc. equivalent makes or re-designated product shall be used conforming to the specific IS codes with the prior approval of Owner / consultant.

In case of some items not covered in this list like fasteners, fixtures etc. may be procured form the market conforming to IS codes with test certificates and prior approval from the Owner / consultant.

Sr.N o.	Item	Manufacturer
1	Structural Steel	SAIL, RINL, Tata Steel, JINDAL, ESSAR or as approved by IITB / CCPL
2	Electrodes	ADOR (Advani Oerlikon), D & H, ESAB or equivalent approved manufacturers as approved by IITB / CCPL
3	Paint	BERGER, SHALIMAR, AKZONOBEL, SIGMA Coating, ASIAN PAINTS, Grand Polycoat or as approved by IITB / CCPL
4	Colour coated Galvalume troughed Steel Sheets and Translucent Sheeting (FRP)	a) Shree Precoated, b) CRIL, c) Bhushan Steel, d) JSW e) Japan Metal Building System, Bangalore f) M/s. Llyods, g) UttamGalva, h) Kailash Roofing Solutions Pvt Ltd. Bangalore i) Tatabluescope building products, Pune or as approved by IITB / CCPL

Testing of building materials

The contractor shall carry out the following tests, unless otherwise mentioned and as directed by the engineer in charge at his own expense. The Engineer in charge reserves the right to ask the contractor to carry out any further tests on the materials which is being used in the project.

For particle size test, it is recommended that the set of sieves and weighing machines be arranged by the contractor at site. Necessary manpower for conduction of the tests also to be arranged by the contractor.

For crushing strength of concrete, it is recommended that the contractor arrange the compression testing machine at the site along with the calibration certificate for gauge.

In case, if any of the machine comes to repairs and tests could not be carried out at the site, contractor shall arrange to transport the material to an approved laboratory to carry out the tests. All transports and labour costs also are to borne by contractor.

Sl. No.	Material	Tests	Test procedure	Acceptance criteria	Periodicity
1	Water	a) PH value b) Limits of Acidity c) Limits of Alkalinity d) Percentage of solids e) Chlorides f) Suspended matter g) Sulphates h) Inorganic solids i) Organic solids	I.S. 3025	I.S. 456	From the source at the beginning of work/ change of source.
2	Cement	a) Fineness b) Soundness c) Setting time (Initial& Final) d) Compressive	I.S. 4031	I.S. 8112 / 12269	Manufacturer's test certificate and Lab test for each batch brought to site.

Sl. No.	Material	Tests	Test procedure	Acceptance criteria	Periodicity
		strength e) Consistency			
3	Sand For concreting	a) Particle Size distribution (Zoning) b) Sp. Gravity c) Deleterious substance d) Organic impurities e) Water absorption f) Fineness modulus	IS 2386	IS 383	One test for each source Min. 3 tests periodically during tenure of contract.
4.	Coarse aggregate For Concreting	a) Percentage of soft / deleterious material b) Particle Size distribution c) Organic impurities d) Sp. Gravity e) Bulk density f) Aggregate crushing strength g) Aggregate impact value h) Alkali Reactivity i) Flakiness	I.S. 2386	I.S. 383	One test for each source Min. 3 tests periodically during tenure of contract.

Sl. No.	Material	Tests	Test procedure	Acceptance criteria	Periodicity
		index			
5	Reinforcement steel	a) Physical properties b) Chemical test c) Bend & re-bend test d) Elongation test e) 0.2% Proof stress f) Tensile strength	I.S. 1608 I.S. 228 I.S. 1599	I.S. 1786	One test per batch from each source for each dia. Min. Qty10 MT. Min. 3 tests periodically during tenure of contract.
5	Reinforcement steel	a) Physical properties b) Chemical test c) Bend & re-bend test d) Elongation test e) 0.2% Proof stress f) Tensile strength	I.S. 1608 I.S. 228 I.S. 1599	I.S. 1786	One test per batch from each source for each dia. Min. Qty10 MT. Min. 3 tests periodically during tenure of contract.
6.	Cement Concrete (For PCC)	a) Slump test	I.S. 1199	I.S. 456	15 Cum or part thereof
7	Cement concrete (For RCC)	a) Slump test b) Cube test (three cubes for 7 days strength and 3 cubes for 28 days strength for every sample)	I.S. 1199	I.S. 456	Every5 cum Qty. No. of Samples 1-5 M3 : 1 6-15 M3 : 2 16-30 M3 : 3 31-50 M3 : 4

Sl. No.	Material	Tests	Test procedure	Acceptance criteria	Periodicity
					51& above: 4 plus one additional sample for each additional 50 M3 or part thereof.
8	Sand for filling	a) Particle size distribution b) Organic content c) Silt content d) Uniformity coefficient (D60/D10) e) Max. Dry density f) Optimum Moisture content	I.S. 2386 I.S. 2720	Max. organic content 3% by wt. Silt content 10% by weight Particle size max. 5mm Uniformity coefficient 2.0 to 8.0 Compaction as per PO specs.	One lab test for each source. Field compaction test: 1 test for each layer. There shall be min. 3 density measurements for each test.
9	Murum for filling	(a) Particle size distribution (b) Organic content (c) Max. Dry density (d) Optimum Moisture content	I.S. 2386 I.S. 2720	Compaction as per PO specs.	One lab test for each source. Field compaction test: 1 test for each layer. There shall be min. 3 density measurements for each test.
10	Bricks	a) Compressive strength b) Water absorption c) Efflorescence	IS 3495 IS 5454	IS 1077	1 Test for each source/brand. Min. 3 tests periodically during tenure of contract.
11	Structural Steel	a) Tensile strength	IS 1599 IS 1894	IS 2062	1 Test per every batch for each size of material.

Sl. No.	Material	Tests	Test procedure	Acceptance criteria	Periodicity
		b) Bend Test c) Dimensional check d) Unit weight e) % Elongation			Min. 3 tests periodically during tenure of contract.
12	Tubular steel	a) Tensile strength b) Bend Test c) Dimensional check d) Unit weight e) % Elongation	IS 1599 IS 1894	IS 1161	1 Test per every batch for each size of material. Min. 3 tests periodically during tenure of contract.

List of approved brands of materials for civil work

(Only approved brand of materials as mentioned below shall be used in the work. Equivalent brands are applicable only in the case non-availability of the approved brands.)

Sr. no.	Item	Approved Brands
1	Portland Cement	BIRLA/ACC/ UltraTech/RAMCO/Ambuja/ DLF/ or equivalent ⁹
2	Tor / Mild Steel	SAIL / RINL / TISCO or equivalent ¹¹
3	Roofing sheets	Jindal, Tata Bluescope or equivalent ¹¹
4	Structural steel	Refer structural work section
5	Paint	
A	Waterproof Cement Paint	'SNOWCEM'/'SUPERCEM' or equivalent ¹¹
B	Synthetic Enamel Paint	ICI / 'ASIAN' / 'NEROLAC' or equivalent ¹¹
C	Red-oxide primer	'SHALIMAR' or equivalent ¹¹

⁹ - Prior approval of EIC required

Technical specifications for instrumentation work.

Instrumentation work - General

1.0 DEFINITIONS

1.1 PLC - Programmable Logic Controller

1.2 SUPPORTS - Supports shall mean the MS angles, flats, channels that are generally provided to support the main cable ways, cable ducts, junction boxes, angle trays, perforated trays, instrument piping, signal tubing, instrument air supply lines etc., at specified intervals from the structures, concrete columns etc., to keep all items firmly secured against vibration, warping, bending etc.

2 GENERAL CONDITIONS

The contractor shall during the execution of his work use exclusively new material to the standards laid down in this or any supplementary documents given thereafter. Any inconsistency or ambiguity in the design documentation supplied by Owner shall be resolved by the "Engineer In-charge" before work commences.

The contractor shall carry out the work in accordance with the standards listed herein and in accordance with any local statutory regulations and supplementary documentation.

The contractor shall instruct his staff, skilled and semi-skilled on the standards required by the Owner and shall ensure that only competent staff handle or work on the instrument system.

3 WORKMANSHIP, TIDINESS & SAFETY

The contractor shall not allow rubbish & scrap materials from his operations to lay about the site. Such rubbish & scrap shall be collected daily and be deposited at a place approved by the "Engineer In-charge".

No dangerous or noxious wastes products, chemicals or materials shall be disposed of on the site without approval of "Engineer In-charge".

The contractor shall be responsible for protecting installed equipment from damage & pilferage, and shall ensure that all covers, caps, screws and weather protection, etc. are replaced at the end of each working day.

Only the best trade practices are to be used, and all work must be done to the satisfaction of the "Engineer In-charge" who should be consulted on any point requiring clarifications. The Contractor is free to suggest to the "Engineer In-charge" alternative methods for the execution of the work where this would result in improvement.

Upon completion of the work, the contractor shall promptly remove his equipment and return to the relevant place any unused materials supplied by the "Engineer In-charge". Finally the contractor must clear the site of all rubbish and scrap deposited by him to the satisfaction of the "Engineer In-charge".

The contractor shall ensure that adequate precautions are taken during use and storage of pressure bottles. Bottles left unattended to shall be isolated at the main stop valve.

The contractor shall prepare a comprehensive bar chart programmed for carrying out the installation before the commencement of the actual work.

The contractor shall submit before commencement of the actual work, a comprehensive list of tools, tackles, and test equipment which will be employed by him for carrying out the installation.

4. STANDARDS

The instrumentation installation and calibration works shall be carried out generally in accordance with various latest editions of international standards (IS, ISO, API, ANSI) in instrumentation listed below but not limited to the following -

API-RP-551 on "Process Measurement Instrumentation".

"International Society of Automation (ISA)" Standards Library for Measurement and Control: Guidelines for Quality, Safety & Productivity.

Manufacturer's standards and Practices.

Instrumentation – inclusions in scope of work

The Scope of work includes complete instrumentation installation, calibration, testing & providing commissioning & startup assistance & making "AS BUILT" drawing markups.

The contractor shall have full knowledge of all applicable Local regulations & laws & all specific rules applicable at site.

The instrumentation installation work covers various jobs listed under the "Schedule of Quantities". However, to ensure proper execution and completeness of instrumentation works any or all of the following shall also form the part of the scope and shall be covered in the quoted rates.

- Fabrication of pipe nipples, including threading wherever required.
- Filling of seal pots with filling liquids as per instructions from "Engineer In-charge".
- Seal welding of screwed fittings as required by standards.
- Laying of cables from Junction box located at the battery limit to field in the cable Tray on the pipe rack, branch cable trays, up to field instruments / local panels etc. including glanding termination on both sides.
- For underground cables (if any) the scope includes excavation, sand filling, brick laying and back filling & glanding termination on both sides.
- Connection of purging devices for instruments as per drawings.
- Minor civil works like chipping of pavement and grouting on the pavements the instrument panels / supports / stanchions and chipping, refilling and finishing of the pavement for conduits.
- Sealing of cables / tube entries into the control panels after laying and testing of all tubes, cables etc. Rotation of control valve bonnet wherever required.
- Reversing the action of control valves either by replacement of springs, accessories or in positioner wherever required.
- Painting of all structural supports for trays, pipes, junction boxes, instruments, ducts, trays etc., as per agreed painting specification.
- Identification with approved colour of paint the instruments / impulse lines manifold connected with alarm / trip circuit.
- Also, punching of tag numbers on items shall be carried out as per instructions of "Engineer In-charge".
- Coordination with mechanical and other sub-contractors for proper installation of line / vessels / equipment mounted instruments like control valves, on-off valves, orifice assemblies, level transmitters, level gauges other type flow meters, safety & thermal relief valves & any other type of line / vessel mounted instruments which are not covered above,

which involve removal of instruments, disconnection of tubes / cables, reconnection for alignment and proper installation etc.

- Drilling holes on all panels, shut down cabinets, power supply cabinets, control panels, pneumatic enclosures, junction box etc., for cables / glands.
- Grounding of shield of all shielded cables to respective instrument earth bus provided in the JB / local panel. Laying and termination at both ends between instrument earth buses provided in JB / local panel to instrument earth pit provided by others.
- Supply of all types of consumables required for the execution of the job.
- Submission of monthly material appropriation statements for cables, tubing, piping materials fittings, indicating the quantity issued and expended in standard performances. Contractor should build up his own site office and material storage facility within the compound.
- Preparation and submission of "as built" drawings (marked up copies) as required.
- Start-up and commissioning assistance.
- Submission of final material appropriation statements for all the materials issued by the Owner.
- Where requested by the Owner / "Engineer In-charge" or his authorized representatives, all or any of the works detailed above and works as per "Schedule of Quantities" shall also be performed on package units, local panels / cabinets / gauge board installed by package units or by others.
- Sealing of safety valves / switches with standard lead seals after final setting in the presence of Engineer In-charge.
- Installation and termination of tubing, cables etc., for analyzers (if any) & its accessories like sample coolers etc.
- Instrument electrical tracing (where specified on instrument process hook-up) shall be by electrical heat tracing contractor & insulation to impulse tubing by piping insulation contractor.
- Contractor shall remove instruments installed in package skid for calibration. After calibration instrument shall be installed back with related tubing & wiring.

- Contractor shall dismantle limit switch, solenoid valve, positioner, Air filter regulator from control valve/ On-Off valve, tag it properly prior to control valve / On-Off valve shall install back after clearance from the Engineer in-Charge.
- Any other work not mentioned above, but required for the proper execution of the works. Instrument contractor to specify direct & indirect work hours rate in the quotation with break-up.
- Installation of PLC system cabinets, RTU control boxes, Image processing server station, SCADA PC Stations.
- Grounding of Junction boxes / cabinets will be done by Electrical contractor.
- All package instruments, Junction boxes & local panel (LCP) are pre-installed & pre-wired by respective package vendors up to skid installed JB or panel.
- Supply, Laying & termination of home-run cabling between instrument junction boxes to control system &/or Package Vendor Junction boxes / LCP to control system.
- Training (of operations, calibration, maintenance etc.) of client / DEC personnel for various instruments and instrumentation, softwares etc. as required.

6 CONTRACTOR'S SCOPE OF SUPPLY inclusions.

The Scope of supply of Contractor includes instrument tubes & fittings, instrument cable tray with cover plate, cable duct if any, air manifolds, condensate pots, canopies & steel, all the consumables required to execute the work at site & the material listed under **Clause 26.0** of this document.

All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The bidder shall provide sufficient documentation and program listing so that it is possible for the Employer to carry out modification at a later date.

The Bidder shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification.

Industry standard operating system like UNIX/WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry standard protocols (OPC on TCP-IP) shall be provided. The system shall have user friendly programming language & graphic user interface.

All system related software including Real Time Operating System, File management software, screen editor, database management software. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum. These will include MS Office (latest version, complete package including MS Outlook, Access etc. and all requirements thereof, Adobe professional, etc.

All application software for PLC system functioning like input scanning, acquisition, conditioning processing, control and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions shall be provided.

The Bidder shall provide software locks and passwords to Employer's engineers at site for all operating & application software so that Employer's engineers can take backup of these software and are able to do modifications at site.

7 INSTALLATION OF INSTRUMENTS

Each instrument or item of equipment, to be installed by the contractor shall be inspected visually for any damage. The Contractor shall then take it from where it is stored, lift it into position and ensure it is levelled, plumbed and firmly secured. The instrument installation contractor shall be responsible for transporting equipment to be installed by him from the stores to the place of installation.

The contractor shall responsible for all free issue material until acceptance by the Client after completion of job. Care shall be taken by contractor to protect from damage, deterioration due to atmosphere & weather condition. The contractor shall properly maintain a Register of receipt of free issue material. The register shall be available to the Client as & when required.

Throughout the construction period, instruments shall be adequately protected where necessary, by covering with plastic bags of an approved type. The contractor shall supply and fit these bags as required.

Instruments shall not be bracketed directly off process lines except where specified by the "Engineer In-charge".

Local mounted instruments shall be bracketed, mounted in sub-panels or placed on a suitable pedestal. They shall wherever necessary, be secured to the nearest suitable firm steelwork or

masonry in a manner prescribed by the "Engineer In-charge"; wherever possible instruments shall be located so that they are protected from damage by passing or falling objects.

Local instruments with the exception of those on lines and vessels shall be mounted with the centre line at approximately 1.5 metre above platform or floor in a position accessible for operation and maintenance.

Handrails shall not be used for supporting instruments without prior approval from the "Engineer In-charge".

Instruments shall be installed in strict accordance with the appropriate hook-up diagrams or as per the Manufacturer's recommendations, wherever hook-up diagrams are not available. The instrument installation contractor is not permitted to deviate from these diagrams without prior written approval by the Engineer In-charge.

8 INSTRUMENT CABLE INSTALLATION

The contractor must ensure that wherever an electrical specification is issued the appropriate sections shall be read in conjunction with this specification and any omissions or ambiguities should be resolved by the Engineer In-charge.

The cable installation drawings and documentation provided by the "Engineer In-charge" will normally specify or incorporate regulations for the elimination of electrical noise pick-up. However, the following general rules apply.

Parallel runs of instrument cables and power cables should be avoided but where parallel runs must be made cable spacings specified in the documentation must be maintained.

Where instrument and power cables cross in close proximity the cross shall be made at the right angles.

Thermocouple cables shall be run completely independently of other instrument cables with a minimum separation and with cross over at right angles.

Multi-core / multi-pair cables shall not be bent to radius less than the manufacturer's recommendations.

Multi-core / multi-pair cables shall be cut after the exact site measurements are taken between ends and the cable drum shall be selected before cutting the lengths to avoid any wastage.

Where cables are run through pipes, the entry and exit shall be smooth and free from burrs. Cables must be pulled into such pipes in a way that ensures there is no damage to the cable.

Joints shall only be made at terminals in instruments or approved equipment. No intermediate joints shall be made on cable tray or in conduit. Cables must be run in accordance with the design documentation.

All copper cables shall be terminated at junction boxes and instruments by proper glanding.

The panel wiring connections shall be done in an approved manner by qualified electrician.

Where conduit terminates at a cabinet, terminals box trunking or ducting, it shall be secured lock-nutted, brushed and ferruled in an approved manner. Sharp edges shall be removed and conduit not otherwise connected shall be terminated in smooth brushes.

Clips and saddles securing to steel work or tray shall be metal, preferably aluminum / Hot Dip Galvanized (GI); clips shall be spaced at 500mm intervals.

Conduit shall not be fixed by hook bolts unless agreed by the "Engineer In-charge". Where hook bolts are used they shall be supplied by the contractor from a manufactured source and not performed at site.

Conduit junction boxes shall be provided at distances not exceeding three random lengths of 3 meters, not more than two right angle bends occurring in one pull.

All cables shall be identified close to their termination point by cable number as per cable schedule / junction box schedule. PVC ferrule / S.S. tag plate shall be used and these identification tags shall be securely fastened to the cables.

9 INSTRUMENT CABLE DUCT / TRAY

The GI Ladder / Perforated cable trays shall be properly supported at a regular interval of maximum 1.5 meter from insert plates or steel structures. Wherever insert plates are not available supports on concrete structures & ceiling shall be fixed with minimum 10mm diameter expansion bolts. Angle supports for perforated trays shall be fabricated from 50 mm x 50 mm x 6 mm MS angles as a minimum.

All supports shall be cut with hacksaw only. Any work executed by gas cutting for making holes or cutting pieces will be totally rejected. Free ends of angle supports shall not have sharp edges and shall be properly rounded off.

Perforated GI trays shall be used for branch cables from the main Cable Ladders/Trays. Width of trays shall be as per Schedule of Quantity. Trays shall be laid generally as per site conditions with the approval of Engineer-In-Charge.

All the supports / Structural Steel shall be painted as per painting specifications detailed elsewhere in this section.

10 PAINTING

All ferrous materials for brackets and supports supplied by the contractor and other materials not already protected in an approved way shall be cleaned and primed before erection with primer as per painting specifications specific to the project.

All the supports / Structural Steel installed by the instrument installation contractor shall be painted as agreed with Engineer in-charge.

11. IDENTIFICATION OF LINES AND INSTRUMENTS

All site mounted instrument, junction boxes, air header isolation valves, tubing and wiring terminations shall be labeled or tagged in a manner approved by the Engineer In-charge.

The Engineer In-charge will provide a table of the label details for labels within the contractor's supply.

All cable terminations shall be identified by ferrules (cross).

12 TESTING

All the necessary test equipment for performing the following tests shall be provided by the instrument installation contractor.

The instrument installation contractor shall furnish a list of test and calibration equipment that will be provided by him.

All pneumatic signal lines shall be disconnected and blown through with instrument air for 15 minutes to remove traces of oil, dust and moisture.

All instrument air mains shall be isolated from the instrument and pressurized pneumatically, 1.5 times maximum working pressure and isolated from the source of pressure. The pressure shall not fall by more than 0.1 kg / cm² in ten minutes.

All thermocouple, electric and electronic instrument wiring shall be tested for resistance between conductors and earth and for insulation between conductors with a potential not less than 500V D.C. These tests shall be carried out with all conductors disconnected except from the test instruments. The resistance shall not be less than 10 mega ohms.

Electrical continuity of cable armoring or braiding, conduits and any associated flexible tubing, earthing conductor and / or equipment enclosures are to be checked.

Correct operation of all alarms and function of interlocks shall be checked.

The written results of all tests in duplicate for retention by the Owner / Engineer In-charge shall be approved by the "Engineer In-charge".

The instrument installation contractor is responsible for supplying the necessary test equipment and reasonable evidence of the satisfactory condition of this shall be provided, if required.

All errors or faulty workmanship discovered during this testing or during subsequent testing and commissioning shall be corrected by the instrument installation contractor at his cost.

All test results shall be recorded in the approved formats.

13 CALIBRATION

All test equipment used for calibration shall have the approval of Agency approved by above mentioned authorities. On demand, calibration certificates shall be submitted to "Engineer In-charge".

All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control room instruments of all types namely, pneumatic, electronics, electrical, etc.

Contractor shall use his own oil free instrument air compressor for calibration purposes.

Calibration Procedure for different items is outlined below. However the detailed procedure shall be submitted to Engineer In-charge for approval before proceeding with calibration.

All thermocouple receiver instruments shall be calibrated by generating millivolt signals suitable for span and type of thermocouple specified.

Receiver instruments and controllers shall be calibrated and aligned using test hook-up as per instructions from manufacturer's / Engineer In-charge.

All calibration readings shall be recorded in the agreed formats and submitted to Engineer In-charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer In-charge for corrective actions.

The contractor shall clearly state in his offer the complete list of calibration and test equipment along with the range, accuracy and quantity which he proposes to use for this job.

14 LOOP TEST

Loop test shall be performed after calibration of all instruments and leak test of signal lines. Loop tests are conducted to check the functional performance of all elements comprising the loop, thereby ensuring proper connections and operations.

Instrument installation contractor should bring all the field cable and terminate in the Junction box located in the field & further termination to the system cabinet inside the equipment room. Instrument installation contractor shall assist the system vendor in the loop testing,

Before proceeding for loop tests the calibration results of individual elements shall be recorded and approval obtained from "Engineer In-charge" for correctness of installation, measurements and calibration results.

Loop testing for all control loops shall be generally simulation of process conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. Detailed procedure shall be submitted to "Engineer In-charge" for approval before proceeding with the loop testing.

In case of shutdown system field / receiver pressure switches are simulated for abnormality by disconnecting the wires at terminal and function of all associated systems are checked.

After the loop test is complete, the contractor shall connect back any terminations and connections removed for loop test inside the battery limit.

A loop shall be considered as handed over only after measurements in that particular loop are complete and certified by "Engineer In-charge", in addition to loop sheets being duly filled in all respects and approved and accepted by "Engineer In-charge" and the Owner.

In case of loops in which certain instruments of the loops are calibrated by other agency, loop testing shall be performed in coordination with the agency involved. Any defect in the calibration

of the instruments in contractor's scope is observed, same shall be rectified to the satisfaction of the "Engineer In-charge". However, defect in calibration of the instruments in the scope of other agency; same shall be rectified by the agency involved. After the calibration has been rechecked by other agency / agencies the loop checking would be performed to the satisfaction of "Engineer In-charge", and this part covers under the scope of the contract.

Final certified loop sheets shall be submitted in number of copies as agreed with Engineer In-charge.

15 INSTALLATION DRAWINGS

Installation drawings / documents will be furnished to the contractor after award of contract. These generally will include:

- Instrument Location Plan drawings, showing information like indicative position of field instruments, junction boxes, indicative routes of cables, main ducts / cable trays.
- Cable Schedules, Instrument Junction Box Schedules, Junction Box Wiring Diagrams
- Individual Instrument Specifications / Data sheets.
- Bill of Materials.
- Installation Standards / Hook-ups.
- Manufacturers' Manuals with instructions for installation and calibration wherever necessary for reference.

16 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY CONTRACTOR

Filling and submission of Test Reports & Forms.

The drawings for materials that is included in his scope of supply and installation.

- Two sets of layout drawings, hook ups, interconnection diagrams, cable schedules etc., duly incorporating the changes / modification carried out during the course of execution of works, as built markups.
- Material test certificates.
- Routine test certificates

- Functional test certificates
- Hydro-test certificates
- Type test certificates
- Any other special test / certification, if required, shall be arranged by the bidder within the cost quoted.

17 MATERIALS TO BE SUPPLIED BY THE CONTRACTOR AT HIS OWN COST

The procurement and supply in sequence and at the appropriate time of all materials and consumables shall be entirely the contractor's responsibility and his rates for execution shall be inclusive for all these items. They are as follows but not limited to them.

- All industrial gases like oxygen, acetylene or inert gases, compressed air and all types of electrodes, brazing rods, flux etc. for welding purposes, with necessary facilities for testing the welded joints.
- Teflon tape and other pipe jointing compounds for threads and material for sealing of cable entries to control room, local panels, insulation tapes, sealing compounds for conduit fittings.
- Bolts and nuts for supports, U-bolts with nuts, clamps for tubes and pipes, anchor bolts for panels, expansion bolts (pinch anchor / Rawl bolts) for various sizes for fixing to concrete structures.
- Paints, primers and solvents.
- Plastic sleeve ferrules for identification of tubes / wires at panel junction boxes.
- All materials for minor civil works like grouting etc.
- All accessories for electrical wiring like cable lugs, ferrules for identification etc.
- Spool pieces and blinds for testing, wherever required.
- Nozzle cleaning wires.
- Any other item not specified, but required for the completion of the job.

Note: The contractor shall submit in sealed packets all samples of all consumables like bolts, nuts, lubricants, ferrules, lugs etc. for approval from Engineer In-charge which form the standards for installation work.

Schedule of rates shall be furnished in the appropriate formats as issued specific to the Project.
Refer – Annexure 1

PREAMBLE TO SCHEDULE OF RATES / PRICES (SOR)

The Schedule of Rates Prices (SOR) shall be read in conjunction with the drawings, the Conditions of Contract and the Specifications as these documents are jointly explanatory and descriptive of the works included in the Contract. Any interpretation of the scope of work, made from SOR or Technical Specification in isolation shall not be valid for any extra claims.

The quantities of work and material in Schedule of Rates Prices (SOR) are not to be considered as limiting or exceeding the amount of work to be done and material to be supplied by the Contractor. The quantities in the Schedule of Rates Prices (SOR) are an estimate of the amount of work but the work will be measured on completion and the Contractor will be paid on lump sum basis for the entire contract irrespective of the actual measurement of work.

General directions and descriptions of work and materials given elsewhere in the Contract documents are not necessarily repeated in the Schedule of Rates Prices (SOR). Reference is to be made to the other documents for information and guidance.

The Contractor shall be deemed to have visited the Site before preparing his Tender and to have studied and examined for himself the conditions under which the work will have to be priced and all other matters affecting the carrying out of the work and the cost thereof. The contractor will also acquaint himself with the prevailing requirements of Government or any conditions levied by any Local Competent Statutory Body or any Agency duly authorized in connection with carrying on such works and he shall be responsible for compliance of such obligations including taking permission wherever necessary, submitting information when called for etc.

A price or rate in figures is to be entered against each item in the Bills of Quantities, against which quantities are in SOR.

The prices and rates inserted in the Schedule of Rates Prices (SOR) are to be the full inclusive value of the work described under the various items, including all cost and expenses which may be required for preliminary and for the completion of the work described, together with all cost and obligations set forth or implied in the Conditions of Contract, the Specifications and the Drawings.

The price quoted shall include supply of all the materials by the Contractor viz. Cement, sand, bricks, structural steel, consumables like welding rods, gases, insulation material, ferrules, etc. and nothing whatsoever will be supplied by the Owner except as explicitly stated in this tender.

The Contractor shall note that the Structural Steel materials shall be procured from approved manufacturers only. Prior approval shall be obtained for procurement from Engineer in-charge.

Owner reserves the right to cancel/ delete/ curtail any item or group of work if necessary. Such a step shall not be construed as reason for changing the rates.

In this contract, the contractor shall not stipulate any conditions. There shall not be any overwriting. Contractor shall fill in the offer and submit the same in a separate, sealed cover. In case any corrections are required, the original writings shall be neatly cut / penned through and rewritten nearby. No overwriting or erasure of original writings by use of 'White Correction fluid' or otherwise is permitted. In case any erasure using 'White correction fluid' is found, the offer shall be liable to be rejected. All corrections / cuttings / alterations shall be signed in full by the Contractor and dated.

The Schedule of item numbers may not be found in continuous serial order. The missing numbers indicate that the items against missing numbers are not applicable in the scope of the particular tender and hence deleted.

Quoted rates shall include the assembly of the equipment which will be delivered in multiple components in presence of the Vendor/ Drawings/ Specifications. If the components of the package units were received in loose condition, the installation contractor to assemble & erect the same.

Quoted price shall include painting including the colour coding and lettering on the equipment as per project specification.

Quoted price shall include preparation of AS BUILT Drawings & Final Field documentation etc. for all the site activities which will be submitted by the contractor in required number of copies to the Owner. Editable soft copy of all the documents shall be part of as-built documentation.

INCLUSIONS TO BE CONSIDERED IN PRICE / UNIT RATES -

In general activities involving checking/adjustments (e.g. limit switches on valves, timer settings, checking solenoid valve operation, checking annunciators/operation of indicating and mimic lamps etc.) which shall be carried out during loop checking, no separate unit rates shall be

applicable and the same shall be deemed to be a part of loop checking. All loop checking shall be done by actual simulation like operating final control element from PLC/SCADA, applying actuating pressure to the field sensors / transmitters (as per range set) etc. and response reporting to SCADA, PLC as Range, alarm, Set value, trip value, cross ferruling, open loop resistance / voltage etc. shall be recorded tag-wise as a part of loop checking activity. Format for loop checking and cross-ferruling shall be followed by contractor based on joint agreement at site with the Owner concern for Instrumentation work.

Supply of consumables as required, shall be built into the price. No separate rates shall be paid for any items. These include items like welding and filler rods, argon/nitrogen, required for welding; sealants like PTFE tape, M-seal etc. used in impulse lines; ferrules, lugs, Insulation/polyester tapes, cable sealing compounds, tagging etc. used in cable laying and terminations; oxygen and acetylene required for gas cutting; primer and final paint required in painting; polyethylene bags, thermocouple required for protecting the instruments; and so on. In case any consumables are being supplied as free issue items to the contractor, the same shall be highlighted in the specification. In case no such mention is made, the contractor shall estimate these quantities himself and build the same in the price quoted.

Price supply of materials shall be inclusive of Inspection, documentation, all taxes/levies, packing, forwarding and transport charges, handling charges of the contractor etc.

Supply of structural steel shall include costs for required fasteners like nut bolts etc. (except for Anchor fasteners for which separate rates are applicable). Weight of these fasteners will not be considered for measurement and no separate charges for installation of fasteners are applicable. For structural steel, installation shall include surface preparation (shot blasting), all fabrication and installation, including welding, supporting, painting, etc.

For canopies of field instruments, local panels and junction boxes, etc., fabrication + installation shall be included based on 3 mm MS plates, duly painted and including all fasteners as required. Canopy shall be of galvanized material. Coating thickness of galvanizing shall be not less than 66 micron.

Cable laying/Installation shall include: laying of cables in trays/ducts/conduits/angles, dressing, clamping, tagging, glanding, termination with lugs, ferruling, continuity checks and meggering. Materials like Clamps, fasteners (bolts, nuts, washers etc.), ferrules, lugs, tag plates, and Green insulating Sleeves for cable screen etc. are included in unit rates cable laying/installation. For cables laid in conduits: sealing of conduit ends or intermediate joints with sealant (including supply of sealant) is also included in cable laying/installation.

Fibre optic cable installation shall include cost of termination and installation of converter (any special equipment required and skilled manpower required for these terminations shall be arranged by contractor and cost for the same shall be included in fibre optic cable laying/installation).

Cable conduit laying shall include intermediate fittings, pull boxes, making necessary threading with die/taps, termination, sealing of joints with sealant etc. supply of conduit includes clamping/supporting material like "U" bolts, packing material required to avoid galvanic corrosion etc.

Supply of clamping material like self-clamps, U bolts (and other fasteners), packing material for avoiding galvanic corrosion etc. shall be included in installation. For welded impulse pipes the installation shall also include the necessary charges for checks including supply of DP test material.

Installation of RTDs and T/Cs shall include checking of sensor for short Circuit /open circuit and insulation failure, prior to installation. No other checking activity is envisaged.

For all instruments with capillaries, unit rates for installation shall include laying, dressing, clamping of the capillary. Supply of necessary clamping/supporting material shall be included in unit rates of installation.

Panel mounted instruments shall include mounting of instruments and bins using clamps, termination of tubing/wiring (lugging wherever required), ferruling, dressing of wires, clamping using binding straps, flushing of tubing etc. For alarm annunciators no separate rate shall be given for checking operation of the annunciator. The same shall be considered part of loop checking.

Calibration of instruments, control valves, safety valves shall include cost of Consumables required (e.g. compressed air, Nitrogen etc.).

Installation of following instruments/equipment shall include the supply of fasteners, Tag Plates as required:

- Power Distribution Boxes, Local Panels, Control Cabinets/Panels.
- Pressure, DP, Temperature Transmitter, Switches, Temperature Elements.
- Air Filter Regulators, Solenoid Valves.
- Transducers / Transmitters / Converters
- Back of Panel Instruments, Relays, Contactors etc.

- Junction Boxes.
- Auto/Manual or Push Button Stations, Hooters, Flashing Lights, etc.
- Remote mounted Pressure Gauges.
- DP Gauges and Pressure Gauges with capillaries.
- Purge Rota meters with DP Regulator and Air Filter Regulator.

For items not covered in the tender but required to be installed/calibrated, rates of similar Items in the tender shall be taken for approval prior to start of execution and billing. If the same is not possible rates shall be derived from available rates after mutually discussed and agreed upon with the Owner.

Installation rate for all items in Schedule of Rates (SOR) shall include, all machinery, tools and tackle required for shifting of respective items from stores to place of installation, receiving, handling, unloading, unpacking, checking for damage/ short supply and informing Owner, replacement of damaged parts, assembly of all loose items, preservation of all items, transporting equipment, instrument etc. from Owner's storage point or any other location within the project site to location of installation / calibration. This shall also include following -

- Levelling, aligning, grouting, bolting, minor civil work including chipping & then doing finishing work, etc.
- Cleaning either mechanically or manually
- Inspection & Testing as per Site testing & inspection formats.
- Required Documentation as per specification & site requirements.

Unit rate / price quoted for supply of all instrument & erection, bulk items shall include the required detail engineering, vendor's drawing checking, third party inspection, documentation charges and all associated jobs.

Rates for all the items of Schedule of Rates include all cost involved for the performance of the completed item considering all parts of the offer document. In case any activity though specifically not covered in description of item under 'Schedule of Rates' but is required to complete the work which could be reasonably implied/ informed from the consent of Offer Document, the cost for carrying out such activity of work shall be deemed to be included in the item rate / price quoted.

The Contractor shall maintain an effective quality system. A concise description of the Contractor's system and its proposed application to the scope of work, including references where applicable to a quality manual or similar authorized company document, is required with the quotation.

A List of documents, in dossier form, shall be retained as evidence or proof that the product or service supplied complies with specific requirements.

A quality plan, indicating the verification activities that will be applied in order to achieve the required quality will be required to be submitted for approval

Technical specification – Electrical work

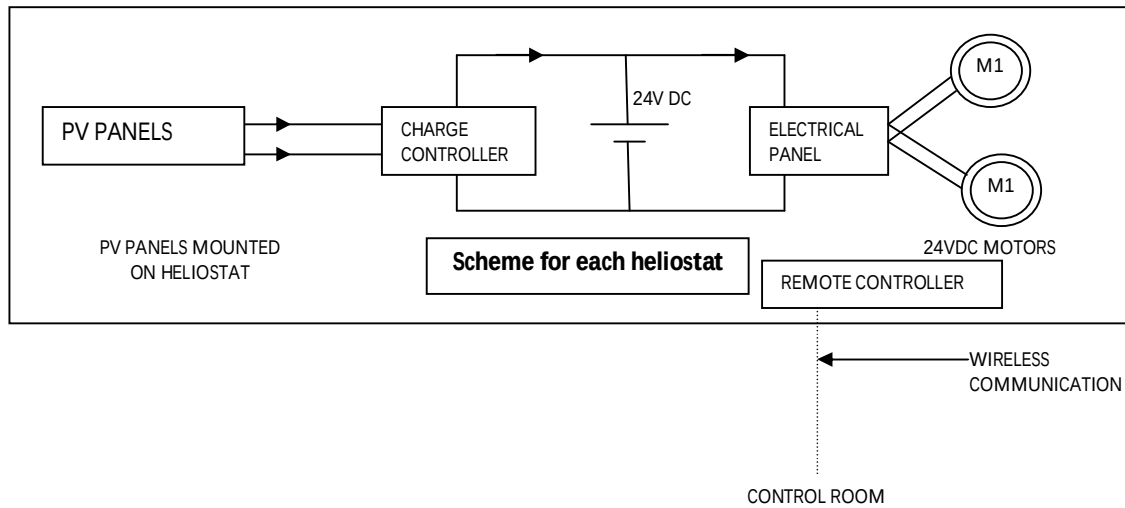
SCOPE:

This document describes the scope of supply, installation, testing & commissioning of complete electrical system and defines guidelines for the design of electrical system for the Heliostat project.

CODES AND STANDARDS:

The design of electrical system and the installation shall be in accordance with the relevant Indian Standards, IEC Standards, CEA guidelines, Indian Electricity Act & rules and Local Rules and Regulations.

SYSTEM PARAMETERS:



Distribution Voltages for the Loads shall be as per table given below:

Equipment	System Voltage	No. Of phases & Frequency	Grounding
DC Brushless motors, Control Panel	24V Generated by PV panels	DC	Ungrounded

Electrical System Description

The system will have 8 nos. heliostats. Each heliostat will have its own control panel which will be fed from 24V DC batteries.

This control panel shall be located near the individual heliostat. The control panel shall house motor-starters / drives, remote I/O modules and wireless communication unit for communication with central PLC. These batteries will be charged from its own PV panel. 2 nos. servo motors are provided for rotation heliostat along vertical & horizontal axis.

Two spare battery-sets shall be provided in the control room, each sufficient for feeding one heliostat load for a day. The battery charger suitable to charge one battery set at a time shall be provided in the control room. The power supply for battery charger shall be made available in the PMCC panel of Molten salt loop.

Electrical scope of supply

Scope includes supply of following equipment & material:

Sr. No.	Description	Qty	Specification clause
1	Local Heliostat Electrical Panel including remote i/o PLC module	8 nos.	C529/EE/SP/A4/426
2	Solar PV systems with PV panel, 24VDC batteries and MPPT Controller	8 sets.	C529/EL/SP/A4/423
3	24V DC batteries (spare)	2nos.	C529/EL/SP/A4/423
4	DC brushless motors with drives (part of heliostat mechanism)	1 lot	C529/EE/SP/A4/425
5	24V DC Battery charger	1 lot	C529/EE/SP/A4/424
6	Electrical Cables	1 lot	C529/EE/SP/A4/427
7	Earthing Material	1 lot	C529/EE/SP/A4/427
8	Erection material like Cable terminations, cable trays, cable ties etc.	1 lot	C529/EE/SP/A4/427

General conditions for electrical work

Contractor shall carry out Supply and Electrical Installation work as per various parts of these documents in an approved manner in required time schedule. Responsibility lies with the Electrical Contractor for the proper execution of the erection work according to the existing laws and by-laws. Electrical Contractor shall conform in all respects to the requirements of local and other statutory authorities, issue of notice, as and when required by them All material in Contractor's scope of supply shall comply with all currently applicable IS and IEC Standards.

Contractor shall furnish all the equipment drawings for client's approval before manufacturing. Manufacturing shall be done as per drawings approved for manufacturing. Any deviations w.r.t specification/tender shall be highlighted clearly by contractor.

All the items/equipment as specified in this specification are minimum requirement for this package for tendering purpose; any more equipment, material, device or system if required for completeness of this package as well as for safe & smooth operation and good engineering practice, are included in scope of contractor without any cost or time implication.

If any equipment supplied by the vendor fails at site during erection, commissioning or service (within guarantee period), the vendor shall repair and put back into successful operation the failed equipment within the time frame and procedure of repair agreed with the purchaser depending on nature of failure at no extra cost to the purchaser.

Contractor shall carryout the installation in accordance with construction drawings, manufacturer's drawings/manual's installation instructions and as per specific instructions of Engineer In-Charge and as per various parts of this tender document.

Sufficient sets of tools and tackles shall be available at site for smooth execution of the job

All meters and testing equipment shall be calibrated by testing and calibrating agencies. All meters and testing equipment shall be calibrated every six months.

Brief specification for supply items

Electrical Cable

Cables shall be Stranded Cu conductor, flexible, PVC insulated cable, voltage grade: 650V.

Colour of outer sheath shall be black.

Quantities of cables shall be supplied shall be as per electrical cable schedule- C529/EE/CS/A4/429.

Cable terminations

Unarmoured cables shall be terminated by single compression type cable glands.

Summary of cable glands

Description	Quantity
2C x2.5 sq.mm Cu, flexible cable	64 nos.
Cables for Solar PV system (Size by PV vendor)	48 nos.
2C x10 sq.mm Cu, flexible cable	2 nos.

Summary of cable lugs

Description	Quantity
2.5 sq.mm Cu,	128 nos.
Cables for Solar PV system (Size by PV vendor)	96 nos.
10 sq.mm Cu	4 nos.

GI cable trays

Cable tray shall be GI perforated type.

50mm wide, 25mm height, 2 m thick GI cable tray: 50 m

Earthing Material

All panels & motors shall be wired using 8 swg GI wire which shall be connected to 25x 3 GI strip which in turn shall be connected to GI earth rod.

BOQ of earthing material

Description	Quantity	Equipment
8 swg GI wire	400m	Motors, Panels
25 x 3 GI earth Strip	80m	On tray, connected to earthing rod
78mm dia.3000mm long GI earth rod directly buried	8 nos	

Heliostat structure shall be earthed and connected to earthing rod using 25X 3 mm GI strip. No separate lightning protection is required to be provided.

Electrical Installation

Panel installation

All panels shall be installed as described in respective specification. All supporting material & hardware shall be in the contractor's scope.

Cable Installation

Cable routes and mode of installation shall be generally be as shown in the construction drawings. Cable shall be secured using cable ties.

Earthing Installation

Location of individual earth rods shall be near the individual heliostat structure..

All connections of earth conductor shall be welded or bolted with appropriate hardware. In case of Cu earth conductor the same shall be brazed or bolted with cadmium hardware. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Cables used as earth conductor shall be connected by crimping type lugs.

Earth connections above the ground to equipment earth pads/terminals shall be bolted type. Connections buried in earth/concrete shall be welded/brazed type.

The pieces to be welded shall be held by pressure clamp and then welding/brazing operation shall be carried. This is to ensure good contact joint. The joints shall be cooled naturally to its ambient. If it is Galvanized Aluminium conductor, bituminous paint shall be applied at joint.

Following codes and standards shall be referred with their latest revisions or amendments for carrying out the power-earthing and lighting installation, erection & commissioning of electrical equipment.

Sr.No.	No.	Title
1	IS 3043	Code of Practice for Earthing
2	IS 732	Code of Practice for Electrical Wiring Installation
3	IS 2309	Code of Practice for Protection of Buildings and Allied Structure against Lighting
4	IS 9537	Conduit for Electrical Installations: Rigid Plan Conduits of Insulating Materials.
5	IS 15429	Code of Practice for Storage, Installation and Maintenance of DC Motors

Technical specification – Heliostat Drive System

1. The heliostat drive system mechanism shall be supported on the heliostat column support structure (refer drg C529/TND...906).
2. The mechanism shall be designed for outdoor use (ambient temperature : 2 °C – 50 °C, humidity – up to 100%, dusty winds – wind speed 50 mps in stowed position).
3. The mechanism shall be design for forces and moments as follows in stowed position.

Directions of forces as below

- x axis - Horizontal axis of heliostat
y axis - Vertical axis of heliostat
z axis - Normal to x axis in horizontal plane

	Position ↓ / Force, kN→	Fx	Fy	Fz
1	Stowed	76	114	0
2	Operating	41	114	7
	Position ↓ / Moment, kNm→	Fx	Fy	Fz
1	Stowed	0	29	293
2	Operating	14	85	78

4. The mechanism shall support and hold the heliostat structure (refer drg C529/TND/GA/A1/905 Rev P0 at its horizontal axis at an elevation of 6000mm above GL (as shown in section 2-2 of the drawing.
5. The mechanism shall be able to
6. Turn the heliostat reflector in a controlled manner about the horizontal axis to an angle of -85° and +00° with respect to horizontal. Also turn the heliostat reflector in a continuous manner about the horizontal axis at a rotational speed of 6°/min.
7. Turn the heliostat reflector in a controlled manner about the vertical axis to an azimuth angle of -100° and +100° with respect to vertical axis.
8. Turn the heliostat reflector as above with accuracy within +/- 0.1 mrad of error for both Horizontal & Vertical axis. Also turn the heliostat reflector in a continuous manner about the vertical axis at a rotational speed of 6°/min

9. Provide feedback to central control system at the rate of 1 pulse of suitable width with suitable no. of counts to suit the above accuracy for both horizontal & vertical axis.
10. The mechanism shall be designed for input power of 24 VDC through batteries (from a solar PV panel).
11. The mechanism shall be designed to consume not greater than 300W of input power during its operation of 10 to 11 hrs between its daily operating schedule from sunrise to sunset.
12. The mechanism shall be designed to support and provide signals of extreme positions as listed in the instrumentation section.
13. The mechanism shall be designed to support and provide signals of parking position as listed in the instrumentation section.
14. The mechanism shall be designed to fit within the dimensions indicated in drg C529-TND-GA-A1-905-P0-a or revisions thereof.
15. The structural parts of the mechanism shall be hot dip / spray galvanized as per specifications given elsewhere in the tender.
16. The mechanism shall be able to withstand a torque of 85 kNm at the horizontal axis without rotational deflection of the heliostat from its horizontal axis of greater than 0.5 mrad.
17. The mechanism shall be able to withstand a torque of 50 kNm at the vertical axis without rotational deflection of the heliostat from its vertical axis of greater than 0.5 mrad.
18. The vendor shall demonstrate the above at site with appropriate tools, tackles, temporary works etc cost of which shall be a part of the rate quoted for this item.
19. The mechanism shall be designed such the both vertical and horizontal axes shall be within 0.5 mrad of true vertical and horizontal in all rotational positions of the mechanism.
20. The mechanism shall be designed to sustain torque of 300 kNm about its horizontal axis and 30 kNm about its vertical axis at wind speed of 50 m/s when the heliostat is in parked condition. The mechanism shall be designed to withstand shear of 70 kN at its base.
21. The mechanism shall be designed such that the heliostat can be maneuvered to parking position (heliostat reflector structure in horizontal position) within 15 minutes from any tracking position.
22. The mechanism shall be designed to be locked in parking position with locking devices operating automatically from the central PLC or from the local heliostat panel or such other suitable means

and mechanisms. Lock shall be designed for forces suitable for the torques stated at point 18 above.

23. The mechanism shall be design for service life of 25 years.
24. Vendor will submit design calculations to substantiate the proposed mechanism to be in compliance with above specifications.
25. Backlash in both axes of rotation shall be less than 0.5 mrad with provision for compensation.

List of Annexure for Technical Bid

Sr. No.	Document No.	Document Title
Drawing List		
1	C529/AR/GA/A1/021-P1	Architectural Plan & Section For Central Receiver Tower
2	C529/CI/GN/A1/051-P0	General Notes & Abbreviations for Heliostat
3	C529/CI/RC/A1/052-P1	Layout & R.C. Details of Foundation for Heliostats
4	C529/CI/RC/A1/053-P0	G.A. & R.C. Details of Foundation for Central Receiver Tower
5	C529/CI/GA/A1/054-P0	G.A. & R.C. Details of Grade Slab & Pedestals for Central Receiver Tower
6	C529/CI/RC/A1/055-P1	G.A. & R.C. Details of Column for Central Receiver Tower
7	C529/CI/RC/A1/056-P1	R.C. Details of Plinth Beams at EL.100.350(T.O.C) for Central Receiver Tower
8	C529/CI/RC/A1/057-P0	R.C. Details of Floor Beams at EL.105.600(T.O.C) for Central Receiver Tower
9	C529/CI/RC/A1/058-P1	R.C. Details of Roof Beams at EL.108.000(T.O.C) & 109.600(T.O.C) for Central Receiver Tower
10	C529/CI/RC/A1/059-P0	G.A. & R.C. Details of Staircase for Central Receiver Tower
11	C529/CI/GA/A0/060-P1	G.A. & R.C. Details of Lintel & Chajja at first Floor for Central Receiver Tower
12	C529/ST/GA/A1/132-P0-SHT-1 OF 2	G.A. & Marking Plan of Tower Structure for Central Receiver Tower
13	C529/ST/GA/A1/132-P0-SHT-2 OF 2	Sections & details of Tower Structure for Central Receiver Tower
14	C529/ST/GA/A1/172-P0	Elevation & Section of Dummy Receiver
15	C529/ST/GA/A1/180-P1	G.A. & Details of Focus Fixtures
16	C529/OP/GA/A1/202-P1	G.A. & Details of Mirror supporting frame for Heliostat
17	C529/ME/GA/A2/351-P1	Schematic for Cleaning Mechanism
18	C529/TND/GA/A0/903-P2	Layout of Solar Field
19	C529/TND/GA/A1/905-P2	General Arrangement Of Heliostat
20	C529/TND/GA/A1/906-P1	Heliostat Drive Mechanism Conceptual Arrangement
21	C529/TND/GA/A2/908-P1	Details Of Asphalt Road concrete Pavement & Precast Cover Over Drain

Data Sheet List		
1	C529/EL/SP/A4/423	Technical specification for Solar PV Panels and battery set.
2	C529/EE/SP/A4/424	Technical specification for Battery Charger
3	C529/EE/SP/A4/425	Technical specification for DC motors
4	C529/EE/SP/A4/426	Technical specification for Local Panels
5	C529/EE/SP/A4/427	Technical specification for supply of Bulk & Erection material including cable, earthing, lighting, cable trays, glands, lugs
6	C529/EE/CS/A4/429	Cable schedule for Electrical
7	C529/I&C/IN/A3/502	Cable Schedule for instruments
8	C529/I&C/IN/A3/503	Control System I/O List
9	C529/I&C/SP/A4/504	Specification for Pyranometer
10	C529/I&C/SP/A4/505	Specification for Anemometer
11	C529/I&C/SP/A4/506	Specification for Proximity Sensor
12	C529/I&C/SP/A4/507	Specification for Ambient Air Temperature Sensor
13	C529/I&C/SP/A4/508	Specification for Server based Image processing system along with Camera etc.
14	C529/I&C/SP/A4/509	Specification for Instrument cable
15	C529/I&C/SP/A4/510	Specification for Instrument Junction Box
16	C529/I&C/SP/A4/511	Specification for Instrument Cable Gland

Sr. No.	Document No.	Document Title
17	C529/I&C/SP/A4/512	Specification for Instrument Cable Tray
18	C529/I&C/SP/A4/514	Specification for Receiver Thermocouple Elements
19	C529/I&C/SP/A4/517	Specification for PLC based Control System

List of Mandatory spares, tools and tackles

Sr. No.	Part name	Qty.	Unit	REMARKS
1	Full sets of spanner up to Spanner size suitable for M48 bolt	2	Set	
2	Drive mechanisms - 1 no. spare unit of each component (chains – one packet and exclusions structural parts, machined plates and fasteners)			
a	Vertical axis components (refer price bid for complete list)	1	set	
b	Horizontal axis components(refer price bid for complete list)	1	set	
3	Chain	1	Pckt	
4	Chain Lock (4Nos. Each size)	2	set	Set means 4nos.
5	Grease for Drive mechanism	10	Kg	
6	Oil for Drive mechanisms Component	20	Ltrs.	
7	Lubrication Oil	10	Ltrs.	
8	Motorized Screw for Focus Fixture- Spare Motor for each type	1	Nos.	1nos. of spare motor for each type
9	Camera for Image Process – 1 camera is spare of each type	1	Nos. each	1no. of camera spare for each type
10	Anemometer	1	No.	
11	Pyranometer	1	Nos.	
12	Battery	1	Set	
13	PV Panels	1	Set	
14	Cleaning mechanism - 1 no. spare unit of each component (Except Structure)	1	Set	Motor, brush, pump, etc.
15	Thermocouple (K-types)	20	Nos.	
16	RTD, ambient	1	No.	
17	cable glands 2C x2.5 sq.mm Cu, flexible cable	5	Nos.	
18	cable glands Cables for Solar PV system (Size by PV vendor)	5	Nos.	
19	cable glands 2C x10 sq.mm Cu, flexible cable	2	Nos.	
20	cable lugs 2.5 sq.mm Cu,	5	Nos.	
21	cable lugs for Cables for Solar PV system (Size by PV vendor)	5	Nos.	
22	cable lugs 10 sq.mm Cu	2	Nos.	
23	DI module for Heliostat panel	1	Nos.	
24	DO module for Heliostat panel	1	Nos.	
25	PSM Module for Heliostat panel	1	Nos.	
26	1 set of Communication cable for Heliostat panel	1	Set	
27	DI module for PLC panel	1	No.	
28	DO module for PLC panel	1	No.	
29	1 set of Communication cable for PLC panel	1	Set	
30	wireless modem unit	1	No.	
31	Proximity sensors	8	Nos.	
32	Instrument Junction box	1	no.	
33	cable glands size ½" NPT for 1 Pair x 1.5 mm2 Screened	7	Nos.	
34	cable glands size ½" NPT for 1 Triad x 1.5 mm2 Screened	1	no.	
35	cable glands size M 20* for 1 Pair x 1.5 mm2 Screened	8	Nos.	
36	cable glands size M 50* for 12 Pair x 1.5 mm2	2	Nos.	

Sr. No.	Part name	Qty.	Unit	REMARKS
	Thermocouple			
37	1 Pair x 1.5 mm2 Screened cable	10	mtrs.	
38	1 Triad x 1.5 mm2 Screened cable	10	mtrs.	
39	12 Pair x 1.5 mm2 Individual & Overall Screened cable	10	mtrs.	
40	3 Core x 2.5 mm2 cable	10	mtrs.	
41	Battery Charger	1	no.	
42	DC motors for Horizontal drive along with DC drive	1	no.	
43	DC motors for Vertical drive along with DC drive	1	no.	
44	earthing material 8 swg GI wire	40	mtrs.	
45	earthing material 25 x 3 GI earth Strip	8	mtrs.	
46	earthing material 78mm dia.3000mm long GI earth rod directly buried	1	nos.	
47	Cable size for Electrical - Contractor to work out	10	mtrs.	10mtrs of each cable size
48	Analog module	1	no.	

Note:

1. Specification of spare as per Data sheet and should be supplied with required certifications.
2. Requirement of commissioning spares shall be worked out by the bidder and supplied as required.

SECTION 6 PRICE BID

Sr. No.	Description of Item & Specification	Qty & Units	Lump Sum Price (in Rs.)	VAT , WCT, Service Tax & other taxes / charges if any please specify details (%/ in Rs.)	Total Price (in Rs.)
	Procurement, Construction and Commissioning (PCC) Contract for Execution of “Heliostat Reflector Development with Tracking & Flux Measurement” This project will be implemented at NTPC, NETRA at Greater NOIDA, Uttar Pradesh	1 No.			

1. The bidder should quote the price on the lump-sum basis for the scope mentioned in scope of work, materials, tools & tackles, manufacturing, fabrication, transportation, construction, facilitation of intermittent & final inspection, including statutory payments and compliances as applicable for and arising from the work (no cost will be borne by NTPC / IITB / DEC), manpower, travel, boarding & lodging, construction and potable water for labour, own and DEC / Client personnel, temporary power arrangements etc. for the entire duration of the contract including extension, if any, thereof.
2. The bidder is required to provide item rates in Cost Drivers Details vide separate sheet.
3. Bidder is requested to visit the site before bidding to inspect the site and its surroundings and ascertain and satisfy himself in all respects to understand the site and surroundings, the development necessary by way of site clearing, filling, drainage, access roads, fences, sheds, material required for temporary and / or construction power and water, permits and procedures etc. to estimate all costs related to the work. No extra claims of any nature on any misunderstanding or otherwise shall be allowed. The site visit shall be conducted entirely at bidder's cost.

Validity - The bidder shall hold the bid valid for 180 days from the date of submission of quotation/tender.

Delivery perioddays

PAN No:.....

VAT/TIN Registration No:.....

Signature:

Place: Name:.....

Date: Business Address:.....

Affix Rubber Stamp:.....

Note: Price Bid and Cost Drivers Details should be submitted in given format only. For additional information / extra items above format may be typed and used.

SCHEDULE OF COST DRIVERS

ARCH/Civil / Structural Steel work

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
1	Removing shrubs, vegetation, etc. including cutting down trees of girth upto 30 cms and grubbing of roots upto 1 M depth from ground, cutting the branches, including clearing of all dirt, muck, waste, garbage, debris etc, clearing & levelling the site, including stacking the useful material & disposal of rubbish outside the OWNER's property as directed by Client / Engineer at all risk and cost to contractor's account. The bidder shall have visited site and acquainted himself fully with the work. Item also includes removal of grass etc. after one monsoon period.	70,000	sqm		
	PART : A				
2	EARTHWORK : Earthwork in excavation up to a depth of 2000 mm to the required profile for all types of soil (other than hard rock) including shoring, strutting, de-watering, if any, disposal of total excavated earth inside/outside the plant premises as directed by the Engineer-in-charge including all labour, transportation vehicles, loading & unloading, spreading, compacting for all leads & lifts etc. complete as per the detailed technical specifications and as directed by the Engineer-in-charge. The surplus earth to be dumped out of the plant premises at a place which is not objectionable to any private / Govt. Agencies and NTPC is not responsible for any issues arising due to dumping of surplus earth outside plant premises.	710	Cu.m.		
3	Same as Item no.1, but excavation for the depth beyond 2 m & upto 4.0 m	50	Cu.m.		
4	Backfilling the sides of foundations, pile caps, sub-structures, trenches for pipes & drains, sumps, pits etc. and filling under floors or	356	Cu.m.		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	within plinth, open trenches, tank foundations etc. with approved quality of selected earth available within premises or to be brought from outside and laid in layers not exceeding 150mm in thickness including watering ramming levelling and compacting to 95% proctor density with use of mechanical rammers etc. complete as directed and instructed by Engineer /Owner and standard drawing				
4.1	Same as above but with selected excavated earth available & stacked somewhere within Owner's premises	100	Cu.m.		
4.2	Same as above but with murrum of approved quality. Murrum provided and brought by Contractor from outside the Owner's premises.	20	Cu.m.		
4.3	Same as above but with approved quality of sand provided and brought by contractor from outside Owner's premises with complete hydraulic consolidation, including retention methods if any.	Rate only	Cu.m.		
5	EARTHWORK IN FILLING : GOOD EARTH FILLING				
	Supply & laying of approved quality Good Earth for roads, drains, pathways, floors etc. as per specifications in IRC, including payment of all royalties, taxes, handling, transportation, spreading in layers of 150 mm compacted thickness, or as required as per site conditions, leveling and dressing to the required profile/camber, watering, ramming, rolling with 10-12 MT mechanical vibratory roller, achieving compaction to 95% standard proctor density including the initial compaction of the cleared & stripped ground surfaces etc. complete as per the detailed technical specifications and as directed by the Engineer.	100	Cu.m.		
6	Same as Itemno.4, but filling with good quality Sand approved by Engineer-in-charge.	100	Cu.m.		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
7	Supplying, providing, mixing and laying blinding layer of P.C.C. 1:4:8 for any thickness below footings, plinth beams, grade slab foundations, trenches, pits, sumps, drains etc. with 40 mm and downgraded coarse aggregates including mechanical mixing, mechanical compaction, curing etc. complete as per Technical specifications mentioned in the tender and as directed by the Engineer-in-charge. Rate includes providing required good quality plywood shuttering also.	60	Cu.m.		
8	Same as Item no. 7 but providing PCC 1:3:6 with 40 mm downgraded coarse aggregates.	Rate only	Cu.m.		
9	Same as Item no. 7 but providing PCC 1:3:6 with 20 mm downgraded coarse aggregates.	Rate only	Cu.m.		
10	Same as Item no. 7 but providing PCC 1:2:4 with 20 mm downgraded coarse aggregates.	Rate only	Cu.m.		
11	Supplying, providing, mixing and placing in position R.C.C of mix ratio M25 as per specification and drawings with 20 mm downsize crushed graded coarse aggregates for plinth protection, grade slab, footings, plinth beams, columns, slabs, equipment foundation other cast-in-situ works etc. for all depths and heights, including mechanical mixing & vibrating, curing complete as per Technical specifications (mentioned in the tender and as directed by the Engineer-in-charge. Rate includes providing required good quality plywood shuttering also. (Reinforcement steel to be paid separately)	330	Cu.m.		
12	For Floors& Pathways: Providing, mixing and placing in position R.C.C of grade 1:2:4 (M15) as per specifications and drawings with 20 mm downgraded coarse aggregates for RCC plinth protection, pathways & other in-situ works etc. including providing ISMC shuttering, vibrating (with screed vibrator), curing complete as per Technical specifications mentioned in the	35	Cu.m.		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	tender and as directed by the Engineer-in-charge. (Reinforcement will be paid separately).				
13	Supplying transporting, stacking, straightening, cleaning, cutting, bending, placing, tying in position (including providing 16 gauge annealed binding wire, will not be measured) High yield strength deformed (HYSD) TMT bars (thermo mechanically treated bars) conforming to IS 1786 (latest edition / revision) as reinforcement steel as per drawings, technical specifications mentioned in the tender & as directed by the Engineer-in-charge. (The rate shall be applicable for any height & depth and shall be inclusive of transport, loading, unloading, wastage etc.).	32	MT		
14	Supplying, providing & constructing 230 mm and above thick Brick masonry with cement mortar 1:4 (CM1:4) using approved quality bricks including scaffolding, curing, raking the joints etc. complete as specified for buildings, sheds, parapets, drains, culverts and other miscellaneous jobs etc. as per the technical specifications mentioned in the tender and as directed by the Engineer-in-charge.	240	Cu.m.		
15	Supplying & laying 230 mm thick rubble stone soling to the required grade and profile in building flooring, road works, paving, ramps etc. using approved quality black stone properly hand packed & filling up the crevices with smaller size stones followed by stone dust and watering so as to fill voids for thickness as shown on drawing, including rolling with power roller etc. Complete as per the Technical specifications mentioned in the tender document and as advised by the Engineer-in-charge.	1061	Sqm		
16	Supplying, providing & applying 20 mm thick external waterproof sand faced plaster in C.M. 1:4 in two layers, undercoat 12 mm thick using	305	Sqm		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	sand in C.M. 1:6 and 8 mm thick top layer in C.M. 1:3 using approved water proof compound as recommended by the manufacturer, the rate of which is inclusive in the item itself at all levels including surface preparation, staging, scaffolding, roughening, curing etc. complete as per the Technical specifications mentioned in the tender document and as directed by the Engineer-in-charge.				
17	Supplying, providing & applying smooth finish 12 mm thick plaster to internal surfaces of was/drains in two layers, under coat in cement mortar 1:6 and finishing coat of 3 mm thick, at all levels including surface preparation, staging, scaffolding, roughening, curing etc. complete as per the Technical specifications mentioned in the tender document and as directed by the Engineer-in-charge.	1126	Sqm		
18	Supplying, providing & applying smooth finish 6 mm thick ceiling plaster as per drawings and as directed by the Engineer-in-charge.	155	Sqm		
19	Providing & laying 175 mm thick consolidated WBM-I layer of well graded broken down stone aggregates of 90 mm downgraded to 40 mm size of approved quality, well-watered and rolled to full compaction with 10 MT vibratory road roller using good quality murrum as bandage to required grade and profile including filling the interstices with spas and chips screenings, good quality murrum, preparation of camber board to achieve the required road camber etc. complete as per Technical specifications mentioned in the tender document & as directed by the Engineer-in-charge NOTE : After final compaction the road shall be allowed to cure overnight and any unevenness noticed on the surface shall be filled with smaller size of aggregates, murrum, watered and rolled. Quoted rates shall be inclusive of taking levels during the course of work and	4330	Sqm		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	getting lab tests done on materials. LA Abrasive value: 40% max. Flakiness Index: 15% max				
20	Same as Item No. 19, but for supply & laying of 75 mm thick WBM Gr. II layers with 63 to 40 mm size of aggregates.	4330	Sqm		
21	Providing & laying 50 mm average consolidated thick premix asphalt carpet using bitumen gr. 60 / 70, spreading the premix with a mechanical paver machine to the required camber / slopes / compacted thickness and rolling with 10 MT mechanical vibratory roller. Rate includes removal of excess murrum with wire brushes to expose the WBM metal surface, application of tack coat (with bitumen gr. 80/100) on existing WBM surface, etc. complete as per the Technical Specifications mentioned in the tender document and as directed by the Engineer-in-charge	4330	Sqm		
22	Providing & laying 12 mm average consolidated thick sealcoat using bitumen gr. 60 / 70, spreading the premix with a mechanical paver machine to the required camber / slopes / compacted thickness and rolling with 10 MT mechanical vibratory roller. Rate includes application of tack coat (with bitumen gr. 80/100) on premix carpet as per the detailed specifications mentioned in the tender, etc. complete as per the Technical Specifications mentioned in the tender document and as directed by the Engineer-in-charge	4330	Sqm		
23	Supplying, providing & laying 450 mm Dia NP 3 class Hume pipes conforming to relevant BIS specification including supply & fixing of course, laying the pipes to proper alignment, jointing as per manufacturer's specifications and as advised by the Engineer-in-charge, curing, checking for leak-proof ness etc. complete as directed at site, for cable crossings, pipe crossings, storm water drains etc. complete as directed by the Engineer-in-charge and complete as per drawings	20	RM		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
24	Supplying and laying of 100 mm dia HDPE pipes of heavy-duty & first quality as approved by Engineer-in-charge. Scope includes supply & laying of all the necessary pipe bends, sockets/coarse required for joining the pipes etc. complete as directed by the Engineer-in-charge and complete as per drawings	50	RM		
25	Same as Item no. 28 but for supply & laying of 75 mm dia HDPE pipes of heavy-duty.	50	RM		
26	Providing pockets of 300 mm deep and dia suitable for fixing/grouting the anchor bolts of trusses & equipment at all heights & depths including all the necessary accessories required to provide the pockets complete as per drawings and as directed by the Engineer-in-charge.	100	Nos		
27	Supplying, providing and applying three coats of approved white/color wash to internal/ external surfaces to give good even shade, including surface preparation, primer, staging, scaffolding etc. complete as per the Technical specifications mentioned in the tender document and as directed by the Engineer-in-charge.	725	Sqm		
28	Supplying, providing, aligning and fixing in position anchor bolts for supporting structural columns and equipment, of all sizes and diameters, anchor plates, hooks, washers, nuts and check nuts etc. complete as per drawings and as directed by the Engineer-in-charge.	3500	Kg		
29	Supplying & Grouting with 1:2 cement mortar for column bases, anchor bolt pockets, machine base, pipe sleeves, pocket holes and other miscellaneous works as per technical specifications mentioned in the tender document and as advised by the site Engineer including roughening and cleaning of surfaces, curing, etc. Complete.	1.5	Cu.m.		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
30 a	Providing and fixing aluminum door made from standard heavy aluminum sections with 15 microns anodizing complete with all accessories including Everite or equivalent make with floor springs, hardware locking, push/pull handles etc. with 5.5 mm thick plane glass etc. complete as directed by the Engineer-in-charge and complete as per drawings spec.	6	Sq.M		
b	Door with end fixed & central double open able shutter	Rate only	Sq.M		
c	Door with single shutter	Rate only	Sq.M		
31	Providing and fixing in position glazed anodized aluminum windows or standard anodized aluminum sections of approved quality and make, including all anodized aluminum fixtures, fastenings etc. including making recesses in brick / concrete surfaces and making good the same after fixing windows, all as per manufacturer's specifications etc. complete as per spec complete as directed by the Engineer-in-charge and complete as per drawings				
a	Fully fixed with 4 mm thick glass	5	Sq.M		
b	Sliding type	10.1	Sq.M		
c	Providing and fixing framed glass louvers, all as per manufacturer's specifications etc. complete as per as directed by the Engineer-in-charge and as per drawings	3	Sq.M		
32 a	Providing & applying 3 coats of Plastic emulsion paint of different shade and make as per manufacturer's specifications including necessary scaffolding and surface preparation etc. complete as per specification, drawings and directions of engineer in charge.	470	Sq.M		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
b	Same as item above but providing & applying minimum two coats of Sandtex matt or equivalent approved texturized waterproof exterior paint in approved shade including application of one coat of cement paint primer including necessary scaffolding and surface preparation etc. complete as per specification, drawings and directions of engineer in charge.	305	Sq.M		
c	Providing & applying anti-dusting paint as per specification, drawings and directions of including necessary scaffolding and surface preparation etc. complete as per specification, drawings and directions of engineer in charge.	16	Sq.M		
33	Thermal Refractory lining 115 mm thick for protection of structural steel parts supported with suitable cleats, including necessary scaffolding and surface preparation etc. complete as per specification, drawings and directions of engineer in charge.	25	Sq.M		
34	Providing, fabricating and fixing in position at required locations to correct lines and levels, angles, inserts, pipe sleeves, anchor bolts for columns, floors, machine foundations, cable trenches and all types of RCC, PCC & masonry including lugs, etc., including necessary scaffolding and surface preparation etc. complete as per specification, drawings and directions of engineer in charge. (Plate inserts including hold fasts)	200	kgs		
35	Supplying and fabricating edge angles welded to hold fasts fixed at 450 c/c				
a	50X50X6	10	RM		
b	65X65X6	10	RM		
36 a	Fixing anti-skid glazed tiles of approved type, make and shade of size 2' x 2' in areas fixed as per pattern of various sizes and colors in perfect line, level, fixed over cement mortar	50	Sq.M		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	bedding with neat cement slurry, closely jointed, filling the joints with white cement by adding matching color pigment, applying protective coat of plaster of Paris on top of flooring, removing and cleaning after completion of works etc. complete at all levels.				
36 b	Fixing anti-skid glazed tiles of approved type, make and shade in skirting as per pattern of various sizes and colors in perfect line, level, fixed over cement mortar bedding with neat cement slurry, closely jointed, filling the joints with white cement by adding matching color pigment, applying protective coat of plaster of Paris on top of flooring, removing and cleaning after completion of works etc. complete at all levels.	50	RM		
37	Providing & laying 25 to 40 mm thick hand cut machine polished Kota stone in stair treads and riser & landing laid on 15 mm thick base cement mortar 1:4 and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing & finishing nosing to uniform thickness. complete as directed by the Engineer-in-charge and complete as per drawings	28	Sq.M		
38	Providing and laying acid / alkali resistant tile of approved make and quality in flooring. complete as directed by the Engineer-in-charge and complete as per drawings	Rate only	Sq.M		
39	Granolithic flooring complete as directed by the Engineer-in-charge and complete as per drawings	64	Sq.M		
40 a.	Providing, laying and Fixing Anti-skid vitrified of approved type, make and shade of size 2' x 2' in areas fixed as per pattern of various sizes and colours in perfect line, level, fixed over cement mortar bedding with neat cement slurry, closely jointed, filling the joints with white cement by adding matching colour	35	Sq.M		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	pigment, applying protective coat of plaster of Paris on top of flooring, removing and cleaning after completion of works etc. complete at all levels. as directed by the Engineer-in-charge and complete as per drawings				
b.	Providing, laying and Fixing vitrified tiles of approved type, make and shade of size 2' x 2' in areas fixed as per pattern of various sizes and colours in perfect line, level, fixed over cement mortar bedding with neat cement slurry, closely jointed, filling the joints with white cement by adding matching colour pigment, applying protective coat of plaster of Paris on top of flooring, removing and cleaning after completion of works etc. complete at all levels. as directed by the Engineer-in-charge and complete as per drawings	50	Sq.M		
c.	Providing, laying and Fixing Ceramic/glazed tiles of approved type, make, and shade of and colours in perfect line, level, fixed over cement mortar bedding with neat cement slurry, closely jointed, filling the joints with white cement by adding matching colour pigment, applying protective coat of plaster of Paris on top of flooring, removing and cleaning after completion of works etc. complete at all levels. as directed by the Engineer-in-charge and complete as per drawings	20	Sq.m		
41	SKIRTING Fixing avg. 20 mm Thk. machine cut, approved quality mirror finish polished acid resisting tiles, and vitrified tiles respectively for UPS / BATTERY ROOM, CONTROL ROOM and ENTRANCE AREA skirting 150 mm high in perfect line, level fixed over cement mortar bedding with neat cement slurry, closely jointed, filling the joints with white cement by adding matching colour pigment and cleaning after completion of all the works etc. complete as directed by the Engineer-in-charge and complete as per drawings	105	RMT		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
42	WATER PROOFING Providing & laying brick bat lime concrete 1:4 1 part of lime mortar (1:1) (Lime : 1 Sand) and 4 parts of brick bats of approximately 40 mm size for toilet sunken portions, terrace etc. in required thickness & gradient including watering, ramming, consolidating etc. complete as directed by the Engineer-in-charge and complete as per drawings	73	Sq.M		
43	Unless otherwise specified damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement, sand, stone chips (10 mm down) with admixture of a waterproofing compound as approved by the CDPL Site-In- charge.	15	SQ.M		
44	Sanitary items. Following sanitary items should be complete as directed by the Engineer-in-charge and complete as per drawings				
44.1	Western pattern water closet including flush tank, water taps, supports, fittings and plumbing	1	no.		
44.2	Urinal including water taps, supports, fittings and plumbing	1	no.		
44.3	Partition stone	1.50	Sq.M		
44.4	Wash basin including water taps, supports, fittings and plumbing	1	no.		
44.5	Soak pit and septic tank of capacity of 5 person	1	set		
44.6	Rainwater down take pipe including pipes supports, fittings and plumbing	18	RMT		
45	Providing and fixing Exhaust fan as directed by the Engineer-in-charge and complete as per drawings	1	no.		
46	Hand railing: Supplying, fabricating, erecting pipe hand	150	RMT		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	railing with top rail and verticals as per drg. & specifications & Engineer-in-charge and complete as per drawings.				
47	Precast cover panels (600mm x 600mm) over drains as per drg and as directed by Engineer-in-charge	230	NOS.		
48	Precast panels of M25 (100 x 700 x 50 mm thk) for counter weight of Heliostats as per drg and as directed by Engineer in charge	45	Sq.m.		
49	Develop and construct a 120 sqm (about 8m x 12m) covered and enclosed space with clean and leveled flooring for storage of the mirrors and for all work related to assembly on mirror frames etc. The bidder shall make all necessary provisions for electrical power points and lighting, including temporary electrical power supply, ventilation, lockable doors, windows etc. as directed at site.	L.S	L.S		
50	Design and provide a site office in portable container / porta-cabin construction, duly insulated, air conditioned, furnished with 8 nos 4' x 2' tables, steel structure with laminated plywood top, reclining, fabric covered cushioned chairs with PU arms-rest and castors, electrical connections with 3 x 5 amp x 3 pin switch socket at each table for computers etc. as per description in the tender including decommissioning and removing the same from site on completion of the project.	1	No.		
51	Providing and fixing precast cement concrete blocks / panels for counter weight for heliostat and focus fixture as per drawing and directed by Engineer-in-charge	approx. 3400	No.		
	TOTAL =				
	ADD TAXES				
	TOTAL =				

Structural steel work

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
1	Procurement and supply of structural steel as per drawings and details, consisting of plates, rolled steel sections such as channels, angles, rods / pipes / tubes etc., straightening of the steel if required, fabrication of steel structures, built-up sections, trusses, stairs, hand rails, gratings, chequered. Plates, gutters & down corners etc. as per drawings, loading, transportation, unloading and delivery at erection site of all fabricated structures, erection, alignment connection bolts and welding of all structures true to line, level, plumb and dimension including rectification if any splicing, site assembly all as per technical specifications, drawings and instruction of the Engineer-in-Charge.				
a	As above for Heliostat	55.2	MT		
b	As above for Central Receiver Tower, including the focus monitoring plate as per drawings and details.	30	MT		
c	As above for Focus Fixture	3.6	MT		
e	As above for structural steel mirror frame structures as per drawing and detail.	7	MT		
f	Nut and bolts M6 (SS-304) for Mirror Frames	6144	NOS		
g	As above for Finish Cut MS (IS 2062) plate with HDG size of 250X250X5mm Thk. with center drill of ϕ 12.5mm, as per drawing and as directed by Engineer in charge.	1300	Nos		
h	As above for Cleaning mechanism parking structure	3	MT		
i	As above for Dummy Receiver, including dismantling the dummy receiver after successful completion of testing, lowering to	1.6	MT		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	ground, dismantling as directed, including disconnection and removal of thermocouples etc. and handing over to stores as directed by EIC.				
2	Supplying, transporting, fabricating, loading, unloading and erecting in position to the required line & level, steelwork made out of tubes as per IS 1161 Gr. Y st 250 or as per IS: 2062 for trusses, bracings, tie runners, pipe supports, towers & cleats, base plate gussets, girts, purlins, side runners etc. including cutting, welding, bolting, threading, preparation for fabrication including painting, staging, scaffolding etc. complete as per the Technical specifications and the Engineer In-charge mentioned in the tender document and as directed by the Engineer-in-charge. (the plates used for making the trusses will be measured under this item only).	Rate only	MT		
3.1	Supplying & providing, fixing in position G.I. pre-coated color sheets as roofing sheets, as per manufacturers specification Including G.I. hooks, bolts, nuts, bituminous washers etc. allowing for lapping, drilling, cutting and wastage including scaffolding for working at all heights etc. complete as per spec. and direction of Engineer-in-charge.	55	Sqm		
3.2	Providing & Fixing G.I. color coated sheets as per manufacturer's specification For cladding / louvers including G.I. Hooks, bolts, nuts, bituminous washers, etc. allowing for lapping, drilling, cutting and wastage including scaffolding for working at all heights etc. complete as per spec. and direction of Engineer-in-charge.	80	Sqm		
3.3	Supplying & providing, fixing in position G.I. pre-coated color sheets for adjustable ridges in pairs fittings including G.I. bolts, flat washers, etc. as necessary allowing for cutting, lapping and wastage etc. complete as per spec. and	Rate only	RM		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	directions.				
3.4	Supplying & providing, fixing in position G.I. pre-coated color sheets for barge board's fittings including G.I. bolts, flat washers, etc. as necessary allowing for cutting, lapping and wastage etc. complete as per spec. and directions.	20	RM		
4 a	Supply and assembly of hot dip galvanized steel fasteners as per IS 1367 as per design drawing and details, weight of finished galvanized fasteners will be considered for payment. Galvanizing as per specification stated in the tender.	1800	kgs		
b	Supply and assembly of SS 304 fasteners as per ASTM A276 Type 304 QQ-S-763 Class 304, AISI 304, mechanical properties as per ASTM F593-91 as per design drawing and details	500	kgs		
5 a	Hot dip galvanizing of structures, mirror frames (payment will be made on basis of weight of finish galvanized structure, weightment may be witnessed by client / consultant).	19	MT		
B	Spray galvanizing of structures (payment will be made on basis of weight of finish galvanized structure, weightment will be witnessed by client / consultant).	39	MT		
C	Cleaning the surface with brushing, chipping, scrapping, removing dust and loose particles including all labour, tools, consumables etc. and applying one coat of red oxide, zinc chromate primer (D.F.T. 25 microns) and 2 coats enamel paint, of approved quality and make as specified to the surface of structural steel fabricated out of angles, channels, beams, built-up sections etc. to consistency of finish paint.	36	MT		
D	As above but with Epoxy paint	Rate only	MT		
6 a	Mirror and frames assembly and erection :	800	Nos		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	Collecting precut mirror in packed condition from store and transporting the same to a clean, illuminated, dust free mirror assembly room / area (to be provided by contractor at site). Assembly of mirrors with mirror frames using approved industrial adhesive non-reactive (of tensile strength of 580 psi (ASTM D 412), service temperature range of – 40 °C to 90 °C) as directed by the Consultant.				
B	Supply of labour for lifting and fixing the assembled mirror frames on to the heliostat structure using fasteners supplied by others in line and level as directed by the Consultant.	800	Nos		
C	Supplying and fixing refractory protection lining -115 thick				
7	Supplying and fixing Insulation pad at the back of dummy receiver	13.5	Sq.m		
8.	Supplying and fixing MS motorized Rolling shutter size of 3X3 mtrs. As per drawing and instructed by Engineer In-charge.	1	no.		
	TOTAL =				
	ADD TAXES				
	TOTAL =				

Unit rates for supply and labour

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
1	Unit rates for supply of civil work material – Landed cost at site, including Taxes, Transport, loading, unloading, shifting to store, stacking, wastage etc. complete				
a	Cement Grade 53	Rate only	Bag		
b	Cement Grade 43	Rate only	Bag		
c	Cement Grade 33	Rate only	Bag		
d	Sand	Rate only	Cu.m		
e	Reinforcement	Rate only	MT		
f	Brick	Rate only	Nos		
g	Coarse Aggregates 20mm	Rate only	Cu.m		
h	Coarse Aggregates 40mm	Rate only	Cu.m		
i	Concrete Mixer M25 (premix)	Rate only	Cu.m		
j	Concrete Mixer M20 (premix)	Rate only	Cu.m		
k	Concrete Mixer M15 (premix)	Rate only	Cu.m		
l	Concrete Mixer M10(premix)	Rate	Cu.m		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
		only			
m	Vitrified Tiles	Rate only	Sq.m		
n	Acid resistant Tiles	Rate only	Sq.m		
o	Kota Stone	Rate only	Sq.m		
p	Granolithic flooring	Rate only	Sq.m		
q	Partition Stone	Rate only	Sq.m		
r	Stone Chips	Rate only	Cu.m		
s	Lime	Rate only	kg		
t	Water Proofing	Rate only	Sq.m		
u	Shuttering	Rate only	Sq.m		
v	Plastic Emulsion Paint	Rate only	Ltr		
w	Texturized waterproof exterior paint	Rate only	Ltr		
x	Anti-Dusting Paint	Rate only	Ltr		
2	Unit rates for supply of labour– Including all statutory dues and charges, food, accommodation, sanitary, potable water etc. arrangements etc. complete				
a	Helper	Rate	Nos		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
		only			
b	Welder	Rate only	Nos		
c	Fitter	Rate only	Nos		
d	Bender	Rate only	Nos		
e	Site Engineer	Rate only	Nos		
f	Supervisor	Rate only	Nos		
g	Mistry	Rate only	Nos		
h	Polisher	Rate only	Nos		
i	Plumber	Rate only	Nos		
j	Carpenter	Rate only	Nos		
k	Painter	Rate only	Nos		
l	Skilled Worker	Rate only	Nos		
3	Machinery Rate per Day – Including Taxes, Transport, Fuel , Operator cost etc.				
a	Vibrator	Rate only	Per day		
b	Concrete Mixture	Rate only	Per day		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
c	Dewatering pump	Rate only	Per day		
d	Earth Compacter	Rate only	Per day		
e	JCB	Rate only	Per day		
f	Tools & Plants	Rate only	Per day		
4	Mechanical & Other Material - Landed cost at site, including Taxes, Transport, loading, unloading etc.				
a	Full sets of spanner (Full Complete Set)	Rate only	Set		
b	Electrical component with 1 no. spare unit of each component as per specification in data sheet C529-EE-SP-A4-427	Rate only	Set.		
c	Electrical Local Panel component with 1 no. spare unit of each component as per specification in data sheet C529-EE-SP-A4-426	Rate only	Set.		

Mechanical work

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
1	Heliostat drive Mechanism				
1.1	Vertical axis components: Design, Supply, fabrication, assembly, testing, erection and commissioning of Components of Heliostat drive Mechanism for Vertical axis as per specifications and Annexure given below and drawing and as directed by DEC.	8	SET		
1.2	Horizontal axis components Design, Supply, fabrication, assembly, testing, erection and commissioning of Components of Heliostat drive Mechanism for Horizontal axis as per specifications and Annexure and drawing and as directed by DEC.	8	SET		
2	Heliostat cleaning system Design, Supply, fabrication, assembly, testing, erection and commissioning of heliostat cleaning system including 5 MT truck, rotating column, horizontal rotating shaft, cleaning brushes, cleaning water pump, piping, jets as per drawings, details & as directed by DEC.	1	SET		
3	Mobile Aerial access platform Procurement, supply, testing and commissioning of truck / tractor mounted aerial access platform, suitable for working at height of 10m, 200 kg weight, basket of minimum size 600 x 1000 with safety railing and toe guard, telescopic boom with internally hard-chrome plated double-acting cylinders with high quality seals, safety limits for boom travel, basket made from high strength tubular sections, duplicated controls in basket protected from unintentional operation, basket levelling system, outreach 4.5m (min), at least one performance certificate from any government /	1	no.		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	semi-government organization in India for same make and model, right hand drive, shall comply with EURO IV / BS IV or latest emission norms.				
	TOTAL =				
	ADD TAXES				
	TOTAL =				

Heliostat Drive Mechanism : Vertical Axis Components per heliostat								
			Qty/ heliostat, all weights are Raw weights.					
S.N.	Item	Unit	Bought outs	Structural	Machined Items	Rate	Amount (Rs.)	Remarks
1	100 teeth Sprocket for 1 inch Triplex Chain	No.	1					MOC : EN8
	(with support cleats 12 Nos)	kgs		15				
2	Support frame for Ver Drive	kgs		750				MOC : MS IS2062
3	Shaft of 540 dia x 16 thk pipe x ~650 long (with pad plate at the Bush location)	kgs			105			MOC : MS IS2062
4	Bush of 556 ID , 616 OD, 60 thk for the above(in 2 halves)	kgs			135			MOC : Gun metal
5	Bush housing - attached with Static Tower (Top)	kgs			225			MOC : MS IS2062
6	Shaft of 225 dia ROD x ~300 long	kgs			115			MOC : MS IS2062
7	Bush of 225 ID , 285 OD, 120 thk for above	kgs			60			MOC : Gun metal
8	Bush housing - attached with Static Tower (Bot)	kgs		50	100			MOC : MS IS2062
9	Thrust Bush of 105 dia x 28 mm thk	kgs			2			MOC : Gun metal
10	Planetary / Worm Gear W63P4095 Foot Mounted, Horizontal,	No.	1					

	Ratio:26557:1, Rated Torque 1300 kgm, Longer shaft							
11	Bush for Gear Shaft support (2 Nos)	kgs			1			MOC : Gun metal
12	Support plate for Gear Shaft	kgs			45			MOC : MS IS2062
13	Chain - Triplex 25 mm pitch, TR2517 / 16B-3	m	5					
14	Sprocket - 18 teeth for 1 in pitch Triplex chain	No.	1					MOC : EN8
15	Key 10 x 10 x 100 long	No.	2					MOC : MS IS2062
16	Sprocket - 18 teeth for 5/8 in pitch Triplex chain(Tensioning sprocket)	No.	1					MOC : EN8
17	Tensioning Bolt M48x 215mm Long, with Nut, Lock nut and washer	No.		1				Class 4.6, IS 1367 - HDG
18	Shaft for Tensioning Sprocket 50 dia x 220 long(With End Locking plate)	kgs			15			MOC : MS IS2062
19	Bush for the above	kgs			1			MOC : Gun metal
20	Counter (Mounted on Shaft) 300 dia sheet - 16 g	No.		1				
21	Servo Motor AC(230V)/BLDC (24V), IP66, Torq 7 kg-cm Flange mntg, speed 200 to 2600 RPM,Including drive suitable for panel mounting	No.	1					
22	Static Tower	kgs		850				MOC : MS IS2062

23	Bolts for connecting with Support column(45 dia x 260 mm Long)	No.	12					Class 4.6, IS 1367 - HDG
24	Proximity Switches, Position (E, W, Parking)	No.	3			Incl.in instruments item list		
	Counter	No.	1					

Heliostat Drive Mechanism : Horizontal Axis Components per Heliostat								
			Qty/heliostat, all weights are Raw weights.					
S.N.	Item	Unit	Bought outs	Structural	Machined Items	Rate	Amount (Rs.)	Remarks
1	1800 mm dia Wheel with Chain locking(special spoke with extension for locking)	kgs		400				MOC : MS IS2062
2	Shaft of 450 dia x 10 thk pipe x ~1450 long (with pad plate 450 ID x 100 wide x 10 thk at each Bush location)	kgs		290	15			MOC : MS IS2062
3	End connection plates	kgs		290				MOC : MS IS2062
4	Bushes for the above (in 2 halves) 544 OD,464 ID, 50 thk, 2 Nos	kgs			185			MOC : Gun metal
5	Plummer blocks for housing the Bushes	kgs		310	600			MOC : MS IS2062
6	Connection Bolts to support the upper half of P.B.(M30 x 130 Long)	Nos.	12					Class 4.6, IS 1367 - HDG
7	Connection Bolts to support the Btm half of P.B.(M36 x 135 Long)	Nos.	20					Class 4.6, IS 1367 - HDG
8	Planetary / Worm Gear W63P4095, Foot Mounted, Horizontal, Ratio:26557:1,	No.	1					

Heliostat Drive Mechanism : Horizontal Axis Components per Heliostat								
			Qty/heliostat, all weights are Raw weights.					
S.N.	Item	Unit	Bought outs	Structural	Machined Items	Rate	Amount (Rs.)	Remarks
	Rated Torque 1300 kgm, Longer shaft							
9	Connection bolts for the above (20 dia x 95 long)	No.	4					Class 4.6, IS 1367 - HDG
10	Bush for Gear Shaft support (2 Nos)	kgs			1			MOC : Gun metal
11	Support plate for Gear Shaft	kgs			25			MOC : MS IS2062
12	Connection bolts for the above (20 dia x 95 long)	No.	8					Class 4.6, IS 1367 - HDG
13	Chain - Triplex 25 mm pitch, TR2517 / 16B-3	m	7.5					
14	Sprocket - 18 teeth for 25mm pitch Triplex chain	No.	1					MOC : EN8
15	Key 10 x 10 x 100 long	No.	2					
16	Sprocket - 18 teeth for 25mm pitch Triplex chain(Tensioning sprocket)	No.	1					MOC : EN8

Heliostat Drive Mechanism : Horizontal Axis Components per Heliostat								
			Qty/heliostat, all weights are Raw weights.					
S.N.	Item	Unit	Bought outs	Structural	Machined Items	Rate	Amount (Rs.)	Remarks
17	Tensioning Bolt M48x 240mm Long, with Nut, Lock nut and washer	No.		1				Class 4.6, IS 1367 - HDG
18	Shaft for Tensioning Sprocket 50 dia x 220 long	kgs			15			MOC : MS IS2062
19	Bush for the above	kgs			1			MOC : Gun metal
20	Support plate for the tensioning sprocket	kgs		12				MOC : MS IS2062
21	Guide Channels for Tensioning arrgt.	kgs		40				MOC : MS IS2062
22	Servo Motor AC(230V)/BLDC (24V), IP66, Torq 7 kg-cm Flange mntg, speed 500 to 5500 RPM, including drive suitable for panel mounting	No.	1					
23	Locking Plate 140 x 60 x 320 mm long	kgs		25				MOC : MS IS2062
24	Actuator for Lock operation(Stroke = 300 mm and capacity = 25 kg)	No.	1					

Heliostat Drive Mechanism : Horizontal Axis Components per Heliostat								
			Qty/heliostat, all weights are Raw weights.					
S.N.	Item	Unit	Bought outs	Structural	Machined Items	Rate	Amount (Rs.)	Remarks
25	Counter (Mounted on Shaft) 300 dia sheet (16 g)	No.		1				MOC : MS IS2062
26	Proximity Switches							
	Lock control	No.	2			Included in instruments item list		
	Position (N, S, Parking)	No.	3			Included in instruments item list		
	Counter	No.	1					

Controls and Instrumentation work

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
1.0	Off-Line Field Instruments												
1.1	Ambient air temperature sensor - RTD Type with mounting etc. complete.	1	No.										Bracket / wall mounting
1.2	Pyranometer - Solar radiation (shaded/unshaded) with 4-20 mA transmitter, shading ring, mounting assembly, mounting structure, foundation for mounting, finishing, painting etc complete.	2	no.										Bracket / wall mounting
1.3	Anemometer - 3-Cup type with 4-20 mA transmitter with mounting assembly, mounting structure, foundation for mounting, finishing, painting etc complete.	4	no.										Bracket / wall mounting

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
1.4	Proximity probes - 3 wire inductive type with pigtail	64	no.										Bracket / wall mounting
1.5	RTU Control box with wireless modem with PB/ Switches / Lamps, 1000 x 1000 x 600 mm(L x H x D)	8	no.										Bracket / wall mounting
1.6	Dummy receiver plate embedded with skin type, type K thermocouple elements, 121 no.	1	Set										
1.7	CCTV Cameras - imaging cameras												
a	Type 1 for focus screen	1	nos										Bracket / wall mounting
b	Type 2 for heliostat field	4	nos										
c	Type 3 for MF alignment	1	nos										
2.0	Control room mounted system component												

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
2.1	PLC Cabinet with wireless modem & Ethernet switch floor mounted type & Redundant CPU, 800 x 800 x 2100 mm (W x D x H)with door mounted 14" LCD monitor (supply & fabrication of base plate frame by contractor)	1	No.										
2.2	Image processing server station - Desktop PC server with ethernet switch	1	Set							N/A	N/A		
2.3	DVR, monitor & camera interface control unit for alignment & Image processing system.	2	Set							N/A	N/A		
	Instruments installation material												
3.0	Junction boxes - JB for 12	1	no.			N/A	N/A	N/A	N/A				

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	pair signal cable (150 terminals)												
4.0	Instrument signal & alarm cables (installation contractor's job includes laying, dressing, clamping, glanding, ferruling, testing (Meggering, continuity & loop checking) and termination of cables at both ends including supply of materials such as ferrules, crimping lugs and clamps etc.												
4.1	Signal cable – 1 pair x 1.5 sqmm, shielded & armoured cable, outer sheath PVC (grey)	2000	m			N/A	N/A	N/A	N/A				
4.2	RTD signal cable – 1 Triad x 1.5 sqmm, shielded & armoured cable, outer sheath PVC (grey)	50	m			N/A	N/A	N/A	N/A				
4.3	K-type Thermocouple signal cable – 1 pair x 1.5 sqmm, shielded & armoured cable, outer sheath PVC (yellow)	100	m			N/A	N/A	N/A	N/A				

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
4.4	Signal cable - 6 pair x 1.5 sqmm individual & overall shielded & armoured cable, outer sheath PVC (grey)	QR	m			N/A	N/A	N/A	N/A				
4.5	K-type Thermocouple signal cable – 12 pair x 1.5 sqmm, individual and overall shielded & armoured cable, outer sheath PVC (yellow)	1600	m			N/A	N/A	N/A	N/A				
4.6	Power cable - 3 core x 1.5 sqmm, shielded & armoured cable, outer sheath PVC (black)	200	m			N/A	N/A	N/A	N/A				
5.0	Cable glands (Rate of installation shall be included in Cable Laying rate),Weatherproof SS 316 double compression type with check nut for Mxx glands (all cable gland make : Cosmos / Comet / Ex-Protecta). All cable glands shall be provided with PVC shrouds / gland hoods												
5.1	Cable Gland 1/2" NPT (	150	no.			N/A	N/A	N/A	N/A				

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	instrument side)												
5.2	Cable Gland M40 - suitable for 6 pair x 1.5 sqmm (cable overall OD-20-23mm)	QR	no.			N/A	N/A	N/A	N/A				
5.3	Cable Gland M40- suitable for 12 pairs 1.5 sqmm (cable overall OD-26-30mm)	80	no.			N/A	N/A	N/A	N/A				
5.4	Cable Gland M20 - suitable for 3 Core x 1.5 sqmm (cable overall OD-30-33mm)	10	no.			N/A	N/A	N/A	N/A				
6.0	Cable trays: ** (Refer Note-2)												
6.1	Ladder trays - GI Collar 100 mm thickness 4mm												
a	150 mm wide (ladder	U/R	m.			N/A	N/A	N/A	N/A				

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	type), 4mm thick												
b	300 mm wide (ladder type), 4mm thick	U/R	m.			N/A	N/A	N/A	N/A				
6.2	perforated trays – GI												
a	50 mm wide (perforated type), 4mm thick	U/R	m.			N/A	N/A	N/A	N/A				
b	100 mm wide (perforated type), 4mm thick	U/R	m.			N/A	N/A	N/A	N/A				
c	150mm wide Tray fittings, 4mm thick												
i	150mm wide 90 deg. horizontal bend, R=300 mm	U/R	no.			N/A	N/A	N/A	N/A				
ii	150mm wide 90 deg. vertical outside bend, R=300 mm	U/R	no.			N/A	N/A	N/A	N/A				
d	300mm wide Tray fittings,												

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	4mm thick												
i	300mm wide 90 deg. horizontal bend, R=300 mm	U/R	no.			N/A	N/A	N/A	N/A				
e	100mm wide Tray fittings, 4mm thick (perforated)												
i	100mm wide 90 deg. horizontal bend, R=300 mm	U/R	no.			N/A	N/A	N/A	N/A				
f	50mm wide Tray fittings, 4mm thick (perforated)												
i	50mm wide 90 deg. horizontal bend, R=300 mm	U/R	no.			N/A	N/A	N/A	N/A				
6.3	Coupler plates (3mm thk.) of suitable size for FRP trays along with SS hardware (for ladder tray, total 4 nos. of coupler plates required for joining	U/R	no.			N/A	N/A	N/A	N/A				

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	2 trays)												
6.4	Coupler plates (4mm thk.) of suitable size for FRP trays along with SS hardware (for perforated tray, total 2 nos. of coupler plate required for joining 2 trays)	U/R	no.			N/A	N/A	N/A	N/A				
7.0	Structural steel for supports Supply, fabrication erection and painting of structural steel including supply of paint and providing 3 coats of paints (1 coat primer and 2 coats finished) for all structural works to be included in the scope of the contractor (refer typical mounting drawings)												
7.1	Channel ISMC 100 x50, 1600 LG	U/R	kg			N/A	N/A	N/A	N/A				as required
7.2	Base plate 250 x 250 6 thk	U/R	kg			N/A	N/A	N/A	N/A				as required
7.3	Angle ISA 65 x 65x 6 thk.	U/R	kg			N/A	N/A	N/A	N/A				as required
7.4	Gusset plate 70 x 140 x 6 thk.	U/R	kg			N/A	N/A	N/A	N/A				as required

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
7.5	Earth bar Flat 50 x 6Thk, 50LG	U/R	kg			N/A	N/A	N/A	N/A				as required
7.6	Pipe (ERW), 2" NB, MS for instrument supports, 1400 Long	U/R	no.			N/A	N/A	N/A	N/A				as required
7.7	Pipe (ERW), 2" NB, MS for instrument supports, 2000 long	U/R	no.			N/A	N/A	N/A	N/A				as required
7.8	Pipe (ERW), 2" NB, MS for instrument supports, 2500 long	U/R	no.			N/A	N/A	N/A	N/A				as required
7.9	Top plate 52.5 Dia 6 THK.	U/R	no.			N/A	N/A	N/A	N/A				as required
7.10	Anchor fasteners / bolts, M10, 40 mm long	U/R	no.			N/A	N/A	N/A	N/A				as required
7.11	plate 150 x 150 x 10 THK.	U/R	kg			N/A	N/A	N/A	N/A				as required
7.12	plate 150 x 150 x 6 THK.	U/R	kg			N/A	N/A	N/A	N/A				as required
7.13	Gusset plate 200 x 110 x 6	U/R	kg			N/A	N/A	N/A	N/A				as required

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	THK.												
8.0	FRP CANOPIES												
8.1	FRP with U.V stabilised, fire retardant properties, mounting of box - 2" pipe mount with SS hardware, colour – grey												
8.2	FRP Canopies for transmitters (4mm thick)	U/R	no.			N/A	N/A	N/A	N/A				as required
8.3	FRP Canopies for junction boxes / Control boxes (4mm thick)	U/R	no.			N/A	N/A	N/A	N/A				
	TOTAL												
13.0	Unit rates for supply of labour– Including all statutory dues and charges, food, accommodation, sanitary, potable water etc. arrangements etc. complete on per				Per Day 10 Hrs shift		Including Tools, Accessories and Consumables like Teflon Tape etc.)						

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	manday basis of 10 hr shift.												
13.1	Instrument technician												
13.2	Electrician												
13.3	Instrument fitter												
13.4	Welder												
13.5	Helper												
13.6	Supervisor												
14.0	Information for the estimation of loop checking and interlock checking :- (Effort Cost to be included in various activities mentioned above) PLC I/O Count -												
14.1	Analog inputs / outputs	10	no.										
14.2	Digital inputs	240	no.										
14.3	Digital outputs	160	no.										

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
14.4	RTD / Thermocouple inputs	120	no.										
15.0	Consumables & miscellaneous items (Supply Cost to be included in various activities mentioned above) - quantity as required												
15.1	Cutting gases												
15.2	Welding electrodes												
15.3	Soldering/ brazing materials												
15.4	Sealing materials / Teflon tapes												
15.5	Clamps/ cable & wire binders, crimping lugs for wires & earth wires												
15.6	Nuts & bolts (SS) for fixing junction boxes, cable trays												
15.7	Marking ferrules												

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
15.8	Other items as required												
16.0	Details of testing												
	Temperature elements:- Testing of resistance / voltage change with temperature												
17.0	Painting of structural items (Instrument tray supports, stanchion, JB frames, air manifold frames etc.)---- 2 coats of primer with 2 coats epoxy paint, surface preparation with wire brush, shade of epoxy will be informed by site.												
	TOTAL												
	ADD TAXES												
	TOTAL												
Not e:	1. Contractor shall terminate field cables in system cabinets, shall coordinate with other for loop checking 2. Cable trays shall be required with coupler plates for 45 deg & 90 deg vertical inside & outside as well as for horizontal bends. Contractor to												

Sr. No.	Description	Qty	Unit	Installation		Calibration & Loop check		Supervision of installation		Supply		Grand total	Remarks
				UR	Total	UR	Total	UR	Total	UR	Total		
	consider the cost in the cable tray rates for ladder & perforated cable trays along with nuts & bolt as required.												
	3. The quantities mentioned for cables, cable tray & associated fittings, structural steel are based on instrument location plans/ tray layout plant. Contractor to verify the site condition & crosscheck the quantity as required before supplying.												

Electrical work

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
1	Design, procurement, supply, testing installation, commissioning of local electrical panels as per specifications C529/EE/SP/A4/426	8	No.		
2	Design, procurement, supply, installation, testing, commissioning of Solar PV systems with PV panel, 24VDC batteries and MPPT Controller as per specifications C529/EE/SP/A4/423	8	No.		
3	Supply, installation, testing, commissioning of spare battery sets as per specifications C529/EE/SP/A4/423	2	No.		
4	Supply, installation, testing, commissioning of battery charger as per specifications C529/EE/SP/A4/424	1	LS		
5	Supply, installation, testing, commissioning of electrical cables as per specifications C529/EE/SP/A4/427				
a)	Cables for PV system(size by PV panel vendor)	184	M		
b)	2C x2.5 Stranded Cu conductor, unarmoured , PVC insulated cable	368	M		
c)	2C x4 Stranded Cu conductor, unarmoured , PVC insulated cable	UR	M		
d)	2C x10 Stranded Cu conductor, unarmoured , PVC insulated cable	10	m		
6	Earthing Material				
a)	8 swg GI wire	400	M		
b)	25 x 3 GI earth Strip	80	M		
c)	78mm dia.3000mm long GI earth rod directly	8	No.		

Sr. no.	Item description	Qty	Unit	Rate in Rs.	Amount in Rs.
	buried				
7	Erection material like Cable terminations, cable trays , cable ties etc.				
a)	50mm wide, 25mm height, 2 m thick GI cable tray	50	M		
b)	single compression type cable glands for following sizes				
i)	2C x2.5 sq.mm Cu, flexible cable	64	No.		
ii)	Cables for Solar PV system (Size by PV vendor)	48	No.		
lii)	2C x4 sq.mm Cu, flexible cable	UR	No.		
lv)	2C x10 sq.mm Cu, flexible cable	2	No.		
c)	Cu cable lugs				
i)	2.5 sq.mm Cu,	128	No.		
ii)	Lugs for cables for Solar PV system (Size by PV vendor)	96	No.		
lii)	10 sq.mm Cu	4	No.		
8	Design, procurement, supply, testing installation, commissioning of 8W blue LED outdoor lamp with weather-proof fixture, fittings, mounting brackets etc, to operate from item 1, supply cabling, armoured, 5m each approx. etc complete.	8	No.		
TOTAL =					
ADD TAXES					
TOTAL AMOUNT =					

Mandatory tools, tackles and spares

Following items shall be supplied as mandatory spares / tools, tackles by the bidder. The cost of supply of below items shall be included in the bid price.

Sr. No.	Part name	Qty.	Unit	REMARKS	Rate in Rs.	Amount in Rs.
1	Full sets of spanner up to Spanner size suitable for M48 bolt	2	Set			
2	Drive mechanisms - 1 no. spare unit of each component (chains – one packet, exclusions –structural parts, machined plates and fasteners)					
a	Vertical axis components	1	set			
b	Horizontal axis components	1	set			
3	Chain	1	Pckt			
4	Chain Lock (4Nos. Each size)	2	set	Set means 4nos.		
5	Grease for Drive mechanism	10	Kg			
6	Oil for Drive mechanisms Component	20	Ltrs.			
7	Lubrication Oil	10	Ltrs.			
8	Motorized Screw for Focus Fixture-Spare Motor for each type	1	Nos.	1nos. of spare motor for each type		
9	Camera for Image Process - 1camrea is spare of each type	1	Nos. each	1no. of camera spare for each type		
10	Anemometer	1	No.			
11	Pyranometer	1	Nos.			
12	Battery	1	Set			
13	PV Panels	1	Set			
14	Cleaning mechanism - 1 no. spare unit of each component (Except Structure)	1	Set	Motor, brush, pump,etc.		

Sr. No.	Part name	Qty.	Unit	REMARKS	Rate in Rs.	Amount in Rs.
15	Thermocouple (K-types)	20	Nos.			
16	RTD, ambient	1	No.			
17	cable glands 2C x2.5 sq.mm Cu, flexible cable	5	Nos.			
18	cable glands Cables for Solar PV system (Size by PV vendor)	5	Nos.			
19	cable glands 2C x10 sq.mm Cu, flexible cable	2	Nos.			
20	cable lugs 2.5 sq.mm Cu,	5	Nos.			
21	cable lugs for Cables for Solar PV system (Size by PV vendor)	5	Nos.			
22	cable lugs 10 sq.mm Cu	2	Nos.			
23	DI module for Heliostat panel	1	Nos.			
24	DO module for Heliostat panel	1	Nos.			
25	PSM Module for Heliostat panel	1	Nos.			
26	1Pair set of Communication cable for Heliostat panel	1	Set			
27	DI module for PLC panel	1	No.			
28	DO module for PLC panel	1	No.			
29	1Pair set of Communication cable for PLC panel	1	Set			
30	wireless modem unit	1	No.			
31	Proximity sensors	8	Nos.			
32	Instrument Junction box	1	no.			
33	cable glands size ½" NPT for 1 Pair x 1.5 mm2 Screened	7	Nos.			

Sr. No.	Part name	Qty.	Unit	REMARKS	Rate in Rs.	Amount in Rs.
34	cable glands size ½" NPT for 1 Triad x 1.5 mm2 Screened	1	no.			
35	cable glands size M 20* for 1 Pair x 1.5 mm2 Screened	8	Nos.			
36	cable glands size M 50* for 12 Pair x 1.5 mm2 Thermocouple	2	Nos.			
37	1 Pair x 1.5 mm2 Screened cable	10	mtrs.			
38	1 Triad x 1.5 mm2 Screened cable	10	Mtrs.			
39	12 Pair x 1.5 mm2 Individual & Overall Screened cable	10	Mtrs.			
40	3 Core x 2.5 mm2 cable	10	Mtrs.			
41	Battery Charger	1	no.			
42	DC motors for Horizontal drive along with DC drive	1	no.			
43	DC motors for Vertical drive along with DC drive	1	no.			
44	earthing material 8 swg GI wire	40	Mtrs.			
45	earthing material 25 x 3 GI earth Strip	8	Mtrs.			
46	earthing material 78mm dia.3000mm long GI earth rod directly buried	1	nos.			
47	Cable size for Electrical - Contractor to work out	10	Mtrs.	10mtrs of each cable size		
48	Analog module	1	no.			

Note: - Specification of spare as per Data sheet and should be supply with required certification.

Spare required for Commissioning other than operation -Bidders have to work out on their own.

SECTION 7 ANNEXURES

ANNEXURE 1: INTEGRITY PACT

(To be printed on Supplier's letterhead)

INTEGRITY PACT

General

This prebid precontract Agreement hereinafter called the Integrity Pact is made on day of the month of, between, on one hand, the President of India acting through Deputy Registrar, Materials Management Division of Indian Institute of Technology, Bombay hereinafter called the "BUYER" of the First Part and M/s..... represented by Shri ,Director /Chief Executive Officer/ General Manager hereinafter called the "BIDDER/Seller" of the Second Part.

WHEREAS the BUYER proposes to procure..... (Name of the Stores/Equipment/Item) and the BIDDER/Seller is willing to offer/has offered the stores and WHEREAS the BIDDER is a private company/public company/Government undertaking/partnership/registered export agency, constituted in accordance with the relevant law in the matter and the BUYER is a Autonomous Body/Department of the Government of India performing its functions on behalf of the President of India.

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 to obtain the desired said stores / equipment 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 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:

1. Commitments of the BUYER

Sr. No.	Commitments of the BUYER
1.1	The BUYER undertakes that no official of the BUYER, 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 will, during the precontract 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 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.
2.0	In case any such preceding misconduct on the part of such official (s) is reported by the BIDDER to the BUYER, with full and verifiable facts and the same is prima facie found to be correct by the BUYER, necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by the BUYER 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 the proceedings under the contract would not be stalled.

2. Commitments of BIDDERS :

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:

Sr. No.	Commitments of the BIDDER	Complied (Y/N)	Remarks
2.1	The BIDDER will not offer, directly or through intermediaries, any bribe, consideration, gift, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the BUYER, 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.		
2.2	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 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.		
2.3	BIDDERS shall disclose the name and address of agents and representatives and Indian BIDDERS shall disclose their foreign principals or associates.		
2.4	BIDDERS shall disclose the payments to be made by them to agents / brokers or any other intermediary, in connection with this bid/contract.		
2.5	The BIDDER further confirms and declares to the BUYER that the BIDDER is the original manufacturer/ integrator/ authorized government sponsored export entity of the defense stores and 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, 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.		
2.6	The BIDDER, either while presenting the bid or during precontract 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 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.		
2.7	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.		
2.8	The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.		
2.9	The BIDDER shall not use improperly, for purposes of competition or personal gain, or pass on to others, any information provided by the BUYER 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.		
2.10	The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.		
2.11	The BIDDER shall not instigate or cause to instigate any third person to commit any of the actions mentioned above.		
2.12	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, or alternatively, if any relative of an officer of the BUYER 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.		
2.13	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.		

3. Previous Transgression

Sr. No.	Previous Transgression	Complied (Y/N)	Remarks
3.1	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.		
3.2	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.		

4. Earnest Money Deposit:

Earnest Money Deposit is mandatory to be enclosed in the tender. While submitting bid, the BIDDER shall deposit an amount mentioned in tender document as Earnest Money, with the IIT Bombay through the following instruments:

Sr. No.	Terms & conditions of EMD	Complied (Y/N)	Remarks
4.1	A confirmed Bank Guarantee by an Indian Nationalized Bank promising payment of the guaranteed sum to the BUYER on demand within three working days without any demur whatsoever and without seeking any reasons whatsoever. The demand for payment by the IIT Bombay shall be treated as conclusive proof of payment.		
4.2	The Earnest Money shall be valid upto a period of 180 days or the complete conclusion of the contractual obligations to the complete satisfaction of both		

	the BIDDER and the BUYER whichever is later.		
4.3	No interest shall be payable by the BUYER to the BIDDER on Earnest Money for the period of its currency.		
4.4	If successful bidder fails to submit the Performance Guarantee Bond within 30 days from the date of placing of Purchase Order then purchase order will be canceled and EMD will be forfeited.		
4.5	If there is any difficulty in submitting Bank Guarantee then Demand draft can be submitted in the favour of 'The Registrar, IIT Bombay' payable at Mumbai.		
4.6	Return of EMD: In case of successful BIDDER, EMD in the form of Bank guarantee will be returned within 30 days from the date of submission of Performance Guarantee Bond.		
4.7	For unsuccessful bidder, Bank Guarantee will be returned within 30 days from the date of placing the Purchase Order.		
4.8	In case of Demand Draft, amount of EMD will be returned within 60 days from the date of placing the purchase order.		

5. SECURITY DEPOSIT /PERFORMANCE GUARANTEE:

Performance Guarantee Bond is mandatory.

Sr. No.	Terms & conditions of Performance Bank Guarantee Bond	Complied (Y/N)	Remarks
5.1	Successful tenderer/ bidder should submit performance guarantee as prescribed above to be sent to Dy. Registrar, Materials management Division, IIT Bombay on or before 15 days from the due date of issue of order acknowledgment. The PGB to be furnished in the form of bank guarantee as per proforma or annexure of the tender documents, for an amount covering 10 % of the purchase order value.		
5.2	The Performance Guarantee should be established in favour of "Registrar, IIT Bombay".		
5.3	PBG to be established through any of the National Banks (whether situated at Mumbai or outstation) with a clause to enforced the same on their local branch of Mumbai or any scheduled bank (other than national bank) situated at Mumbai. Bonds issued by cooperative banks will not be accepted.		
5.4	Performance Guarantee Bond shall be for the due and faithfully performance of the contract and shall remain binding, notwithstanding such variations, alterations for extensions of time as may be made, given, conceded or agreed to between the successful tenderer and the purchaser under the terms & conditions of acceptance to the tender.		

5.5	The successful tenderer is entirely responsible for due performance of the contract in letter and spirit and all other documents referred to in the acceptance of tenders.		
5.6	The PBG shall be kept valid during the period of contract and shall continue to be enforceable for a period of one year or upto warranty period whichever is later from the date of order acknowledge. In case PBG needs extensions upto warranty period then supplier shall initiate extensions to PBG one month prior to expiry of PBG.		
5.7	For successful suppliers, if PBG is not submitted within 15 days from the date of Order Acknowledgment, then the Purchase Order will be cancelled with forfeiting of EMD.		
5.8	No interest shall be payable by the buyer to the Bidder on PBG.		

6. Sanctions for Violations

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 to take all or any one of the following actions, wherever required:

Sr. No.	Sanctions for Violations	Complied (Y/N)	Remarks
6.1	To immediately call off the precontract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.		
6.2	The Earnest Money Deposit (in precontract stage) and/or Security Deposit/Performance Bond (after the contract is signed) shall stand forfeited either fully or partially, as decided by the BUYER and the BUYER shall not be required to assign any reason therefore. To immediately cancel the contract, if already signed without giving any compensation to the BIDDER.		
6.3	To recover all sums already paid by the BUYER, 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 in connection with any other contract for any other stores, such outstanding payment could also be utilized to recover the aforesaid sum and interest.		
6.4	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, along with interest. To cancel all or any other Contracts with the BIDDER.		
6.5	The BIDDER shall be liable to pay compensation for		

	any loss or damage to the BUYER resulting from such cancellation/rescission and the BUYER shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.		
6.6	To debar the BIDDER from participating in future bidding processes of the Government of India for a minimum period of two years, which may be further extended at the discretion of the BUYER.		
6.7	To recover all sums paid in violation of this pact by the BIDDER(s) to any middleman or agent or broker with a view to securing the contract.		
6.8	In cases where irrevocable Letters of Credit have been received in respect of any contract signed by the BUYER with the BIDDER, the same shall not be opened.		
6.9	Forfeiture of Performance Bond in case of a decision by the BUYER to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.		
6.10	The BUYER will be entitled to take all or any of the actions mentioned at para 7.1(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.		
6.11	The decision of the BUYER 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

Sr. No.	Fall Clause	Complied (Y/N)	Remarks
7.1	The BIDDER undertakes that it has not supplied/is not supplying similar product/systems or subsystems 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 product/system or sub system was supplied by the BIDDER to any other Ministry/Department of the Government of India or 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, if the contract has already been concluded.		

8. Independent monitors

Sr. No.	Independent monitors
8.1	The BUYER has appointed Independent Monitors (hereinafter referred to as Monitors) for this Pact in consultation with the Central Vigilance Commission (Chief Vigilance Officer ,Indian Institute of Technology, Bombay).
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 performs their functions neutrally and independently.
8.4	Both the parties accept that the Monitor have the right to access all the documents relating to the project/procurement, including minutes of the meetings.
8.5	As soon as the Monitor notices, or believes to notice, a violation of this Pact, he will so inform the Authority designated by the BUYER.
8.6	The BIDDER(s) accepts that the Monitor has the right to access without restriction to all Project documentation of the BUYER 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 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/ Secretary in the Department/within 8 to 10 weeks from the date of reference or intimation to him by the BUYER / BIDDER and, should the occasion arise, submit proposals for correcting problematic situations.

9. Facilitation of Investigation

Sr. No.	Facilitation of Investigation	Complied (Y/N)	Remarks
9.1	In case of any allegation of violation of any provisions of this Pact or payment of commission, the BUYER 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 & documents in English and shall extend all possible help for the purpose of such examination.		

10. Law and Place of Jurisdiction

Sr. No.	Law and Place of Jurisdiction	Complied(Y/N)	Remarks
10.1	This Pact is subject to Indian Law. The place of performance and Jurisdiction is the Seat of the BUYER.		

11. Other Legal Actions

Sr. No.	Other Legal Actions	Complied (Y/N)	Remarks
11.1	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:

Sr. No.	Validity	Complied (Y/N)	Remarks
12.1	The validity of this Integrity Pact shall be from date of its signing and extend upto 5 years or the complete execution of the contract to the satisfaction of both the BUYER and the BIDDER/ Seller, 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 remains valid. In this case, the parties will strive to come to an agreement to their original intentions.		

13. The Parties hereby sign this Integrity Pact.

BUYER

Joint Registrar (MM), Materials Management
Division, IIT Bombay

Date & Place:

Witness

1. _____

(Indenter)

2. _____

BIDDER

Signature with seal

Date & Place:

Witness

1. _____

2. _____

ANNEXURE 2: FORMAT FOR EARNEST MONEY DEPOSIT / BID BOND

(To be typed on Nonjudicial stamp paper of the value of Indian Rupees of One Hundred) (TO BE ESTABLISHED THROUGH ANY OF THE NATIONALISED BANKS (WHETHER SITUATED AT MUMBAI OR OUTSTATION) WITH A CLAUSE TO ENFORCE THE SAME ON THEIR LOCAL BRANCH AT MUMBAI OR ANY SCHEDULED BANK (OTHER THAN NATIONALISED BANK) SITUATED AT MUMBAI. BONDS ISSUED BY COOPERATIVE BANKS ARE NOT ACCEPTED)

LETTER OF GUARANTEE

To,
Registrar,
Indian Institute of Technology,
Powai, Mumbai – 400 076

IN ACCORDANCE WITH YOUR TENDER No:..... dated..... for supply of, M/s. (hereinafter called the “Bidder”) having its Registered Office at, wish to participate in the said bid for the supply as an irrevocable Bank Guarantee against Earnest Money Deposit for an amount of Rs. (Rupees.....) valid up to **(180 days from the date of issue of Bank Guarantee)**, is required to be submitted by the bidder as a condition precedent for participating in the said bid, which amount is liable to be forfeited by the Purchaser on

(1) the withdrawal or revision of the offer by the bidder within the validity period, (2) Non acceptance of the Letter of Indent / Purchase order by the Bidder when issued within the validity period, (3) failure to execute the contract as per contractual terms and condition within the contractual delivery period and (4) on the happening of any contingencies mentioned in the bid documents.

During the validity of this Bank Guarantee :

We,(Bank name) having its registered Office atguarantee

And undertake to pay immediately on first demand by the amount of Rs.....

..... (Rupees) without any reservation, protest, demur and recourse.

Any such demand made by the IIT Bombay shall be conclusive and recourse. Any such demand made by the purchaser shall be binding on the Bank irrespective of any dispute or difference raised by the Bidder.

The Guarantee shall be irrevocable and shall remain valid up to(180 days from the date of issue of Bank Guarantee) If any further extension is required, the same shall be extended to such required period on receiving instruction from the Bidder, on whose behalf the is Guarantee is issued.

Notwithstanding anything contained herein :

Our liability under this Bank Guarantee shall not exceed Rs.....

(Rupees.....) .

This Bank Guarantee shall be valid up to(date).

We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee

Only and only if you serve upon us a written claim or before (date).

This Bank further agrees that the claims if any, against this Bank Guarantee shall be enforceable at our branch office at situated at (Address of local branch).

Yours truly,

Signature and seal of the guarantor:

Name of Bank:

Address:

Date:

Instruction to Bank: Bank should note that on expiry of Bond Period, the Original Bond will not be returned to the Bank. Bank is requested to take appropriate necessary action on or after expiry of bond period.

ANNEXURE 3: FORMAT FOR PERFORMANCE GUARANTEE BOND

(To be typed on Non judicial stamp paper of the value of Indian Rupees of One Hundred) (TO BE ESTABLISHED THROUGH ANY OF THE NATIONAL BANKS (WHETHER SITUATED AT MUMBAI OR OUTSTATION) WITH A CLAUSE TO ENFORCE THE SAME ON THEIR LOCAL BRANCH AT MUMBAI OR ANY SCHEDULED BANK (OTHER THAN NATIONALISED BANK) SITUATED AT MUMBAI. BONDS ISSUED BY COOPERATIVE BANKS ARE NOT ACCEPTED.)

To,
Registrar,
Indian Institute of Technology,
Powai, Mumbai – 400 076.

LETTER OF GUARANTEE

WHEREAS Indian Institute of Technology, Bombay (Buyer) have invited Tenders vide Tender No..... dated for purchase of
AND WHEREAS the said tender document requires that any eligible successful tenderer (seller) wishing to supply the equipment / machinery, etc. in response thereto shall establish an irrevocable Performance Guarantee Bond in favour of “Registrar, Indian Institute of Technology, Bombay” in the form of Bank Guarantee for Rs (10% (ten percent) of the order value) and valid till **two year** from the date of issue of Performance Guarantee Bond may be submitted within 30 (Thirty) days from the date of Acceptance as a successful bidder.

NOW THIS BANK HEREBY GUARANTEES that in the event of the said tenderer (seller) failing to abide by any of the conditions referred in tender document / purchase order / performance of the equipment / machinery, etc. this Bank shall pay to Indian Institute of Technology, Bombay on demand and without protest or demur Rs (Rupees.....)

This Bank further agrees that the decision of Indian Institute of Technology, Bombay (Buyer) as to whether the said Tenderer (Seller) has committed a breach of any of the conditions referred in tender document / purchase order shall be final and binding.

We, (name of the Bank & branch) hereby further agree that the Guarantee herein contained shall not be affected by any change in the constitution of the Tenderer (Seller) and/ or Indian Institute of Technology, Bombay(Buyer).

Notwithstanding anything contained herein:

1. Our liability under this Bank Guarantee shall not exceed Rs.
(Indian Rupees only).
2. This Bank Guarantee shall be valid up to (date) and
3. We are liable to pay the guaranteed amount or any part thereof under this bank guarantee only and only if IIT Bombay serve upon us a written claim or demand on or before..... (date)

This Bank further agrees that the claims if any, against this Bank Guarantee shall be enforceable at our branch office at situated at (Address of local branch).

Yours truly,

Signature and seal of the guarantor:

Name of Bank:

Address:

Date:

Instruction to Bank: Bank should note that on expiry of Bond Period, the Original Bond will not be returned to the Bank. Bank is requested to take appropriate necessary action on or after expiry of bond period.

Submitted Earnest Money Deposit will be treated as null and void after acceptance of Performance Bank Guarantee by IIT Bombay.

ANNEXURE 4: Format for Deviations / Exclusions schedule

Proposal Ref No. and Date

Name and Address

To,

Indian Institute of Technology Bombay
Department of Energy Science and Engineering,

Sub : IIT-B Tender Ref :

Dear Sir,

We declare that the following are the only deviations, variations and exceptions / exclusions to the supply, services terms and conditions as outlined in your Bidding Documents. The Schedule has been filled in accordance with the Bidding Documents. Except these deviations, subject to the approval and acceptance by IIT-B, the entire work shall be performed as per your requirements and bidding documents. Further, we agree that additional conditions, if any found elsewhere in the offer other than those stated below, save that pertaining to any rebates / discounts offered, shall not be given effect to :

Serial No.	Clause No.	Page No.	Statement of deviation & variation / exclusion	Cost of withdrawal of deviation & variation / exclusion

Date

Place

Signature

Name

Designation

Common Seal

Notes :

- The bidder may use additional sheets of like size and format, if required
- The technical compliance/deviation should be supported by relevant technical literature.
- If specification is Superior/inferior than asked for the enquiry, it should be clearly brought out in the justification.
- If the bidder offers more than one model, then the technical compliance statement must be enclosed for each and every model separately.

ANNEXURE 5: PREVIOUS SUPPLY ORDER FORMAT

Name of the Firm _____

Order placed by (Full address of Purchaser)	Order No. and Date	Description and quantity of ordered equipment	Value of Order	Date of completion of delivery as per contract	Remarks indicating reasons for late delivery, if any and justification for price difference of their supply order & those quoted to us	Has the Equipment being installed satisfactorily (Attach a Certificate from the Purchaser/ Consigner)	Contact Person along with Telephone No., Fax No. and e-mail address.

Signature and Seal of the Manufacturer / Bidder _____

Place: _____

Date: _____

SECTION 8 CHECKLIST

The following items must be checked before the Bid is submitted:

1. Envelope “1” Technical Bid

- a) Demand Draft of Rs.500/- (Rs. Five Hundred only) towards cost of Bid document,
- b) Bank Guarantee for Rs. 7, 60,000/-- (Rs. Seven Lakh Sixty Thousand only) towards Earnest Money Deposit,
- c) INTEGRITY PACT as per format,
- d) Eligibility Criteria & prequalification Criteria Responses (each pages duly sealed and signed by the authorized signatory),
- e) Copy of this tender document duly sealed and signed by the authorized signatory on every pages.
- f) Technical Bid responses

2. Envelope “2”

- a) Price Bid/commercial bid :

Your quotation must be submitted in two envelopes **Technical Bid (Envelope 1) and Price Bid/commercial bid (Envelope 2)** superscribing on both the envelopes the Tender no. and the due date and both these sealed covers are to be put in a bigger cover which should also be sealed and duly superscribed with our **Tender No. & Due Date.**