
IRCON INTERNATIONAL LIMITED
(A Government of India undertaking)

(National Competitive Bidding)

e-Tender

For

“Construction of Melli Yard works including earthwork in cutting, filling, development of drainage system, slope stabilization, retaining structures, Reinforced Soil wall system, Construction of Bridge No. 10 on pile foundation, Bridge No. 11 and other ancillary works between Km. 26.570 to Km. 27.540 in connection with construction of Sivok - Rangpo New BG Railway Line Project.”

(Volume-I)

TECHNICAL BID

(TWO PACKET SYSTEM)

April – 2021

IRCON INTERNATIONAL LIMITED
(A Government of India Undertaking)
MINISTRY OF RAILWAYS

Corporate Office

IRCON INTERNATIONAL LTD.

C-4, District Centre, Saket,

NEW DELHI -110017

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Tender No: IRCON/CC/BR/SR-2046/Melli ,

Date: 12.04.2021

Top Sheet

Name of work :-Construction of Melli Yard works including earthwork in cutting, filling, development of drainage system, slope stabilization, retaining structures, Reinforced Soil wall system, Construction of Bridge No. 10 on pile foundation, Bridge No. 11 and other ancillary works between Km. 26.570 to Km. 27.540 in connection with construction of Sivok - Rangpo New BG Railway Line Project."

Estimated Cost : Rs. 1,82,02,47,857.41 including GST

Earnest Money : Bid Security Declaration Form (Annexure VII)

Completion period : 30 Months

Date of Submission : 03/05/2021 at 15:00 Hrs.

Date of Opening :04/05/2021 at 15:30 Hrs.

IRCON INTERNATIONAL LIMITED,
C-4, District Centre, Saket,
New Delhi-110 017,
Ph. No. 011-29565410,
Fax: 011-26522000, 26854000



IRCON INTERNATIONAL LIMITED
(A Government of India Undertaking)



SECTION-I
e-PROCUREMENT NOTICE
[“National Competitive Bidding”]

Tender No: IRCON/CC/SR-2046/Const./Yard - Melli , Dated: 12-04-2021

e-PROCUREMENT NOTICE

“Construction of Melli Yard works including earthwork in cutting, filling, development of drainage system, slope stabilization, retaining structures, Reinforced Soil wall system, Construction of Bridge No. 10 on pile foundation, Bridge No. 11 and other ancillary works between Km. 26.570 to Km. 27.540 in connection with construction of Sivok - Rangpo New BG Railway Line Project.”

DATA SHEET

1.	Publishing Date	:	12.04.2021	17:30 Hrs
2.	Bid Document Download/ Start Date	:	12.04.2021	18:00 Hrs
3.	Clarification Start Date	:	13.04.2021	10:30 Hrs
4.	Clarification End Date	:	19.04.2021	17:30 Hrs
5.	Pre-bid Meeting Date (Optional)	:	20.04.2021	11:00 Hrs
6.	Bid Submission Start Date	:	27.04.2021	15:00 Hrs
7.	Bid Submission End Date	:	03.05.2021	15:00 Hrs
8.	Bid Opening Date	:	04.05.2021	15:30 Hrs

1. The Chief General Manager/Railway Projects, IRCON INTERNATIONAL LIMITED, C-4, District Center, Saket, New Delhi-110017, **E-mail id: surender.singh@ircon.org, Contact No: 9560595025,011-26530462** invites online bids in two packet system for & on behalf of Northeast Frontier Railway on prescribed forms from bonafide firms/companies having requisite experience and financial capacity for execution of the work detailed in the table given below. The bidder is advised to examine carefully all instructions including addendum/corrigendum, condition of contract data, forms, terms, technical specifications, bill of quantities in the bid document.

Name of work	Estimated Cost of Work (Including GST)	Earnest Money	Completion Period
“Construction of Melli Yard works including earthwork in cutting, filling, development of drainage system, slope stabilization, retaining structures, Reinforced Soil wall system, Construction of Bridge No. 10 on pile foundation, Bridge No. 11 and other ancillary works between Km. 26.570 to Km. 27.540 in connection with construction of Sivok - Rangpo New BG Railway	Rs.1,82,02,47,857.41/-	NIL, [Bid Security Declaration Form (As per Annexure VII)]	30 (Thirty) Months

Line Project."			
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***JV is not permitted to participate in this tender.**

2. Website <https://etenders.gov.in/eprocure/app> may be referred for detailed terms and conditions of the bidding documents, which is available on line. Amendments/Corrigendum/Addendum, if any would be hosted on the website only.

3. ELIGIBILITY CRITERIA

Eligibility of the applicants shall be assessed based on the “Essential Qualifying Criteria” as given in **Annexure-V** to “Instructions to Tenderers”.

4. Accessing/ Purchasing of Bid Documents:

- 4.1 The complete Bid Document can be viewed / downloaded from the e-Procurement portal i.e. <https://etenders.gov.in/eprocure/app> free of cost.
- 4.2 Help for Contractors, FAQ, Information about DSC and Bidders Manual Kit containing the detailed guidelines for e-Procurement system are also available on Central Public Procurement Portal
- 4.3 It is mandatory for all the bidders to have a valid class-III Digital Signature Certificate (in the name of person having power of attorney to sign the Bid) from any of the licensed Certifying Agency (Bidders can see the list of licensed CA’s from the link www.cca.gov.in) to participate in e-Procurement of IRCON.
- 4.4 It is mandatory for the bidders to get their firm /company registered with e-procurement portal <https://etenders.gov.in/eprocure/app> to have user ID & password.
- 4.5 Tender documents will be available online on website <https://etenders.gov.in/eprocure/app> as per date sheet which can be downloaded free of cost. However, to participate in the online bidding process, bidders are required to pay a non-refundable fee of Rs.50,000/- (Rupees Fifty Thousand only) towards the cost of one set of tender documents through NEFT or RTGS only in IRCON’s bank account no.: 57500000076024, IFSC Code: HDFC0000003 at HDFC Bank Ltd., Surya Kiran Building, KG Marg, New Delhi.
- 5.0 **Instructions to Bidders for Online Bid Submission on the e-Procurement portal**
<https://etenders.gov.in/eprocure/app>.
Bidders may download and refer the “Instructions for Online Bid Submission” from
(<https://etenders.gov.in/eprocure/app;jsessionid=F90A7689A0BF87EF35B88D2CA57C6FD4.cppsugep2?page=StandardBiddingDocuments&service=page>).

6.0 Pre-bid Meeting:

- 6.1 A pre-bid meeting (through Video Conferencing) shall be convened on **20.04.2021** from 11:00 Hrs in the office of CGM/RP, IRCON INTERNATIONAL LIMITED, C-4 District Centre, Saket, New Delhi-110 017. The link will be shared approx. 1 hr before the start of the Video

- conferencing to the interested prospective bidders. Any communication for Video Conferencing will be sent to **CGM/Railway Projects** at e-mail ID : **surender.singh@ircon.org**
- 6.2** The purpose of the pre-bid meeting is to clarify issues and to answer questions on any matter that may be raised.
- 6.3** The bidders shall submit their queries in writing to Chief General Manager/Railway Projects at the address given in Para 1.0 above latest by **17:00Hrs. of 19.04.2021**.
- 6.4** Any prospective bidders desirous of attending the pre bid meeting shall send a letter of authority on its letter head specifying the name and designation of the person who will be attending the pre bid meeting on its behalf to the Chief General Manager/Railway Projects, IRCON INTERNATIONAL LIMITED, C-4 District Centre, Saket, New Delhi-110017. E-mail Id : surender.singh@ircon.org
- 6.5** Any such letter of authority shall reach IRCON at least three days before the date of pre bid meeting.
- 7.0** IRCON may issue addendum(s)/corrigendum(s) to the tender documents. In such case, the addendum(s)/corrigendum(s) shall be issued and placed on website <https://etenders.gov.in/eprocure/app> at any time before the closing time of tender. The tenderers who have downloaded the tender documents from website must visit the website and ensure that such addendum(s)/corrigendum(s) (if any) is also downloaded by them. This shall be the responsibility of the prospective registered bidders to check the web site for any such corrigendum/addendum at the time of closing time of tender and ensure that bid submitted by them are in accordance with all the corrigendum(s)/addendum(s). Suitable time extension (not less than 3 days beyond the date of last amendment) for submission of bids will be granted.
- 8.0** The tender documents shall be submitted online in the prescribed format given on the websites and technical bids received online shall be opened as per date sheet or Corrigendum thereof. No other mode of submission is acceptable. Detailed credentials as per the requirement of eligibility criteria and all tender papers except Bill of Quantities are to be submitted in "Technical Bid". Bill of Quantities with rates duly filled in are to be submitted in the format provided online in the name of "Financial Bid". Representative of the bidder, who chooses to attend, may attend the online opening of the technical bids on the scheduled date and time of Bid opening. However, such representatives shall be allowed to attend the opening of the Technical Bids, only, if such person presents the letter of authority issued in his name by the bidder on his letter head.
- 9.0** Bidders cannot submit the tender after the due date and time of e-bid submission. Time being displayed on Central Public Procurement Portal <https://etenders.gov.in/eprocure/app> ("Server System Clock Time") shall be final and binding on the bidder. e-Bids are required to be submitted by bidders, only as per the Indian Standard Time (IST) and not the time as per their location/country.
- 10.0** The bidders are advised to submit their e-bids well before the e-bid due date. IRCON shall not be responsible for any delay in submission of e-bids for any reason including server and technical problems.
- 11.0** The Technical and Financial Bid shall be digitally signed by the Authorized Signatory of the

- bidder & submitted “on-line” only. The authorized signatory of the bidder must be in possession of Power of Attorney before submitting the digitally signed bid. Scanned copies of various documents can be prepared in different file format (PDF, JPEG).
- 12.0 Tender shall be submitted as per “Instructions to Tenderers” forming a part of the tender document.
- 13.0 **Any tender received without original Bid Security Declaration form (Annexure VII) as specified in tender documents shall not be considered and shall be summarily rejected.**
- 14.0 IRCON reserves the right to cancel the tender before submission/opening of tenders, postpone the tender submission/opening date and to accept/reject any or all tenders without assigning any reasons thereof. IRCON’s assessment of suitability as per eligibility criteria shall be final and binding on tenderer/s.
- 15.0 Tenderers may note that they are liable to be disqualified at any time during tendering process in case any of the information furnished by them is not found to be true. Action as per Bid Security Declaration is liable to be taken against them .The decision of IRCON in this regard shall be final and binding.
- 16.0 IRCON reserves the right to pre-qualify the bidder(s) provisionally based on the documents submitted by them and open financial bid(s), subject to their final verification. In the event of any document being found false, the provisional qualification shall stand withdrawn, and the next lower bidder shall automatically come to the position of such disqualified bidder. Action against such disqualified tenderers shall be taken as per above clause no. 15.0 of Notice Inviting Tender.
- 17.0 **The validity of the offer shall be for the period indicated in “Appendix to Tender” after the date of opening (Technical Bid) of the tender.**
- 18.0 **Following tender conditions on Make in India shall be applicable for tenders valuing more than Rs. 5 lacs:-**
- 18.1 In procurement, where there is sufficient local capacity and local competition, and where the estimated value of procurement is Rs. 50 Lakhs or less, only local vendors shall be eligible. If the estimated value of such procurement is more than Rs. 50 Lakhs, the provisions of following clause/ sub-clause 18.3 (i) and 18.3 (ii), as the case may be, shall apply.
(Local vendors mean a supplier or service provider whose product or service offered for procurement meets the minimum local content as prescribed under the Order of Ministry of Commerce and Industry, Department of Industrial Policy and Promotion or by the competent Ministries/Departments in pursuance to this Order.)
- 18.2 Bidders (manufacturer or principal of authorized representative) who have a valid/approved ongoing 'Make in India' agreement/ program and who while meeting "Essential Qualifying Criteria" as given in Annexure-V to " Instructions to Tenderers", would also be considered to be qualified provided:
- i) Their foreign 'Make-in-India' associates meets "Essential Qualifying Criteria" as given in Annexure-V to "Instructions to Tenderers" without exemption, and

- ii) The Bidder submits appropriate documentary proof for a valid/approved ongoing 'Make in India' agreement/program.
 - iii) The bidder (manufacturer or principal of authorised representative) furnishes along with the bid a legally enforceable undertaking jointly executed by himself and such foreign Manufacturer for satisfactory manufacture, Supply (and erection, commissioning if applicable) and performance of The Product' offered including all warranty obligations as per the general and special conditions of contract.
- 18.3 In the procurements not covered by sub-clause 18.1 above, and which are divisible/ splittable in nature, the following procedure shall be followed:
- i) Among all qualified bids, if the lowest bid (L1) is from a local vendor, the contract for full quantity will be awarded to L1.
 - ii) If L1 bid is not from a local vendor, 50% of the order quantity shall be awarded to L1. Thereafter, the lowest bidder among the local vendors, will be invited to match the L1 price for the remaining 50% quantity subject to the local vendor's quoted price falling within the purchase preference margin of (L1 + 20%), and contract for that quantity shall be awarded to such local vendor subject to matching the L1 price. In case such lowest eligible local vendor fails to match the L1 price or accepts less than the offered quantity, the next higher local vendor within the purchase preference margin of (L1 + 20%) shall be invited to match the L1 price for remaining quantity and so on, and contract shall be awarded accordingly. In case some quantity is still left uncovered on local vendors, then such balance quantity may also be ordered on the L1 bidder.
- 18.4 In procurements not covered by sub-clause 18.1 above and which are not divisible and such procurements where the bid is evaluated on price alone, the following procedure shall be followed:
- i) Among all qualified bids, if the lowest bid is from a local vendor (L1), the contract will be awarded to L1.
 - ii) If L1 is not from a local vendor, the lowest bidder among the local vendors, will be invited to match the L1 price subject to local vendor's quoted price falling within the purchase preference margin of (L1+ 20%), and the contract shall be awarded to such local vendor subject to matching the L1 price.
 - iii) In case such lowest eligible local vendor fails to match the L1 price, the local vendor with the next higher bid within the purchase preference margin of (L1+ 20%) shall be invited to match the L1 price and so on and contract shall be awarded accordingly. In case none of the local vendors within the purchase preference margin of (L1+20%) matches the L1 price, then the contract may be awarded to the L1 bidder.
- 18.5 The local vendor at the time of tender shall provide self-certification that the item offered meets the minimum local content and shall give details of the location (s) at which the local value addition is made.
- 18.6 In cases of procurement for a value in excess of Rs. 10 Crores, the local vendor shall be required to provide a certificate from the statutory auditor or cost auditor of the company (in the case of companies) or from a practicing cost accountant or practicing chartered accountant (in respect of supplies other than companies) giving the percentage of local content.

- 18.7 A vendor who has been debarred by any procuring entity for violation of this Order shall not be eligible for preference under this Order for procurement by any other procuring entity for the duration of the debarment.

For & On Behalf Of

North East Frontier Railway

IRCON INTERNATIONAL LIMITED

Chief General Manager/RP

C-4, District Centre, Saket,

New Delhi –110017,

E-mail ID: surender.singh@ircon.org,

Contact no.: 9560595025, 011-26530462

ANNEX - I To e-Procurement Notice – SCOPE OF WORK

The scope of work includes “Construction of Melli Yard works including earthwork in cutting, filling, development of drainage system, slope stabilization, retaining structures, Reinforced Soil wall system, Construction of Bridge No. 10 on pile foundation, Bridge No. 11 and other ancillary works between Km. 26.570 to Km. 27.540 in connection with construction of Sivok - Rangpo New BG Railway Line Project.”

The salient features of the Bridges are as follows:

Bridge No.	Span Configuration
10	4 X 30.50M Composite Girder
11	2 X 4X6 M RCC BOX

1. Construction of foundations for piers and abutments including return wall, approach slab, dirt wall etc. complete. The type and depth of the foundation indicated in the GAD is tentative and may change as per the site conditions.
2. Construction of hollow/solid piers including pier cap, of different size shape and type using Slip form shuttering with necessary facilities for inspection/maintenance as per the drawing and/or instructions of Engineer in Charge
3. Construction of abutments of different size shape and type with necessary facilities for inspection/maintenance as per the drawing and/or instructions of Engineer in Charge.
4. Construction of protection works to foundations, piers and abutments of the bridge etc. as per approved drawings and the specifications and requirements.
5. Fabrication, supply and installation of bearings; transverse and longitudinal stoppers over abutments and piers; supply and installation spring dampeners; provision of back anchors behind Abutments if required for any bridges.
6. Supply, fabrication, assembling, testing and launching of steel girders as per approved drawing. Design, fabrication, supply & installation of bridge expansion joints
7. Construction of Sub structure of Bridge which includes construction of RCC approach slabs, RCC Slabs, abutment, piers, bored cast-in-situ pile foundations, provisional or permanent works such as cutting and embankment works, provisional or permanent shafts or any other temporary structure/work to reach the foundation levels and facilitate construction activity, construction or provision of any kind of auxiliary structures, road approach works to reach the different levels, auxiliary platforms, diversion of river/provision of caisson for construction of foundation and pier located in waterway and all kind of supports, drainage and protection for cuttings.
8. Construction of Superstructure of Bridge which includes shop Fabrication, transportation to site, storing at site, Erection and Launching of Welded Steel Through Trusses by incremental and / or cantilever method – for various spans corresponding to 25T loading, inclusive of testing of Superstructure as specified.
9. Procurement, testing and placement of bearings, including the construction of seismic stopper and restrainer.

10. IROCN shall Provide Approved Construction Design & Drawing for Execution & Construction of Bridge and contractor shall submit the completion and as built drawing once construction is completed including all modification done during construction phases.
11. Any other incidental / ancillary Works required in connection with completion of the above as directed by IRCON in Consultation with Consultant.
12. Construction of all foundation and substructure concrete works including approach slab in both ends. Provision of plaques as per Railway drawings for the bridge nomenclature and direction of flow is also included.
13. Centering and shuttering including strutting, propping etc. and removal of form for all the reinforced cement concrete and plain cement concrete components as per schedule in Volume III of this tender document.
14. Supply and making of reinforcement for all the reinforced cement concrete in bridge site. Load testing of piles as per schedule in volume III of tender document.
12. Extra for chiseling in addition to boring of piles, if chiseling is resorted to in hard rock or big stone boulders larger than 30 cm depth, by any means i.e. by chisel or manual chisel and hammer method.
13. Supply, fabrication, transportation, assembly, erection/slewing and launching of steel superstructure including surface preparation, sand blasting, painting and metalizing etc. with all lead/lift.
14. Providing, cutting, fabricating, treating, fixing & painting structural steel in access ladders, inspection platforms, Trolley refuge, railing, and temporary structure required during construction. Fabrication, supply and fixing of steel chequered plate of specified thickness.
15. Providing, fabricating and installing of casing pipe for bored piles for all diameters with specified thickness. Providing and laying Plain Cement Concrete for foundation items.
16. Supplying, fitting and fixing in position true to line and level bearings. Providing boulder backing behind wing wall, return wall, retaining wall.
17. The Survey work shall involve taking over of sight, contouring of yard and nearby area, with centre line pegs, checking and verification of bench marks and protection of the same, taking & recording cross sections of natural ground levels.
18. Contractor shall do pre-condition survey of existing structure i.e. building, houses, bridges etc. at his own cost before starting of work and submit the data to IRCON.
19. Felling of trees if any and removing of stumps and roots and disposal as instructed.
20. Clearing the site by removing vegetation encountered during earthwork between toe of bank and top of cutting and disposal as instructed.
21. Earth work in excavation in all kind of soils including ordinary rock (not req. blasting) & hard rock (blasting prohibited) etc. by mechanical means (Hydraulic excavator)/manual means at hill slopes up to any height, making required slope for applying shotcrete & rock bolts as required & making of temporary access road as the method of construction is top to down, making of berms, surface drains complete job as per the specifications and approved drawings and disposal of muck as instructed by Engineers. Selected and approved cut muck/spoils after crushing and screening required to use in filling work.
22. Earthwork in filling above the Lower portion using collected earth spoils from cutting, laid in layer and compacted bring it to required profile as per approved drawings and specification as a complete job and as directed by Engineer-in- Charge.
23. Earthwork in filling in Railway formation with contractor's own earth and cut muck/spoils coming out from cutting.
24. Temporary and permanent diversion of existing Nalla as per drawings or as instructed by Engineer-in-charge by deep excavation.
25. Temporary and permanent diversion of existing water supply pipe lines or as instructed by Engineer-in-charge.

26. Maintenance of existing access road, construction of any other internal road and structures or any other road which will be required to be constructed /developed by the contractor to complete the work in all respect.
27. Supply, drilling, installation and grouting of permanent anchors SN type rock bolts with double corrosion protection of the specified length, Self-drilling bolts of the specified length & installing pre stressed permanent grouted anchor of required design capacity as per approved drawings & specifications or as directed by Engineer.
28. Construction of Melli yard including excavation and using of cut spoils for specific use of Reinforced soil filling as per the required gradation and size of material obtained after crushing and screening to achieve high friction, Construction of RCC box culvert, RCC Trough, Cladding walls, Wing wall, Return walls, toe wall, curtain and drop walls side drains, catchwater drains etc. for permanent nalla diversion, retaining structures, slope protection, development of drainage area, support installation, concrete or shotcrete and other concrete works, providing and laying of stone pitching and all other ancillary works required for construction of yard as approved by the ENGINEER and as per approved drawings.
29. Providing and installation of perforated pipe wrapped with geotextile, drainage hole, of various length and diameter horizontal/sub horizontal, Geo textile membrane as per approved drawings & specifications.
30. Providing & fixing of instrumentation for 3D monitoring, Inclinator, Piezometer, Optical Targets with accessories as per approved drawing and specification as directed by Engineer.
31. Providing & placing of granular, stone aggregate filter media of specified thickness as per the requirement as a complete job as per approved drawings, specifications and as directed by Engineer-in-Charge.
32. Providing & placing of 150 x 150 x 6 mm welded wire fabric of Fe 500 as reinforcement on excavated slopes and remaining or re profiling work as per approved drawings & specifications or as directed by Engineer.
33. Providing of sprayed concrete of specified thickness and grade in slope and as per the requirement as a complete job as per approved drawings, specifications and as directed by Engineer-in-Charge.
34. Providing, design, construction drawings, methodology for construction of Reinforced Soil Wall as per drawings and specification as per BS 8006:2010, FHWA NHI-10-024 (2009), and its proof checking from the approved agency. Scope includes supply of all components of Reinforced Soil Wall as per Technical Specifications including all tools, tackles, manpower, machinery, accessories etc as per technical specifications and drawings.
35. Providing and fixing ETA/EAD certified -category A rockfall barrier of various capacity including base plates, anchors, energy dissipaters for energy absorption by deformation and all other components including drilling and grouting including top tie and bottom tie, lateral tie for ground fixity.
36. Providing, laying and compaction in layer of clean RE fill material in solid reinforced zone as per approved drawing and specification, free draining, granular with high friction and non-cohesive, non corrosive, coarse grained, free of any deleterious mineral oil, fungus and microbes of specified PH value, meeting the design parameters. Blasting operations wherever required with prior approval of the Engineer-in-charge with respect to the adequate timings, procedures of blasting, etc.
Any other incidental / ancillary works connected with the above and as directed by the ENGINEER.
37. Submission of detailed construction schedule, excavation advance rate, method

- statements with related detailed drawings and equipment planning, for various items of work. Resource based construction program shall be prepared by the contractor and submitted within 21 days from date of LOA. After submission of this resource based construction program, contract will be signed and it shall be part of the contract agreement.
38. All safety arrangements as per relevant IS, IRC and IRS Codes of practice and as specified in tender documents.
 39. Lighting during construction in night time, pumping/dewatering of water.
 40. Provision and maintenance of quality control laboratory at site with office in the laboratorfor IRCON's quality control engineer.
 41. Regular submission of survey reports as directed by Engineer.
 42. Submission of videos of construction operations and progress report with digital photographs in both hard and soft copies.
 43. Provision of all drainage and service pipe as per approved drawings.
 44. Maintenance of all works for specified period.
 45. The tenderer/s are advised to visit the site of works and ascertain himself/themselves with the proposed works, surroundings and working conditions, environment, prevailing law & order situation etc. The contractor shall carry out the work safely and no unsafe practices shall be followed. The tenderer are expected to take into account these factors while quoting the rates.
 46. All Works to be done as per relevant and approved drawings, specifications.
 47. Excavating and disposal of all type of soils / rocks and conglomerate from open excavation etc. as per NEERI guidelines if required.
 48. All necessary arrangements as per safety, Health and Environment management plan and instructions and as specified in the tender documents.
 49. The work is to be done in a smooth coordinated manner without hindrance to the work of other agencies, local populace and surroundings and as per the instruction of Engineer-in-charge.
 50. No claim for any stoppage of work by local populace for issues related to compensation, employment or any other shall be entertained.
 51. The Drawings attached with these tender documents are only for tender purpose and for guidance. The works shall be done as per GOOD FOR CONSTRUCTION DRAWINGS which shall be issued in due course of time. The tenderer/s will not have any claim on account of this.
The work shall be done as per the instructions of IRCON.

SECTION-II
FORM OF BID

FORM OF BID

To
The Chief General Manager/Railway Project
IRCON INTERNATIONAL Ltd.,
C-4, District Centre, Saket,
New Delhi – 110017

Dear Sir,

I/We, _____ (Name and address of the tenderer) have read the various terms and conditions of the e-Procurement documents attached here with duly signed by me/us and agree to abide by the same. I/We also agree to keep this tender open for acceptance **within the period of the validity of bids for** from the date fixed for opening the same and on default thereof, I/We shall be liable to be banned for period of two years in participating the tenders.

I/We hereby declare that we have visited the site of the work and have made ourselves fully conversant of the conditions therein and including the topography of area, soil strata at site of work, sources and availability of construction materials, rates of construction materials, water, electricity, all local taxes, royalties, octro is etc., availability of local labour (both skilled and unskilled), relevant labour rates and labour laws, the existing road and approaches to the site of work, requirements for further service roads / approaches to be constructed by me / us, the availability and rates of private land etc. that may be required by me / us for various purposes, climatic conditions, law and order situation and availability of working days.

I/We also hereby agree to abide by the “Standard General Conditions of Contract, July 2020” of Indian Railway with latest correction slips and to carry out the work according to conditions and specifications laid down by IRCON in the present tender.

I/We have quoted our rates for various items in the Bill of Quantities taking into account all the above factors and I/We offer to do the work **“Construction of Melli Yard works including earthwork in cutting, filling, development of drainage system, slope stabilization, retaining structures, Reinforced Soil wall system, Construction of Bridge No. 10 on pile foundation, Bridge No. 11 and other ancillary works between Km. 26.570 to Km. 27.540 in connection with construction of Sivok - Rangpo New BG Railway Line Project.”**

the rates quoted in the attached Bill of Quantities and hereby bind ourselves to complete the work in all respects within time schedule depicted in tender documents from the date of issue of letter of acceptance of tender.

I/We also understand that until a formal Contract Agreement is executed, Letter of Acceptance along with all tender documents shall constitute a binding contract between me/us and IRCON International Limited.

Thanking you,

Yours Faithfully,

Signature _____ and name of the signatory _____ in capacity of _____ duly authorized to sign bids for and on behalf of:

_____ (In Block capital letters)

Date this _____ day of _____ 2021.

SECTION-III
INSTRUCTIONS TO TENDERER (ITT)

Instructions to Tenderers

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Instructions to Tenderers (ITT)

A1 GENERAL:

1.1 **Name of the Work:** As indicated in 'Appendix to Tender'.

1.2 A bidder in the capacity of Individual or Sole Proprietor, Partnership Firm or Company can participate in the tender and the bidder must upload attested copies of the constitution of its firm such as partnership deed, Memorandum & Articles of Association, etc along with original Power of Attorney of authorized signatory.

"Place of Registration : As indicated in Appendix to Tender."

Foreign bidder as a single entity is not permitted to participate in the tender if it is not legally valid firm/ company registered in India as per Indian laws.

1.3 Any bidder from a country, which shares a land border with India, will be eligible to bid in this tender only if the bidder is registered with the Competent Authority nominated / Registration Committee constituted by the Department for Promotion of Industry and Internal Trade (DPIIT).

i) "Bidder from a country which shares a land border with India" for the purpose of this Clause means:-

a). An entity incorporated, established or registered in such a country; or

b). A subsidiary of an entity incorporated, established or registered in such a country;
or

c). An entity substantially controlled through entities incorporated, established or registered in such a country; or

d). An entity whose beneficial owner is situated in such a country; or

e). An Indian (or other) agent of such an entity; or

f). A natural person who is a citizen of such a country; or

g). A consortium or joint venture where any member of the consortium or joint venture falls under any of the above.

ii) The beneficial owner for the purpose of (i) above will be as under:

1. In case of a company or limited Liability Partnership, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical Person, has a controlling ownership interest or who exercise control through other Means. Explanation-

a) "Controlling ownership interest" means ownership of or entitlement to more than Twenty-five percent, of shares or capital or profits of the company.

b) "Control" shall include the right to appoint majority of the directors or to control the Management or policy decisions including by virtue of their shareholding or management Rights or shareholders agreements or voting agreements.

2. In case of partnership firm, the beneficial owner is the natural person(s) who, whether acting alone or together, or through one or more juridical person, has ownership of Entitlement to more than fifteen percent capital or profits of the partnership.

3. In case of an unincorporated association or body of individuals, the beneficial owner

are the natural person(s), who, whether acting alone or together, or through one or more Juridical person, has ownership of or entitlement to more than fifteen percent of the Property or capital or profits of such association or body of individuals;

4. Where no natural person is identified under (1) or (2) or (3) above, the beneficial owner Is the relevant natural person who holds the position of senior managing official;
 5. In case of a trust, the identification of beneficial owner(s) shall include identification of the author of the trust, the trustee, the beneficiaries with fifteen percent or more interest In the trust and any other natural person exercising ultimate effective control over the Trust through a chain of control of ownership.
- iii)

iv) An Agent is a person employed to do any act for another, or to represent another in dealings with third person.

The successful bidder shall not be allowed to sub-contract works to any contractor from a country, which shares a land border with India unless such contractor is registered with the Competent Authority nominated/Registration Committee constituted by the Department for Promotion of industry and Internal Trade (DPIIT).

1.4 The work is proposed to be executed under the following relationship:

- a) **Client :As indicated in ‘Appendix to Tender’.**
- b) **Employer : IRCON INTERNATIONAL LIMITED** address as given in ‘Appendix to Tender’.
- c) **Contractor:** The successful tenderer to whom the work is awarded shall become the contractor for the execution of this work.

1.5 Throughout these bidding documents, the terms “bid” and “tender” and their derivatives (“bidder”/ “tenderer”), “bid/tendered”, “bidding”/ “tendering”, etc.) are synonymous. Day means calendar day. Singular also means plural.

1.6 **Scope of Work:**

The scope of work is indicated in Annex-I of e-Procurement Notice. The scope given is only indicative.

1.7 Approximate Estimated cost of the work is as indicated in the **e-Procurement Notice**.

1.8 A bidder shall submit only one bid in the capacity of an Individual or Sole Proprietor, Partnership firm. Violation of this condition is liable to disqualify the tenders in which such bidder has participated and action as per Bid Security Declration is liable to be initiated.

2.0 COST OF BIDDING

2.1 The bidder shall bear all costs associated with the preparation and submission of the bid and the Employer will in no case be responsible or liable for these costs regardless of the conduct or the outcome of the bidding process.

B THE BIDDING DOCUMENTS

The tenderers must use the online technical and financial sheets available in excel format in this Tender Document for submission of their Technical as well as Financial Bid. Any Bid not conforming to the prescribed format is liable to be declared non-responsive.

3.0 CONTENT OF BIDDING DOCUMENTS

3.1 The bidding documents include the following:

1. e-Procurement Notice
 2. Form of Bid
 3. Instructions to the Tenderer/s
 4. Appendix to Tender.
 5. Special Conditions of Contract
 6. Indian Railways Standard General Condition of Contract, July.2020(GCC)
 7. Technical Specifications
 8. Tender Drawings
 9. Bill of Quantities
- 3.2 The bidder is expected to examine all instructions, terms, conditions, forms, specifications corrigendum/addendums and other information in the bidding documents. Failure to furnish all information required by the bidding documents or submission of a bid not substantially responsive to the bidding documents in every respect will be at the bidders' risk and may result in rejection of his bid.
- 3.3 Except where specifically stated otherwise in the Tender Documents, the work is to be carried out in accordance with standard General Conditions of Contract, July 2020 of Indian Railway, corrected up to date with all amendments and with definition as mentioned in these tender documents.

4.0 UNDERSTANDING AND AMENDMENT OF TENDER DOCUMENTS

- 4.1 The bidder must obtain for itself on its own responsibility and its own cost all the information including risks, contingencies & other circumstances in execution of the work. It shall also carefully read and understand all its obligations & liabilities given in tender documents.
- 4.2 The bidder is advised to visit and examine the site where the work is to be executed and its surroundings or other areas as deemed fit by the bidder and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and execution of the contract. The cost of visiting the site and collecting relevant data shall be at the bidder's own expenses. It is a condition of the tender that the tenderer is deemed to have visited the site and satisfied him-self with all the conditions prevailing including any difficulties for executing the work.
- 4.3 Bidders will examine the various provisions of The Central Goods and Services Tax Act, 2017 (CGST)/ Integrated Goods and Services Tax Act, 2017 (IGST)/ Union Territory Goods and Services Tax Act, 2017 (UTGST)/ respective state's State Goods and Service Tax Act (SGST) also, as notified by Central/State Government and as amended from time to time and applicable taxes before bidding. Bidders will ensure that full benefit of Input Tax Credit (ITC) likely to be availed by them is duly considered while quoting rates.
- 4.4 The successful bidder who is liable to be registered under CGST/IGST/UTGST/SGST Act shall submit GSTIN along with other details required under CGST/IGST/UTGST/SGST Act to IRCON immediately after the award of contract, without which no payments shall be released to the contractor. The contractor shall be responsible for deposition of applicable GST to the concerned authority.
- 4.5 In case the successful bidder is not liable to be registered under CGST/IGST/UTGST/SGST Act, IRCON shall deduct the applicable GST from his/their

bills under Reverse Charge Mechanism (RCM) and deposit the same to the concerned authority.

- 4.6 At any time prior to the deadline for submission of bids, Employer may for any reason whether at its own initiative or in response to any request by any prospective bidder amend the bidding documents by issuing Corrigendum, which shall be part of the Tender documents. The amendment shall be advised to all the prospective bidders.
- 4.7 Employer may at its discretion extend the deadline for submission of the bids at any time before the time of submission of the bids.
- 4.8 The term “Correction slip” if any and where referred to in this tender document includes the following terms also.
 - a) Addendum slip.
 - b) Correction slip.
 - c) Addendum slip and Corrigendum slip which are issued in consecutive serials.

C. **PREPARATION OF THE BIDS**

5.0 LANGUAGE OF BID

- 5.1 The bid prepared by the bidder and all documents related to the bid shall be written in English.

6.0 SIGNING OF ALL BID PAPERS AND COMPLETING BILL OF QUANTITIES

- 6.1 It shall be deemed that e-bid uploaded by the tenderer is digitally signed by his authorized representative holding the Power of Attorney.
- 6.2 While filling up the rates in the Bill of Quantities, tenderer shall ensure that the rates are filled up in figures only. System will automatically convert such filled up rates into words. In case of item rate tenders, the system will automatically calculate the total price by multiplying the unit rate with quantity.
- 6.3 The bid should be submitted online only in the prescribed format given in the e-procurement portal of IRCON. No other mode of submission is accepted. The Technical and Financial Bid shall be digitally signed by the authorized signatory of the bidder & submitted “online” only. **No hard copy of Technical and Financial bid is required to be submitted.**

The tenderer may download financial bid form and upload the same duly filled through online e-Procurement process.

- 6.4 The tenderer must fill and submit the prices as per instructions given in Bill of Quantities. The system does not permit any addition or alteration in the tender documents. The requisite details should be filled in by the tenderer wherever required in the documents. Incomplete tender or tender not submitted as per instructions is liable to be rejected

7.0 DEVIATIONS

- 7.1 The tenderer should clearly read and understand all the terms and conditions, specifications, drawings, etc. mentioned in the original tender documents. If the tenderer has any observations, the same may be indicated in his forwarding letter along with the tender.

8.0 TRANSFER OF TENDER DOCUMENTS

Tender Documents will be received in electronic form only after payment of Tender

document fee.

9.0 EARNEST MONEY

9.1 Earnest money for this tender has been kept as NIL, however the tenderer has to submit “Bid Security Declaration” as per the format attached as Annexure-VII of the ITT failing which the tenderer is liable to be rejected.

- a) ~~Pay Order/Demand Draft of any scheduled bank in India in favour of IRCON INTERNATIONAL LIMITED payable at a place given in “Appendix to Tender”. It is mandatory for bidders to provide their banker’s details (Name of Bank & Branch) along with their own bank details (Account No., Name of Account Holder, NEFT/RTGS details).~~
- b) ~~Fixed Deposit Receipt issued by any Scheduled Bank in India endorsed in favor of IRCON INTERNATIONAL LIMITED.~~
- c) ~~EMD value up to Rs 10.00 Lacs must be in the form of Pay Order/DD/FDR. In addition, EMD may also be paid through NEFT or RTGS in IRCON’s Bank *Account no.: 57500000076024, IFSC code: HDFC0000003 at HDFC Bank Ltd., Surya Kiran Building, KG Marg, New Delhi in favor of “IRCON INTERNATIONAL LIMITED” payable at New Delhi and email ID emgbg@ircon.org.* In case of EMD amount being more than Rs 10.00 Lacs, it can also be deposited in the form of irrevocable Bank Guarantee valid for minimum 180 days beyond the last date of submission of bid, issued by a Scheduled, as per the format enclosed at **Annexure-B.G.** not valid for 180 days beyond the last date of submission of bid, will not be considered a valid EMD instrument. The B.G. must be made invocable at any branch in Delhi/NCR/Project HQ branch of the issuing bank.~~

The scheduled bank issuing the Bank Guarantee must be on the Structure Financial Messaging System (SFMS) platform. A separate advice of the B.G. shall invariably be sent by the issuing bank to the Employer’s *above-mentioned Bank account* through SFMS and only after this, the B.G. shall become operative and acceptable to the Employer.

- d) ~~Earnest Money in the form of Pay Order/DD/FDR/BG shall be scanned & uploaded through online e-Procurement process. Further EMD in original form *along with a copy of ‘SFMS-Messaging Report’ sent by the BG issuing Bank* sealed in an envelope must be received by Employer at the address specified in the “e-procurement Notice not later than the prescribed date and time for e-bid submission.~~
- e) ~~Proof of transaction towards payment of Earnest Money through NEFT or RTGS shall be scanned either in PDF or JPEG format such that file size is not more than 5 MB and uploaded during the online submission of the e-bid. These documents must be received in ‘ORIGINAL’ by Employer at the address specified in the “e-procurement Notice” not later than the prescribed date and time for e-bid submission.~~
- f) ~~No interest shall be allowed on Earnest Money Deposit. EMD in the form of BG shall be strictly as per format attached as **Annexure-”**.~~

~~9.2 — Forfeiture of Earnest Money:~~

- 9.2.1 ~~The Earnest Money of the tenderer shall be forfeited if he withdraws his tender after opening of the tender during the period of tender validity specified in the “Appendix to Tender” or extended validity period as agreed to in writing by the tenderer.~~
- 9.2.2 ~~In case it is found that, the tenderer/s has furnished misleading/wrong or fraudulent information/ documents, the Earnest Money of the tenderer/s will be forfeited.~~
- 9.2.3 ~~The Earnest Money of the successful tenderer is liable to be forfeited if he fails to;~~
- ~~i) sign the Contract Agreement in accordance with the terms of the tender, or~~
 - ~~ii) furnish Performance Guarantee in accordance with the terms of the tender, or~~
 - ~~iii) Commence the work within the time period stipulated in the tender.~~
- 9.2.4 In case of forfeiture of EMD, the tenderer shall be debarred from bidding in case of re-invitation of the tenders.

9.3 – Return of Earnest Money

- 9.3.1 The Earnest Money of the unsuccessful tenderers in the form of FDR/BG shall be discharged and returned as promptly as possible & the Earnest Money in the form of DD/Pay Order shall be directly credited to his bank account through Electronic Fund Transfer, under advice to the bidder.
- 9.3.2 ~~The Earnest Money Deposit of the successful tenderer shall be dealt as under:-~~
- ~~i) If the Earnest Money Deposit is in the form of Fixed Deposit Receipt (FDR)/Bank Guarantee (BG), the FDR/BG shall be returned after deduction of an equivalent amount from the first on account bill and further deduction of retention money from the bills shall commence after adjusting this EMD amount.~~
 - ~~ii) If the Earnest Money Deposit (EMD) is in the form of Demand Draft/Pay Order/NEFT/RTGS, the same shall be retained towards retention money and further deduction of retention money from the bills shall commence after adjusting this EMD amount.~~

10.0 INTEGRITY PACT (IP)

- 10.1 Integrity Pact attached as **Annexure VI** to ‘Instructions to Tenderers’ shall become a part of tender.
- 10.2 Integrity Pact shall be signed by the authorized signatory of the tenderer and witnessed in the format attached as **Annexure-VI** at the time of signing Contract Agreement. Bidders shall abide by the provisions of Integrity Pact by signing the Affidavit attached as **Annexure -IV** of ‘Instructions to Tenderers’.
- 10.3 If the bidder is a partnership or a consortium, this pact will be signed by all partners or consortium members at the time of signing Contract Agreement.
- 10.4 Only those vendors/ bidders who sign the Affidavit shall be qualified to participate in the bidding process.
- 10.5 The Integrity Pact will be signed by IRCON at the time of execution of agreement with the successful tenderer.
- 10.6 Name, Designation & Address of Nodal Officer of IRCON:
Shri Surender Singh
Chief General Manager/Railway Projects
IRCON International Limited,
C-4, District Centre, Saket, New Delhi-17
Mobile No : 9560595025,011-26530462

E-mail ID : surender.singh@ircon.org

- 10.7 Name & Address of IEM:
Dr T.M. Bhasin
Independent External Monitor (IEM)
C/o Chief Vigilance Officer,
IRCON INTERNATIONAL LIMITED,
C-4, District Centre, Saket,
New Delhi-110 017
e-mail ID : iem.reference@ircon.org

11.0 PERIOD OF VALIDITY OF THE TENDER

- 11.1 The tender shall remain valid for the period indicated in “Appendix to Tender” after the date of the opening of the tender. If the Tenderer gives validity period less than that fixed/prescribed by Employer, the tender shall be liable to be rejected.
- 11.2 Notwithstanding the above clause, Employer may solicit the tenderers’ consent to extend the validity period of the tender. The request and the response shall be made in writing.

D. SUBMISSION OF BIDS

12.0 DEADLINE FOR SUBMISSION OF TENDER

- 12.1 Bid Security Declaration required in physical form as per sub-clause 9.1 of "Instructions to Tenderers" must be received by Employer at the address specified in the “e-Procurement Notice” **not later than the prescribed date and time for e-bid submission.**
- 12.2 Any tender related documents received after opening of the tender shall be rejected..

Tenderers must upload the good scanned copy of relevant documents required to be submitted on e-Procurement website as mentioned in the tender documents. The document which is not readable or legible will not be given cognizance. e-Bids which are not supported by relevant documents shall not be considered during evaluation of bid.

13.0 MODIFICATION/ SUBSTITUTION/ WITHDRAWAL OF TENDER

- 13.1 The tenderer may modify, substitute or withdraw his e-bid after online submission prior to the date and time of e-bid opening.
- 13.2 For modification of e-bid, bidder has to upload/ resubmit digitally signed modified e-bid in the CPP portal (<https://etenders.gov.in/e procure/app>)
- 13.3 For withdrawal of e-bid, bidder can withdraw his e-bid by clicking on withdrawal icon at e-procurement portal.
- 13.4 Before withdrawal of an e-bid, it may specifically be noted that after withdrawal of an e-bid for any reason, tender fee will not be refunded. The bidder trying to re-submit the e-bid will have to pay the cost of tender document again.

14.0 SUBMISSION OF TENDERS

- 14.1 All documents/forms/instructions/specifications etc. listed in **item 3.1** of this “Instructions to Tenderer” and those attached as per the **Annexure-VIII** are deemed to be a part of the bid/tender and accepted by the bidder.
- 14.2 In case of any ambiguity, IRCON will be free to seek confirmation of information from the issuer of the document.
- 14.3 Submission of an e-bid by a tenderer implies that he had read all the tender documents including amendments if any, visited the site and has made himself aware of the scope and specifications of the work to be done, local conditions and other factors having any bearing on the execution of the work.

E. e-BID OPENING AND EVALUATION

15.0 OPENING OF THE TENDER

- 15.1 Tenders will be opened at the address mentioned in “e-Procurement Notice” in presence of tenderers or authorized representatives of tenderers who wish to attend the opening of tenders. Physical presence during e-Bid opening is optional.
- 15.2 Tenderers or their authorized representatives who are present shall sign register in evidence of their attendance.
- 15.3 Tenderer’s name, presence or absence of requisite Bid Security Declaration, total cost of work quoted or any other details as Employer may consider appropriate will be displayed with list to all participating bidders online after bid opening.

16.0 CLARIFICATION OF THE TENDERS

- 16.1 To assist the examination, evaluation and comparison of the tenders, Employer may at his discretion ask the tenderers for any clarifications as considered essential. All such correspondence shall be in writing and no change in price or substance of the tender shall be sought or permitted. The above clarification for submission of the details shall form part of the tender and shall be binding on tenderer.

17.0 PRELIMINARY EXAMINATION OF BIDS

- 17.1 The Employer shall examine the bids to determine whether they are complete, whether physical copy of all relevant documents have been received **not later than the prescribed date and time for e-bid submission** and generally in order.
- 17.2 Prior to the detailed evaluation, Employer shall determine whether each bid is of acceptable quality, is generally complete and is substantially responsive to the bidding documents. For purposes of this determination, a substantially responsive bid is one that conforms to all the terms, conditions and specifications of the bidding documents without material deviations, objections, conditionality or reservation. A material deviation, objections, conditionality or reservation is one;
 - (i) That affects in any substantial way the scope, quality or performance of the contract.
 - (ii) That limits in any substantial way, inconsistent with the bidding documents, the Employers’ rights or the successful Bidder’s obligations under the contracts; or
 - (iii) Whose rectification would unfairly affect the competitive position of other Bidders who are presenting substantially responsive bids.
- 17.3 If an e-bid is not substantially responsive, it shall be rejected by the Employer.
- 17.4 In case of tenders containing any conditions or deviations or reservations about contents

of tender document, Employer may ask for withdrawal of such conditions/ deviations/ reservations. If the tenderer does not withdraw such conditions/deviations/ reservations, the tender shall be treated as non- responsive. Employer's decision regarding responsiveness or non-responsiveness of a tender shall be final and binding.

18.0 EVALUATION AND COMPARISON OF TENDERS

- 18.1 The tenders, which are determined as substantially responsive, shall be evaluated based on criteria as given in **Annexure–V** of 'Instructions to Tenderers'. The tenderer/s must scan and upload all necessary authentic data with necessary supporting certificates of the various items of evaluation criteria failing which his/their tender is liable to be rejected.
- 18.2 The Employer/Engineer reserves the right to negotiate the offer submitted by the tenderer to withdraw certain conditions or to bring down the rates to a reasonable level. The tenderer must note that during negotiations of rates of items of BOQ can only be reduced and not increased by the tenderer. In case the tenderer introduces any new condition or increases rates of any item of BOQ, his negotiated offer is liable to be rejected and the original offer shall remain valid and binding on him.

19.0 CANVASSING

- 19.1 No tenderer is permitted to canvass to Employer on any matter relating to this tender. Any tenderer found doing so may be disqualified and his bid may be rejected.

20.0 RIGHT TO ACCEPT ANY TENDER OR REJECT ALL TENDERS

Employer/Engineer reserves the right to accept, split, divide, negotiate, cancel or reject any tender or to annul and reject all tenders at any time prior to the award of the contract without incurring any liability to the affected tenderers or any obligation to inform affected tenderer, the grounds of such action.

If the tenderer, as individual or as a partner of partnership firm, expires after the submission of his tender but before award of work, the Employer/Engineer shall deem such tender as invalid.

21.0 AWARD OF CONTRACT

- 21.1 Employer/Engineer shall notify the successful tenderer in writing by a Registered Letter/ Courier/ Speed Post or per bearer or delivering the same by e-mail duly attached with scanned copy of proof of dispatch (POD) that his tender has been accepted.
- 21.2 Letter of Acceptance after it is signed by the Contractor in token of his acceptance shall constitute a legal and binding contract between Employer/Engineer and the contractor till such time the contract agreement is signed.

22.0 CONTRACTOR PERFORMANCE FEEDBACK AND EVALUATION SYSTEM

The employer will have a "Contractor Performance Feedback and Evaluation System" for periodic evaluation of Contractor performance during execution of Contract. In case Contractor's overall performance is found unsatisfactory (<85% of works Contracts) based on the parameters as listed in **Annexure–II** of 'Instructions to Tenderers', the Contractor is liable to be declared a "Non-Performer" and will become ineligible for participation in future tenders of this organization for a period of 2 (two) years from the date of such decision. This decision is to be conveyed to the Contractor in writing. The non-performer status may be revoked during currency of the contract on improvement of performance parameters during the next annual review.

This is without prejudice to any other recourse available to the Employer under the Condition of Contract.

23.0 INELIGIBILITY TO PARTICIPATE IN RE-TENDERS/ FUTURE CASES

Notwithstanding anything contained in the Qualification Clauses of ITT, if a bidder withdraws from an offer after having been declared a preferred bidder or after notification of Award or does not sign the Contract Agreement pursuant to the Letter of Acceptance or does not submit an acceptable performance security which results in tender being annulled then such bidder shall be treated as ineligible for participation in re-tendering of this particular work and also for any other work for a period of 6 months. A repeat incident of similar type within a period of 2 (two) years will render the bidder ineligible for participation in all future tenders for a further period of 2 (two) years.

24.0 DECLARATION OF NON – PERFORMANCE OR BAN STATUS OR TERMINATION

Tenderers are not eligible to participate in the tender process under the following conditions:

- (a) They have been declared a non-performer by Central/ State Government Department in India including authority controlled by them during the last two years prior to the date of bid submission.
- (b) They are currently debarred for tendering, blacklisted, suspended in Central/ State Government Department in India including authority controlled by them.
- (c) Any previous contract awarded to them has been terminated by IRCON on account of contractor's default during the last two years prior to the date of bid submission.
- (d) The bidder (any partners in case of JV) is in Corporate Insolvency Resolution Process (CIRP/liquidation/Winding up/CDR/SDR/S4A/Flexible Structuring or any other restructuring scheme due to financial stress and is in default on any debt obligations on the bid due date. An undertaking of bidder (All partners in case of JV) duly certified by the statutory auditor of the bidder must be submitted along with the bid.

Accordingly, tenderers are required to sign an Affidavit as per the enclosed pro-forma in **Annexure-IV**, declaring their status of non-performance or debarment/ termination or Corporate Insolvency Resolution Process (CIRP) or Corporate Resolution Process/liquidation/Winding up/CDR/SDR/S4A/Flexible Structures or any other restructuring scheme due to financial stress or in default on any debt obligations.

25.0 TENDERER TO BE FULLY RESPONSIBLE FOR THE CONSEQUENCE OF MISREPRESENTATION

- (a) Any suppression of information and misrepresentation will render the tenderer ineligible for the tender along with the action as per Bid Security Declaration. The tenderer will also be liable for disqualification for future tenders of IRCON for a period of 2 years.
- (b) If any suppression of information and misrepresentation is found after the award of Contract, the Contract may be terminated with action as per Bid Security Declaration, forfeiture of PG and SD (if any). The Contractor will also be disqualified for future tenders of IRCON for a period of 2 years.

Annexure-I

(Ref.: Form Of Bid)

Sl. No	DETAILS OF THE BIDDER	
1	Name of the Bidder	
1.1	Registered Address of the Bidder	
	Land Line Telephone Number with STD Code	
	FAX Number with STD Code	
1.2	Address for communication	
	Land Line Telephone Number with STD Code	
	FAX Number with STD Code	
	e-mail Address	
2	Banker's Details for Payment through Electronic Clearing System (ECS):	
	Name of the Bank	
	Address of Bank	
	Account No.	
	Name of Account Holder	
	IFSC	
	Telephone No. with STD Code	
	e-mail Address	

Annexure - 'II'

(Ref. Clause 22 of 'Instructions to Tenderers')

ASSESSMENT OF PERFORMANCE OF WORKING SUBCONTRACTOR

S. No.	Description	Weightage		Remarks
		Assigned	Obtained	
1	Resource Management/ Financial Status			
1.1	Timely mobilization of manpower, as per the requirement of work and/or as suggested by Engineer in writing	5		
1.2	Timely mobilization of machinery, as per the requirement of work and/or as suggested by Engineer in writing	5		
2	Physical Progress /Project Execution Capability	75		
2.1	Target vs Achieved review of the progress and adherence to milestones of the work as per above submitted & approved programme (may be judged as below, to be modified depending on availability of front/site or as indicated in Contract)			
a	At 33% time: >15%			
b	At 50% time: >30%			
c	At 100% time: >60%			
d	At 175% time: >98%			
3	Quality Assurance Capability			
3.1	Documentation of procedures, work instructions, check list and adherence to the requirements of ISO 9001:2008	4		
3.2	Rectification of defects/non-conformity to quality standards within 30 days: (Nos. mentioned in writing/Rectified within 30 days of writing)	4		
3.3	Implementation of corrective and preventive measures to control non-conformities/ rejections	2		
4	Claims and Disputes			
4.1	Raising unnecessary claims and litigation	5		
	TOTAL:	100		

Annexure-'III'

(Ref. Clause 22 of 'Instructions to Tenderers')

ASSESSMENT OF PERFORMANCE OF WORKING CONSULTANT

S. No.	Description	Weightage		Remarks
		Assigned	Obtained	
1	Resource Management	15		
1.1	Mobilization time	5		Shall be immediate as per the submission
1.2	Deputation of qualified team leader overall co-ordination	5		Person so nominated at the time of submission shall not be changed
1.3	Deputation of experienced staff for specific job/trade	5		Persons identified at the time of submission may not be changed
2	Quality Assurance	20		
2.1	Methodology of submission of drawing	5		There has to be a document stating the methodology of forwarding the drawing
2.2	Methodology to ensure that integrated drawings are issued and not in isolation	5		Working on the same platform and on the same corrected drawing
2.3	Formats for delivery stages of project	5		So as to segregate the drawings for info, tender and working drawings
2.4	Quality of submission -adequate detailing	5		Is there in house cross checking facility
3	Physical Progress	65		
3.1	Submission of detailed schedule of delivery with number of drawings to be submitted	5		This needs to be tweaked with construction programme
3.2	Adherence to Milestones for various submissions	10		Important to ensure smooth working
3.3	Capability of change management and incorporation of changes	10		
3.4	Timely response to the queries			Important for execution and is measure of seriousness about the project
a	During design stage	5		
b	During execution stage	5		
3.5	Quality and detailing of Report	20		Speaks about the effort and sincerity
3.6	Timely submission of the reports/details/ calculations etc.	10		Mandatory for timely execution of the project
	TOTAL:	100		

Annexure-'IV'

FORMAT OF AFFIDAVIT

I/we, the undersigned, do hereby solemnly affirm and declare that-

1. Neither our firm nor any of the members/partners in any manner as an individual or the constituent partner in case of partnership firm have been declared non-performer by Central/State Government Department in India including authority controlled by Them during the last two years prior to the date of bid submission.
2. As on date our bid submission, neither our firm nor any of the members/ partners in any manner as an individual or the constituent partner in case of partnership firm are debarred for tendering, blacklisted, suspended in Central/State Government Department in India including authority controlled by them.
3. As on date our bid submission neither our firm nor any of the members/ partners in any manner as an individual on the constituent partner in case of partnership firm. JV are in corporate insolvency resolution process (CIRP)/ liquidation/ Winding up/ CDR/SDR /S4A / Flexible Structuring or any other restructuring scheme due to financial stress and have not be in default on any debt obligation on the bid due date.
4. No contract agreement between IRCON or its wholly owned subsidiaries and either our firm or any of the members/partners in any manner as an individual or the constituent partner in case of partnership firm have been terminated on account of our default during the last two years prior to date of our bid submission.
5. We have no objection to IRCON requesting to any bank, person, firm or body and any such agency furnishing pertinent information as deemed necessary or to verify this statement or regarding our competence and general reputation.
6. We understand that further qualifying information may be requested by IRCON and we agree to furnish any such information at the request of IRCON within the prescribed time.
7. We bind ourselves with all the stipulations of the Bidding Document including period of completion, provision of adequate equipment, personnel and other resources required for completion within the stipulated completion period and agree to augment any resources, if found necessary for timely completion of the project, as desired by the IRCON.
8. We have read and understood all the provisions included in the Integrity Pact and abide by them, if applicable.
9. We have read and understood all the provisions included in the bid documents and abide by them.

10.1 Certificate for Tenders

“I have read the clause regarding restriction on procurement from a bidder of a country

which shares a land border with India; I certify that this bidder is not from such a country or, if from such a county, has been registered with the Competent Authority. I hereby certify that this bidder fulfills all requirements in this regard and is eligible to be considered. [Where applicable, evidence of valid registration with the Competent Authority nominated/ Registration Committee constituted by the Department for Promotion of Industry and internal Trade (DPIIT) shall be attached,]”

10.2 Certificate for Tenders for Works involving possibility of sub-contracting

“I have read the clause regarding restrictions on procurement from a bidder of a country which shares a land border with India and on sub-contracting to contractors from such countries;

I certify that this bidder is not from such a country or, if from such a country, has been registered with the Competent Authority and will not such sub-contract any work to a contractor from such countries unless such contractor is registered with the Competent Authority nominated/ Registration Committee constituted by the Department for promotion of Industry and Internal Trade (DPIIT). I hereby certify that this bidder fulfills all requirements in this regard and is eligible to be considered. [Where applicable, evidence of valid registration with the Competent Authority nominated/Registration Committee constituted by the Department for Promotion of Industry and Internal Trade (DPIIT) shall be attached.]”

- 11 The information furnished by us is correct and we understand the consequences in case any of the information furnished is not found to be true.

(Signed by the Authorized Representative of the Firm)

Name of the Authorized Representative.
Name of the Firm.....
Dated:.....

ANNEXURE – V

(Ref. Clause 3.0 of e-Procurement Notice & sub-clause 18.1 of ITT)

Essential Qualifying Criteria

1. Technical Eligibility Criteria

1.1 The contractor should possess the experience of having successfully completed similar works during the last 7-years (ending last day of the month previous to the one in which tenders are invited) which should be any one of the following: -

- i) Three similar completed works each costing not less than the amount equal to 30% of the advertised value of the tender, or
- iii) Two similar completed works each costing not less than the amount equal to 40% of advertised value of the tender, or
- iv) One similar work costing not less than the amount equal to 60% of the advertised value of the tender.

Similar work means execution of Civil Works in Railway/Metro/Highway/Roads/Hydro Project involving Earthwork in Embankment/Cutting or Slope Stabilization works.

1.2 **Experience in following Specialized Activities:** In addition to above, Bidder* should have executed following activities in last Seven (07) financial years and in the current financial year upto the last day of the month previous to the one in which tender is invited:

- i) Slope stabilization works including Rock Bolts, Rock Anchors, etc. for a value of **₹ 5.0 Crore**
- ii) Completion of Design & Supervision of at least one project of Reinforced soil embankment/wall/slope of height not less than 25 m in Seismic zone IV & above for rail/road/water Carrying works

NOTE for 1.2 above :

1)*If the bidder does not have experience of execution of above specialized activities, they must have an MOU with any agency having above experience of specialized activities as a specialized sub-contractor and submit copy of the Notarized MOU along with the tender as per enclosed format. Post award of the tender, the contractor shall enter into a consortium agreement for the specialized works with specialized agency (Pre-bid MOU partner) and the agency shall be jointly and severally liable for the performance of the specialized works in the project.

2) The specialized sub-contractor can be associated with the main contractor in more than one bid.

GENERAL NOTES: -

- a. The minimum quantity/Value mentioned in 1.2 (i) above may be covered under one

- contract or more than one contract and can be from completed or ongoing works.
- b. The work completion certificates should clearly reflect quantities / value of the specialized activities. In case of certificate from international clients, the same to be got Apostilled/Attested by the Indian Embassy of respective country where the project has been executed. of the specialized activities.
 - c. The bidder should submit Certificates in reference to Sl.No. 1.1 & 1.2 above issued by Government Organizations/ Semi-Government Organizations/ Public Sector Undertakings/Autonomous bodies/ Municipal bodies for having successfully completed/ ongoing similar works. In addition, work experience certificates issued by Public listed company having average annual turnover of Rs 500 crore and above, in last 3 financial years excluding the current financial year, listed on National Stock Exchange or Bombay Stock Exchange, incorporated / registered at least 5 years prior to the date of opening of tender, shall also be considered provided the work experience certificate has been issued by a person authorized by the Public listed company to issue such certificates.

In case tenderer submits work experience certificate issued by public listed company, the tenderer shall also submit along with work experience certificate, the relevant copy of work order, bill of quantities, bill wise details of payment received duly certified by Chartered Accountant, TDS certificates for all payments received and copy of final/last bill paid by company in support of above work experience certificate.

Proof of executed item of work in 1.2 above, will also be accepted from Private Company/Concessionaire Company/JV Company, supported with TDS Certificate (Form 16A/26AS). The certificate shall be supported with copy of work order, Payment receipt duly certified by Chartered Accountant

- d. In case of MOU with specialized agencies being submitted by the bidder, the completion certificates as mentioned in para (b) & (c) above will also have to be submitted for the agencies mentioned in the MOU.
- e.(Applicable to both 1.1 and 1.2 above) Value of a successfully completed/ongoing work done by a Member in an earlier JV shall be reckoned only to the extent of the concerned member's share in that JV for the purpose of satisfying his/her compliance to the above mentioned technical eligibility criteria in the tender under consideration.
- f. The bidder shall submit relevant technical information and materials specifications of the proposed reinforced soil structure matching the technical specifications of the tender, along with the bid for technical evaluation.

2. Financial Eligibility Criteria

The average annual Revenue from operations during the preceding 3-years should be at least 30% of the estimated cost.

Notes

- a. The tenderer shall have to submit Audited Financial statements like Balance Sheet, Profit and loss statement, etc for past 3 years i.e FY 2018-2019,2019-2020 & 2020-

2021 along with a Certificate duly signed by the Statutory Auditor who has audited last Financial Statements with UDIN (Unique Document Identification Number) for the Revenue from operations.

- b. The turnover criteria will be judged based on given guidelines for the tender.
- c. In case financial statements of the latest financial year i.e FY 2020-2021 has not yet been audited for which the tenderer cannot make it available, the tenderer shall give an undertaking to this effect and the statutory auditor shall certify the same. In such case, the tenderer shall provide the Audited Annual Reports for 3 years preceding the year for which the Audited Annual Report is not being provided i.e FY 2017-2018, 2018-2019 & 2019-2020. In case, undertaking duly certified by Statutory Auditor is not submitted, the annual turnover for the year for which audited annual financial statements are not available shall be considered as 'NIL' for the purpose of arriving at the average annual Revenue from operations."

3. The net worth should be at least 10% of the estimated cost.

NOTE : "Net Worth of the bidder should be judged from the audited Balance Sheet of the last financial year ending on a date not prior to 18 months from the date of invitation of the tender, but not earlier than a year immediate prior Financial Year."

4. Bid Capacity: The tender/technical bid will be evaluated based on bid capacity formula detailed as Annexure-VI of Indian Railway GCC July'2020

5. Submission of Affidavit : The bidder shall submit the signed Affidavit as enclosed in Annexure-'IV' of **Instructions to Tenderers**". In case of MOU with specialized sub contractor, the Affidavit to be signed by the MOU partners as well.

Annexure-VI

(Ref. Clause 10 of Instructions to Tenderers)

INTEGRITY PACT

General

This Agreement (hereinafter called the Integrity Pact) is made on----- day of the month of ----- 201 ---- between IRCON International Limited (hereinafter called “IRCON”), a government company under the Ministry of Railways, and M/s -----(hereinafter called the “BIDDER”) Description of Bidder.

The expressions “IRCON” and “BIDDER” shall mean and include their respective legal representatives, successors in interest, and assigns and shall collectively be referred to as “the Parties” and individually as “the party”.

WHEREAS IRCON intends to award, under laid down organizational procedures, contract(s) for (Name of the tender/work).....(hereinafter referred to as the ‘Contract’).

WHEREAS IRCON necessarily requires full compliance with all relevant laws of the land, rules and regulations, economic use of resources, and fairness/transparency in relations with its Bidder(s) and/or Contractor(s).

WHEREAS in order to achieve these goals, IRCON has appointed Independent External Monitors (IEMs), as detailed in para 6 of this Pact, to monitor the entire tender process till the final completion of the contract for compliance with the Integrity Pact by all the parties concerned for all works covered in the Contract.

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;

To Enable IRCON to obtain the desired works/stores/equipment at a competitive price in conformity with defined specifications by avoiding high cost and distortionary impact of corruption on public procurement, and

To Enable BIDDERS to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that IRCON will commit to prevent corruption, in any form, by its officials by following transparent procedures.

THE HERETO HEREBY AGREE TO ENTER INTO THIS INTEGRITY PACT AND AGREE AS FOLLOWS:

1. Scope

THE Integrity Pact, in respect to the said contract, would be operative from the stage of invitation of bids till the final completion of the contract. Any violation of the same would entail disqualification of the BIDDERS and exclusion from future business dealings as specified in this Integrity pact.

2. Commitments of IRCON

- 2.1. No official of IRCON, connected directly or indirectly with the contract, will demand, take a promise for or accept, directly or through intermediaries, any bribe, any 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.

- 2.2. IRCON will, during the entire tender process stage, treat all BIDDERS with equity and reason. It 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.
- 2.3. IRCON shall obtain bids from only those party /parties who have been short-listed or pre-qualified or through a process of open advertisement/ web publishing or any combination thereof.
- 2.4. In case in any misconduct on the part of any official(s) of IRCON is reported by the BIDDER to the Chairman & Managing Director of IRCON with full and verifiable facts and the same is prima facie found to be correct by the Chairman & Managing Director of IRCON, necessary disciplinary proceedings, or any other action as deemed fit, may be initiated by IRCON and such a person shall be removed from further dealings related to the subject contract process, in such situations of misconduct, while an enquiry may stand initiated or may be going on, the progress of bidding execution, etc. under the contract shall not be stalled.

3. **Commitments of BIDDERS**

- 3.1 The BIDDER commits itself to take all measures necessary to prevent corrupt practices, unfair means, and illegal activities during any stage of bid including pre-contract, contract, or post-contract stage. In particular the BIDDER undertakes to abide by the measures given in the following paragraphs.
- 3.2 The BIDDER will not offer, directly or through intermediaries, any bribe, benefit, or any other advantage like commission, fees brokerage or inducement to any official of IRCON, connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting, and implementation of the contract.
- 3.3 The BIDDER has not given, offered, or promised to give, directly or indirectly, any bribe or any benefit or other advantage like commission, fees, brokerage, or inducement to any official of IRCON or their family members 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.
- 3.4 The BIDDER will disclose the name and address of its agents and representatives, if any, in India and/or abroad.
- 3.5 The BIDDER disclose the payments to be made by them to agents/ brokers or any other intermediary, in connection with this bid/contract.
- 3.6 The BIDDER further confirms and declares to IRCON that the BIDDER has not engaged any individual or firm or company, whether Indian or foreign, to intercede, facilitate, or in any way to recommend to IRCON or any of its functionaries, whether officially or unofficially, award of the contract to the BIDDER, nor has any amount been paid, promised, or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation, or recommendation.
- 3.7 The BIDDER will not collude with other parties interested in the contract to impair the competition, transparency, fairness, and progress of the bidding process, bid evaluation, contracting, and implementation of the contract.
- 3.8 The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means, and illegal activities.
- 3.9 The BIDDER will not use for purpose of competition or personal gain, or pass on to other, any information provided by IRCON as part of the business relationship, regarding plans, technical

proposals, and business details, including information contained in any electronic data carrier. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.

- 3.10 The BIDDER commits to refrain from making any complaint, directly or through any other manner, without supporting it with full and variable facts. If the BIDDER submits frivolous or false complaints, it will be liable to attract sanctions as mentioned in para 5 of this Pact.
- 3.11 The BIDDER will not instigate or cause to instigate any third person to commit any of the actions mentioned above.
- 3.12 If the BIDDER or any employees 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 IRCON, or alternatively, if any relative of an officer of IRCON has financial interest/ stake in the BIDDER's firm, the same will be disclosed by the BIDDER at the time of filing of the tender. The term 'relative' for this purpose would be as defined in Section 6 of the Companies Act, 1956 or any amendment thereto (**Annexure-A**).
- 3.13 The BIDDER will not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any employee of the IRCON.
- 3.14 **All disclosures required under this Pact shall be included as Annexure/Appendices there to as in integral part of this Pact.**
- 3.15 If the BIDDER/ Contractor is a partnership or a consortium, this Pact will be signed by all partners or consortium members.

4. **Previous Transgression**

- 4.1 The BIDDER declared that no previous transgression has 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 other Government in India that could justify BIDDER's exclusion from the tender process.
- 4.2 The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract and, if already awarded, can be liable to attract sanctions under this Pact.

5. **Sanctions for Violations**

- 5.1 Any breach of the provisions of this Pact by the BIDDER or anyone employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle IRCON to take all or any one of the following actions, wherever required: -
- 5.1.1 To disqualify the BIDDER in pre-award stage without assigning any reason and without any compensation to the BIDDER. However, the proceedings with other BIDDER(s) would continue.
- 5.1.2 To take such actions/ steps as per provisions made in the tender documents/ contract, if contract already signed, without giving any compensation to the BIDDER.
- 5.1.3 To debar the BIDDER from participating in future bidding processes as per IRCON's policy on "Suspension/Banning of Business Dealings" with Agencies" (**Annexure-B**)
- 5.1.4 To forfeit, either fully or partially Security Deposit/ Performance Bond (after the contract is signed), without assigning any reason therefore.
- 5.2 IRCON will also be entitled to take all or any of the actions mentioned under this para 5 in the event commission by the BIDDER, or anyone employed by it or acting on its behalf of (whether with or without the knowledge of the BIDDER), of an offense as defined in Chapter IX of the Indian Penal Code, 1860, or Prevention of Corruption Act, 1988, or any other status enacted for

prevention of corruption.

- 5.3 The decision of IRCON to the effect that a breach of any provision of this Pact has been committed by the BIDDER shall be final and conclusive on the BIDDER.
- 5.4 The BIDDER shall be liable to pay compensation for any loss or damage to IRCON in the event of any action under this Para 5 and IRCON shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.

6. Independent External Monitors (IEMs)

- 6.1 IRCON has appointed Independent External Monitor hereinafter referred to as IEM) for this Pact in consultation with the Central Vigilance Commission Names and Addresses of the IEM are given below: -

Dr T.M. Bhasin
Independent External Monitor (IEM)
C/o Chief Vigilance Officer,
IRCON INTERNATIONAL LIMITED,
C-4, District Centre, Saket,
New Delhi-110 017
e-mail ID : iem.reference@ircon.org

- 6.2 The task of IEMs shall be to review independently and objectively whether, and to what extent, the Parties comply with the obligations under this Pact.
- 6.3 The IEMs shall not be subject to instructions by the representatives of the Parties and perform their functions neutrally and independently.
- 6.4 Both the parties accept that the IEMs would have a right to access, without restriction, to all Project documentation of IRCON and the BIDDER upon request and demonstration of a valid interest by the IEMs. The same is also applicable to sub-contractors of the BIDDER. The IEMs shall be under contractual obligation to treat the information and documents of all the parties with confidentiality.
- 6.5 In case of non-compliance of the provisions of the Integrity Pact, any complaint/non-compliance can be sent by an aggrieved party, giving specific details of non-compliance with supporting documents, to the designated Nodal Officer of IRCON appointed by the CMD. The Nodal Officer, after verification of the complaint, shall refer the complaint/non-compliance received by him to the aforesaid IEM(s) alternatively, as soon as the IEM notices a violation of this Pact, or has been reason to believe that a violation has occurred, or had received a complaint, he will so inform the CMD of IRCON in the first instance.
- 6.6 The IEMs would then examine all complaints, other than anonymous/pseudonymous complaints, received by them and give their written report to the CMD of IRCON within 6 weeks from the date of reference or intimation to him by IRCON/BIDDER and, should the occasion arise, submit proposals for correcting problematic situations.

7. Law and Place of Jurisdiction

This Pact shall be applicable to all tenders invited and finalized in India. This Agreement is subject to Indian Law and the place and jurisdiction for resolving any issue shall be New Delhi.

8. Other Legal Actions

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

9. Validity

- 9.1 The validity of this Integrity Pact shall be from the date of its signing and extend up to 5 years or the complete execution of the contract to the \satisfaction of the both IRCON and the BIDDER including Defects Liability/ Warranty period, whichever is later. In case BIDDER(s) is (are) unsuccessful, this Integrity Pact shall cease to be valid in the expiry of two months from the date of award of the contract.
- 9.2 Should any provision of this Pact turn out to be invalid, the remaining parts of this Pact shall remain unaffected which shall be honoured and implemented by the Parties in its intend and spirit.
- 10 The Parties hereby sign this Integrity Pact at ----- on -----

(Full name & Registered Office address)

For & on Behalf of

For & On Behalf of

Ircon International Limited

BIDDER (Full name of Bidder & regd address)

Name of the Authorized Officer

Name of the Authorized Officer

Designation

Designation

(SEAL)

(SEAL)

Witness

Witness

1. _____

1 _____

2 _____

2 _____

Annexure-A

LIST OF RELATIVES

Section 2(77) of the Companies Act, 2013

[Effective from 1st April, 2014]

“Relative”, with reference to any person, means anyone who is related to another, if –

- (i) They are members of a Hindu Undivided Family;
- (ii) They are husband and wife; or
- (iii) One person is related to the other in such manner as may be prescribed;

List of Relative in terms of Section 2(77) [as prescribed under Rule 4 of Companies (Specification of Definitions Details) Rules, 2014]

A person shall be deemed to be the relative of another, if he or she is related to another in the following manner, namely: -

1. Father:

Provided that the term “Father” includes step-father.

2. Mother:

Provided that the term “Mother” includes the step-mother.

3. Son:

Provided that the term “Son” includes the step-son.

4. Son’s wife.

5. Daughter.

6. Daughter’s husband.

7. Brother:

Provided that the term “Brother” includes the step-brother;

8. Sister:

Provided that the term “Sister” includes the step-sister.

\

ANNEXURE-B

**Procedure for Suspension/Banning of Business Dealings with agencies
in IRCON**

(Issue No.:01 Date:_____)

**IRCON INTERNATIONAL LIMITED
(A Govt. of India Undertaking)
C-4, DISTRICT CENTRE, SAKET,
NEW DELHI-110017**

**PHONE:+91-11-29565666; FAX:+91-11-26522000,26854000
E-mail: info@ircon.org ; Web: www.ircon.org
CIN L45203DL1976GOI008171**

PROCEDURE FOR SUSPENSION/BANNING OF BUSINESS DEALINGS

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Procedure for Suspension/Banning of Business Dealings with agencies in IRCON

1.0 Introduction

- 1.1 IRCON is a specialized construction organization covering the entire spectrum of construction activities and service in the infrastructure sector, especially Railways. The primary objective of IRCON is timely and efficient execution of projects assigned to it and at the same time ensuring the quality thereof. As a commercial organization IRCON is expected to adopt ethics of highest standards and a very high degree of integrity, commitment and sincerity towards the work undertaken. Accordingly, it is not in the interest of IRCON to deal with such Agencies who commit deception, fraud or other misconduct in the execution of contracts awarded/orders issued to them. Appropriate action needs to be taken against them in accordance with the procedure prescribed herein.
- 1.2 This procedure shall be applicable for effecting suspension/banning of business dealings with Agencies working for IRCON. It is incumbent upon IRCON to ensure compliance with the laws and principles of natural justice for banning the business dealings with any Agency. After issue of the Ban order for dealings in IRCON the Management may consider whether or not to refer the matter to the Indian Railways to consider imposition of similar ban by Indian Railways.
- 1.3 Since banning of business dealings involves severe consequences for the Agency concerned, it is essential that an adequate opportunity is provided to the Agency to present its case and any explanation, if tendered, is properly considered. If necessary, a personal hearing may be given to the Agency, before passing an order of banning based on the facts and circumstances of the case on record.

2.0 Scope

- 2.1 The procedure for (i) Suspension and (ii) Banning of Business Dealings with Agencies, is laid down in these guidelines.
- 2.2 It is clarified that these guidelines do not cover the process for declaring an Agency as "Non Performer" for which instructions have been issued separately.
- 2.3 The suspension / banning shall be with prospective effect, i.e., it will affect future business dealings only.
- 2.4 These guidelines shall apply to all the Projects/Regional Offices of IRCON.

3.0 Definitions

- 3.1 In these Guidelines, unless the context otherwise requires:
- i. 'Agency' means a 'Bidder/Contractor/Supplier/Consultant'
 - ii. 'Competent Authority' and 'Appellate Authority' shall mean the following:
 - a) 'Competent Authority' shall be the concerned Director of IRCON and
 - b) 'Appellate Authority' shall be CMD, IRCON

Note: 'Competent Authority' and 'Appellate Authority' shall not be the same person.

- b) 'Investigating Agency' shall include Central Vigilance Commission (CVC), the

Vigilance Departments of IRCON/Ministry of Railways, Central Bureau of Investigation, or any Central/State Government Department having powers to investigate into the propriety of working of the Agency for IRCON.

- c) Other Terms used in this Circular shall have the same meaning as assigned to them in Clause 1102 of Chapter-XI of Vigilance Manual of Indian Railways.

4.0 Grounds on which Suspension/Banning of Business Dealings can be initiated:

- 4.1 For security considerations, including suspected disloyalty of the Agency to the State or IRCON, as the case warrants;
- 4.2 If any Director/Owner/Proprietor or partner of the Agency, is convicted by a Court of Law for an offence involving moral turpitude in relation to its business dealings with IRCON, any Government Department/ Ministry or any other Public Sector Enterprise.
- 4.3 If there is strong justification for believing that any Director, Proprietor, Partner, owner of the Agency has been guilty of malpractices, such as bribery, corruption, fraud, substitution of tenders, interpolations, etc.
- 4.4 If the Agency engages a public servant dismissed/removed from service on account of corruption or employs a person convicted for an offence involving corruption, moral turpitude or abetment of such offence; in a position where he could corrupt government servants.
- 4.5 If the Agency has resorted to corrupt, fraudulent malpractices including misrepresentation of facts;
- 4.6 If the Agency uses intimidation/threats or brings outside pressure on the Company (IRCON) or/on its officials in acceptance of Tender or performance of the job under the contract;
- 4.7 Based on the findings of the investigation report of the Investigating Department against the Agency that it has resorted to mala-fide/ unlawful acts or improper conduct on its part in matters relating to IRCON, any Government Ministry/Department or any other PSU;
- 4.8 If the Agency has submitted a false or wrong Affidavit along with its bid with regard to the credentials of the firm or misrepresented/ manipulated the facts in regard to or in connection with any bid submitted to IRCON.
- 4.9 Established litigant nature of the Agency to derive undue or benefit.
- 4.10 If the Agency misuses the premises or facilities of the IRCON, forcefully occupies or damages the IRCON's properties including land, water, resources, forests / trees or tampers with documents / records etc.
- 4.11 If the business dealings with the agency have been banned by the Ministry of Railways.
- (Note: The above grounds are illustrative only and not exhaustive. The Competent Authority may decide to suspend/ban business dealings for any other reasonable cause and sufficient reason)

5.0 Initiation of Suspension/Banning:

- 5.1 Suspension of Business dealing
- 5.1.1 Action for suspension may be initiated by the concerned ED/IRCON on receipt of a report from the Project head/Functional head/ Investigating Department and if it is considered that allegations are of a serious nature, which may warrant banning of business dealings with the Agency. The report should also bring out whether pending banning of business proceedings it would be in the interest of IRCON to enter into fresh business dealings with the Agency or order immediate suspension of further business dealings with the Agency. The ED shall submit his report to the Competent Authority.
- 5.1.2 As far as possible, the existing contract(s) with the Agency may be continued unless the Competent Authority, having regard to the circumstances of the case decides otherwise in the interest of IRCON.
- 5.1.3 If the Competent Authority, after consideration of the matter, including the recommendations of the Investigating Department/report of the ED, decides that it would not be in the interest of IRCON to enter into business dealings with the Agency pending investigations, he may order suspension of business dealings with the Agency.
- 5.1.4 The Investigating Department may be advised to complete their investigations and submit a final report within a period of three months.
- 5.1.5 The order of suspension of business dealings would not remain effective for a period beyond three months from the date of the issue of the suspension order unless show cause notice for banning of business is issued to the Agency within this period. However, if the final investigation report is not received within this period, the Competent Authority may extend the period of suspension by another three months, during which period the show cause notice must be issued. Once the show cause notice is issued the suspension order will continue till decision by Competent Authority.
- 5.1.6 In case of suspension the Agency must be informed immediately of the suspension order with brief charges under investigation. It is not necessary to enter into correspondence with or offer explanations to the Agency at this stage.
- 5.1.7 The order of suspension can be issued without giving any show cause notice or personal hearing to the Agency. However, the suspension cannot be continued for an indefinite period, unless a show-cause notice for banning of business is issued within 6 (six) months, the period of suspension will either be extended or the suspension shall be revoked.
- 5.2 **Banning of Business Dealings**
- 5.2.1 A decision to ban business dealings with any Agency shall normally apply throughout IRCON. However, the Competent Authority can impose such a ban project/region wise only if in the particular case banning of business dealings in respective project/region will serve the purpose and achieve its objective and banning throughout the Company is not required in view of the local conditions and impact of the misconduct / default. Any ban imposed by Corporate Office shall be applicable across all Units of IRCON.
- 5.2.2 An Investigating committee consisting of ED concerned, ED/Finance and an ED

nominated by Competent Authority shall look into the charge(s) against the agency. The functions of the committee shall, inter-alia include:

- i. To study the report of the project head/Functional head / Investigation agency and decide if a prima-facie case for banning exists, if not, send back the case to the Competent Authority.
- ii. To recommend for issue of show-cause notice to the Agency by the competent authority as per clause 5.2.3.
- iii. To examine the reply to show-cause notice and call the Agency for personal hearing, if required.
- iv. To submit final recommendations to the Competent Authority for banning or otherwise.

5.2.3 On receipt of the report of the Investigating Committee if the Competent Authority is prima-facie of the view that action for banning of business dealings with the Agency is called for, a show-cause notice may be issued to the Agency after approval by the Competent Authority.

5.2.4 The show cause notice, duly approved by the Competent Authority, may be issued by Regd. A.D./Speed Post by concerned ED in charge of the project along with a statement containing the imputation of misconduct or malpractice and the Agency should be asked to submit its written explanation or statement in defense within 30 days of the date of notice. If no reply is received, a decision may be taken ex-party by the Investigating Committee based on facts and evidence on record.

5.2.5 If the Agency requests for inspection of any relevant document mentioned in the show cause notice in possession of IRCON, the facility for inspection of such documents may be provided.

5.2.6 After considering the reply of the Agency and other circumstances and the recommendation of the investigating committee, a final decision shall be taken by the Competent Authority, if considered necessary after giving an opportunity for personal hearing to the Agency. The Competent Authority may then consider and pass an appropriate speaking order:

- a) Exonerating the Agency, if the charges are not established;
- b) Banning the business dealings with the Agency along with the period for which the ban would be operative, if the charges are proved.
- c) Whether or not to refer the matter to the Indian Railways to consider imposition of similar ban by Indian Railways.

5.2.7 The order for banning of business dealings by all units of IRCON shall be applicable to the Agency including its allied firms as defined in Para 1102 of IR Vigilance Manual.

5.2.8 Decision of Competent Authority will be intimated to the concerned ED, who will convey the same to the delinquent Agency and its allied firms and circulate it to the corporate office and all Project head / Functional head for applying these orders uniformly in IRCON. The reasons may not be disclosed in such communications. However, the fact that the representation has been considered should invariably be mentioned in the communication.

5.2.9 The validity of the banning order shall be for a specified time period, on expiry of which, the banning order shall cease to operate, unless extended further by competent authority.

6.0 **Appeal against the Decision of the Competent Authority**

6.1 The Agency may file an appeal against the order of the Competent Authority for suspension continuing beyond six months or order of banning business dealings with the Agency. The appeal shall lie with the Appellate Authority. Such an appeal shall be preferred within one month from the date of receipt of the order banning of business dealings or order of continuance of suspension order beyond six months.

6.2 Appellate Authority shall consider the appeal and pass an appropriate order which shall be communicated to the Agency as well as the Competent Authority. If the decision of the Competent Authority is modified by the Appellate Authority the same will be intimated by concerned ED to the delinquent agency and its allied firm and circulates it with advice to all Project Heads and Corporate Office of IRCON.

This procedure order is issued with the approval of CMD/IRCON.

P.S.: Where ED is not dealing with the case of a particular contract (or), the same action may be taken by the Coordinating GM or any other officer made in-charge for the work

ANNEXURE – VII

**Format for Bid Security Declaration
(On Non-judicial stamp paper of Rs. 100)**

Whereas, I/we _____ (name of agency) has submitted bid for _____ (name of work) and whereas the Earnest Money Deposit is being exempted in the aforesaid tender to give relief to the bidders as per Govt. of India guidelines due to severe financial crunch on account of slowdown in economy due to the pandemic,

I/we hereby submit following “Bid Security Declaration” in lieu of exemption from submitting Earnest Money Deposit:-

1. If I/we withdraw or modify my/our bid during the bid validity period (including extended validity of tender) specified in the tender documents;

or

2. If, after the award of work, I/we fail to accept LOA/LOI, or to sign the contract agreement or fail to submit performance guarantee, or fail to commence the work within the stipulated time period prescribed in the tender documents;

or

3. If I/we furnish any incorrect or false statement/information/document;

or

4. If I/we hide any relevant information or do not disclose any material fact in the tender;

or

5. If I/we commit any breach of Integrity pact,

I/we may be disqualified and banned for a period of two years and shall not be eligible to bid for future tenders of Ircon International Ltd. for the period of two years from the date of issue of such order.

(Signed by the Authorized Representative of the Firm)

Name of the Authorized Representative

Name of the Firm

Dated:

Annexure -VIII

(Ref. Clause 8.0 of e-Procurement Notice, sub- clause 'C.6.3' of ITT, sub-clause'D.12.2 of ITT & sub-clause D.14.1 of ITT)

CHECK LIST for list of documents duly page numbered, signed, stamped by authorized signatory of the Bidder to be scanned, uploaded (in PDF/ JPG format such that file size is not more than 5 MB) with the e-tender and submitted online not later than the prescribed date and time for e-bid submission:

1. Forwarding Letter of the bidder
2. Form of Bid
3. Details of similar works completed in last seven years (Format - 1).
4. Bid Capacity (Annexure- VI of GCC-July 2020 of Indian Railway)
5. Annual Revenue from Operations for the last three years with supporting documents (Format-2)
6. Programme for deployment of Key Personnel (Format - 3).
7. Programme for deployment of Plant and Machineries on the Project. (Format - 4).
8. Attested copies of the constitution of its firm such as Partnership Deed, Memorandum and Articles of Association, etc.
9. GSTIN
10. ISO 9001-2008 certificate (if any).
11. Schedule of start and completion of work in the form of Bar Chart.
12. Methodology for execution of works.
13. Proof of transaction towards payment of Cost of Tender Document through NEFT or RTGS and copy of Bid Security Declaration.
14. **Power of Attorney** duly attested by Notary Public in favour of the person signing the e-bidding documents digitally as well as manually.
15. Bankers details (name of bank and branch) along with bidders own bank details (Account No., Name of Account Holder, NEFT/RTGS details) as per Format given in Annexure-I).
16. Affidavit (as per Format given in Annexure-IV)
17. Bid Security Declaration (as per Format given in Annexure-VII)
18. Certificate of Familiarisation (as per Format given in Annexure-IX).
19. Tender Acceptance letter.
20. Any other details sought through ITT

Note :

- i) **Hard copy of above documents in original must be presented to IRCON, if requested so, either during the process of finalization or after finalization of the tender.**
- ii) **Financial bid submitted by any bidder in physical form shall not be considered and the same will be left un-opened.**
- iii) **Submission of Bid Security Declaration as referred in clause no. 9.0 of 'Instructions to Tenderers'.**

Annexure -IX

CERTIFICATE OF FAMILIARISATION

I/We hereby solemnly declare that I/We have visited the site of work and have familiarized myself/ourselves of the working conditions there-in all respects and in particular, the following:

- a) Topography of the Area.**
 - b) Soil & rock conditions at the site of work.**
 - c) Sources & availability of man power.**
 - d) Borrow areas of earth and Muck dumping sites.**
 - e) Rates for construction materials.**
 - f) Availability of local labour, both skilled and unskilled and the prevailing labour rates.**
 - g) Availability of water & electricity.**
 - h) The existing roads, bridges, culverts and access to the site of work.**
 - i) Availability of space for putting labour camps. Officers, stores, godown, Engineering Staff quarters etc.**
 - j) Climatic condition and availability of working days.**
 - k) Political environment and law & order situation of the project/camp area.**
 - l) Soil conditions at the site of work**
 - m) Methodology to be adopted for successful completion of work.**
 - n) Working hours and shifts for completing the work as per tender conditions.**
- B. I/We have kept myself/ourselves fully informed of the provisions of this tender document comprising Instructions to the Tenderers, General Conditions of the Contract, Special Conditions, Specifications and Additional special conditions apart from information conveyed to me/us through various other provisions in this tender document.**
- C. I/We have quoted my / our rates as ‘Percentage above / at par ‘of total cost as per Schedule of Items Rates and Quantities (BOQ) in TENDER DOCUMENT taking into account all the factors given above.**

(Signature of Tenderer/s)

FORMAT-1
(Ref. Sr. No. 3. of Annexure-VIII to Instructions to Tenderers)
DETAILS OF SIMILAR WORKS COMPLETED IN LAST SEVEN YEARS

S. No.	Description of the Work	Name and address of the Employer	Contract No. and date	Date of award of work	Stipulated date of completion	Date of actual completion	Value of completed work (In Lacs of Rs.)	Reasons for delays, if any	Penalty, if any, imposed for delay	Any other relevant information	Remarks
1											
2											
3											
4											
5											
6											

Note :

1. Please attach copies of the certificates issued by the Client.
2. Only those works shall be considered for evaluation for which copies of the certificates issued by the client are attached.

FORMAT-2 <i>(Ref. Sr. No. 5 of Annexure-VIII to Instructions to Tenderers)</i> ANNUAL REVENUE FROM OPERATIONS RECEIVED FOR THE LAST THREE FINANCIAL YEARS & CURRENT FINANCIAL YEAR.			
S. No.	YEAR	Annual Revenue from operations received during the financial year (In Lakh of Rs.)	Remarks
1	2017-18		
2	2018-19		
3	2019-20		
4	2020-21*		

* Till date of Submission

Note :

1. Please attach certified/attested copies of the latest ITCC and/or Profit and Loss Account statement to support the information furnished.
2. Certified Copy of Chartered Accountant showing turn-over.

FORMAT-3

(Ref. Sr. No. 6 Annexure-VIII to Instructions to Tenderers)

PROGRAMME FOR DEPLOYMENT OF KEY PERSONNEL

S. No.	Name	Qualification	Designation	Total Experience (in years)	Programme for Deployment
1					
2					
3					

FORMAT-4

(Ref. Sr. No. 7. of Annexure-VIII to ITT)

PROGRAMME FOR DEPLOYMENT OF PLANT AND MACHINERY PROPOSED TO BE ENGAGED ON THE PROJECT

S. No.	Description	Make	Model & Year of manufacture	Capacity	Condition	Nos. proposed to be deployed	Programme of Deployment	Remarks
1								
2								
3								
4								

Annexure-“ A1”

Specialized Subcontractor -MOU

NON JUDICIAL STAMP

MEMORANDUM OF UNDERSTANDING (MOU)

MEMORANDUM OF UNDERSTANDING (MOU) ENTERED INTO AT (place) THIS..... DAY OF (Month)Year

Between

1.(name of firm) having its registered office at.....(full address)
(hereinafter referred to as(say A, short form of firm)) acting as the “Bidder”
of the first part,

And

2. (name of firm) having its registered office at(full address)
(hereinafter referred to as(say B, short form of firm)) in the capacity of
“Specialized sub-contractor” of the other part.

The expressions of A & B shall wherever the context admits, mean and include their respective legal representatives, successors-in-interest and assigns and shall collectively be referred to as “the Parties” and individually as “the Party”.

WHEREAS the parties hereto have agreed to enter into an agreement for the purpose of participation in Tender in respect of the project work of “
_____ (complete name of work to

furnish) (hereinafter referred to as "The Work") mentioned in Tender Notice No. _____ Dtd: _____, invited by _____, Ircon International Limited. (hereinafter referred to as "Employer").

Whereas in the event the "Bidder" being successful in its bid the parties have agreed to perform the contract in accordance with the agreed terms and conditions and thereof and in the spirit of mutual co-operation to achieve the objective of this agreement/MOU to the full satisfaction of the Employer.

Now therefore for and in considerations and covenants hereinafter set forth the parties hereby agree as follows:

1. The specialized sub-contractor certifies that it is fully familiar with all of the terms of the tender documents, the location of the job site, and the conditions under which the work is to be performed and that it enters into this subcontract based upon its investigation of all such matters and is not relying on any opinions or representations of contractor.

This subcontract represents the entire agreement between contractor and subcontractor, and supersedes any prior oral or written agreements or representations. All the terms and conditions of tender document are incorporated in this subcontract by reference, insofar as it relates in any way, directly or indirectly, to the work.

The specialized subcontractor agrees to be bound to contractor in the same manner and to the same extent as contractor is bound to Employer as per tender documents, including, but not limited to, all applicable terms and provisions thereof. Where, in the tender documents, reference is made to contractor, and the work or specifications therein pertain to specialized sub-contractor's trade, craft or type of work, such work or specifications shall be primarily interpreted to apply to specialized sub-contractor.

The following documents shall be deemed to form and be read and construed as

an integral part of this MOU/agreement.

- (i) Tender Notice and
 - (ii) Tender Document
 - (iii) Any Amendment/ Corrigendum issued by “the Employer”
 - (iv) The tender submitted on our behalf by the “Bidder”.
2. The “Parties” have studied the documents and have agreed to participate in submitting a tender under the name “A” (*Name of Bidder to be furnished*) and “B” as specialized sub-contractor.
3. A _____ (*Name of bidder*) shall be the “bidder” for all intents and purpose and shall represent in its dealing with the Employer. For this purpose of submission of bid proposals, the parties agree to nominate Shri..... (name with designation) of(name of the parties to which he belongs) as the leader duly authorized to sign and submit all documents and subsequent clarifications, if any, to the Employer.
- However, Shri (name with designation) shall not submit any such proposals, clarifications or commitments before securing the written clearance of the specialized sub-contractor _____ (*Name of specialized sub-contractor*), which shall be expeditiously given.
4. The “Parties” have resolved that the scope of work of specialized sub-contractor in the agreement shall be as under:
- (a) Scope of work... [Sub-contractor’s scope of work shall be clearly defined and it shall be in accordance with the qualification requirement].
 - (b) The specialized subcontractor agrees to furnish all the resources including all labor, materials, equipment, tools, test equipment, services and other facilities required to complete the work as per work programme of the bidder and their

scope of work in time period as mentioned in tender document or any extensions allowed by Employer,

The specialized sub-contractor shall fully comply the SHE policy, labour laws and quality assurance during execution of works.

[The prices and payment terms is not required to be divulged]

5. **JOINT AND SEVERAL RESPONSIBILITIES**

The Parties undertake that they shall be jointly and severally legally liable to the Employer to their extent, in the discharge of all the obligations and liabilities as per the tender document/contract agreement with the Employer and for execution of project in accordance with General and Special Conditions of the Contract if the work is awarded to the “bidder” along with specialized sub-contractor.

The bidder and specialized sub-contractor shall be fully responsible for execution of contract and for the loss, damages caused to the Railway during the course of execution of the contract or due to non-execution of the contract or part thereof.

In case of failure of specialized sub-contractor, all liabilities will be on the bidder “A”. The bidder “A” shall be responsible (technically and financially) for complete execution of the work as per timeline given in the contract.

In the event of any dispute between contractor and specialized subcontractor over the scope of the work under the contract documents, subcontractor will not stop work but will prosecute the work diligently to completion as directed by Employer, and the dispute will be resolved amicably by the parties.

[This MOU is in line with the contractual obligations and the subcontractor shall be responsible for their scope of work and accountable to Employer in accordance with the contract terms, and a relevant statement to this effect shall be included in the MOU].

6. **AGREEMENT**

If the contract is awarded to the bidder and he himself does not have requisite experience as above, he is required to submit legally enforceable agreement with the specialized sub-contractor immediately after award of work, but prior to entering into contract agreement. The agreement must specify the specific role and responsibility of the subcontractor.

7. **GUARANTEES AND BONDS.**

The Bank Guarantees, Earnest Money deposit etc and other Bond shall be furnished only by “the bidder” and that shall be legally binding on “the bidder”.

8. **BID SUBMISSION.**

Each Party shall bear its own cost and expenses for preparation and submission of the bid and all costs until conclusion of a contract with the Employer for the Project.

9. **INDEMNITY**

Each party hereto agrees to indemnify the other party against its respective parts in case of breach/ default of the respective party of the contract works of any liabilities sustained by them.

10.0 For the execution of the respective portions of works, the parties shall make their own arrangements as per mutual agreement/understanding between them from time to time to bring the required finance, plants and equipment, materials, manpower and other resources.

11. **VALIDITY**

This MOU shall remain in force till the occurrence of the earliest to occur of the following, unless by mutual consent, the Parties agree in writing to extend the validity for a further period,

The bid submitted by the bidder “A” is declared unsuccessful, or

Cancellation/ shelving of the Project by the Employer for any reasons prior to award of work, Execution of detailed agreement by the parties, setting out detailed terms after award of work by the Employer.

12. The parties undertake not to make any modification/alteration/termination to the MOU during the validity of the tender.
13. The parties undertake not to make any changes in this MOU or terminate this Joint Venture, after submission of the tender bid except when modification becomes inevitable due to successive laws etc., without prior written consent of the Employer duly following all the conditions of eligibility criteria.

[For the successful Bidder, the work shall be executed by the specialized subcontractor whose credentials have been considered for evaluation. The proposed specialized Sub-contractor shall not be altered or substituted except under inevitable circumstances and with the express written approval of the Employer duly following all the conditions of eligibility criteria.

In case of specialized subcontractor's work/performance found unsatisfactory by Employer at any stage then the bidder shall replace the specialized sub-contractor without any extra cost implication to the Employer.]

14. All parties to the agreement/MOU (name) certify that the parties are not black listed or debarred by Railways or any other Ministry/Department/PSU (Public Sector Undertaking) of the Govt. of India/State Govt. from participation in tenders/ contract on the date of opening of bids either in their individual capacity or as a member of the JV Firm in which they were/are members.
15. This MOU shall be construed under the laws of India.

Now the parties have joined hand to form agreement/MOU on this day of(month) two thousand (Year) with reference to and in confirmation of their discussions and understanding brought on record on(Day).

The Bidder

Specialized sub-contractor

(Name of signatory with designation and name of firm should be furnished)

IN WITNESS WHEREOF THE PARTIES, have executed this agreement/MOU the day, month and year first before written.

Witness

1.2.3.4.5

SECTION-IV
APPENDIX TO TENDER

APPENDIX TO TENDER

<u>Description</u>	<u>Reference Clause</u>
Name of the work: "Construction of Melli Yard works including earthwork in cutting, filling, development of drainage system, slope stabilization, retaining structures, Reinforced Soil wall system, Construction of Bridge No. 10 on pile foundation, Bridge No. 11 and other ancillary works between Km. 26.570 to Km. 27.540 in connection with construction of Sivok - Rangpo New BG Railway Line Project."	1.1 of Instruction to tenderers.
Place of Registration of: Anywhere in India	1.2 of Instruction to tenderer.
Client: Northeast Frontier Railway.	1.4 (a) of Instruction to tenderers.
Employer: IRCON INTERNATIONAL LIMITED C-4, District Centre, Saket, New Delhi-110 017.	1.4 (b) of Instruction to tenderers.
Scope of work: As indicate in ANNEX - I to e-Procurement Notice - SCOPE OF WORK.	1.6 of Instructions to Tenderers. and Annexure-I of e-NIT.
Approximate Estimated cost of the work: Rs. 1,82,02,47,857.41 /- including all taxes	1.7 of Instruction to tenderers.
Earnest Money Deposit: NIL (Required "Submission of Bid Security Declaration Form" as Annexure VII)	9.1 of Instructions to Tenderers and 1.0 of e-NIT.
Period of Validity of tender: 90 days from the date of opening of tender	11.0 of Instructions to Tenderers and 17.0 of e-NIT
Period of Completion: 30 (Thirty) Months including Monsoon Period	74.0 of SCC-I& 1.0 of e-NIT
Defect liability period: 12 months from date of issue of completion certificate.	76 of SCC

SECTION-V
SPECIAL CONDITIONS OF CONTRACT

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Special Conditions of Contract

1.0 DEFINITIONS:

In the Contract, as herein after defined, the following word expressions shall have the meanings hereby assigned to them, except where the context requires otherwise.

- a) **“RAILWAY”** shall mean the president of the republic of India or the Administrative officers of the Northeast Frontier Railway/IRCON or of the successor Railway authorized or any other officer of IRCON authorized to deal with any matters which these presents are concerned on his behalf.
- b) **“CLIENT”/“PRINCIPAL EMPLOYER”** means the Northeast Frontier Railway represented through the Chief Administrative Officer/Construction.
- c) **“Employer”** means the IRCON INTERNATIONAL LIMITED, A Govt. of India Undertaking (IRCON in abbreviation) acting through its Chairman and Managing Director or any other authorized officer and shall include their legal successors in title and permitted assignees.
- d) **“Engineer or Engineer in Charge”** means the project Head of IRCON INTERNATIONAL LTD. (Employer) or any other officer authorized by the Employer to act on his behalf and for the purpose of operating the contract.
- e) **“Engineer’s Representative”** means any official nominated from time to time by the Engineer to act on his behalf.
- f) **“Contractor”** means the individual, firm, Company, Corporation whether incorporated or not, who enters into the Contract with the Employer/Engineer, and shall include its heirs, executors, administrators, successors, legal representatives, as the case may be.
- g) **“Contractor’s Representative”** Shall mean the person responsible for execution of the contract who shall be so declared by the Contractor and who shall be authorized under a duly executed power of attorney to comply the instructions and to use, receive materials issued by the Engineer to the Contractor for works. He shall be capable of taking responsibility for proper execution of works.
- h) **“Sub-Contractor/s”** means the individual, firm company, corporation having direct Contract with the Contractor and to whom any part of the work has been sublet by the Contractor with the consent of IRCON and shall include his heirs, his executors, administrators, successors, legal representatives, as case may be.
- i) **“Other Contractor”** means individuals, firm, company, corporation employed by or having a contract directly or indirectly with the Client/Employ/Engineer other the contractor.
- j) **“Tenderer or Bidder”** means the individual, firm, Company, Corporation submitting a bid/tender.
- k) **“Scheduled Bank”** means a bank included in the second schedule to the Reserve Bank of India Act, 1934, or modification thereto.
- l) **“Contract”** shall mean an include the agreement or letter of acceptance, the accepted bill of quantities and rates, the General Conditions of Contract, Special Conditions of Contract, Appendix to Tender, Form of Bid, Instructions to the Tenderers, Drawings, Specifications & Other Tender Documents.
- m) **“Tender or bid”** means the offer (Technical and/or Financial) made by individual, firm, Company, Corporation for the execution of the works.

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- n) **“Specification”** means the specifications referred to in the contract and any modifications thereof or addition thereto, or as may from time to time be furnished or approved in writing by the Engineer.
- o) **“Bill of Quantities (BOQ)”** means list of items of work, their quantities and rates).
- p) **“Original Contract Value”** means the sum stated in the letter of acceptance/Contract Agreement.
- q) **“Contract Value”** means the original contract value subject to the adjustments in accordance with the provisions of the Contract.
- r) **“Temporary works”** means all enabling works of every kind required for the execution of the works.
- s) **“Permanent work(s)/Work(s)”** means the works (other than temporary works) to be executed in accordance with the contract or part/s thereof as the case may be and shall include extra or additional, altered or substituted items or the work as required for performance of the contract.
- t) **“Construction Plant”** means all machinery, appliances or things of what so ever nature required for the execution, completion and maintenance of the works, but does not include materials or other things intended to the form or forming part of the permanent works.
- u) **“Site”** means the land and/or other places on, under, in or through which the works are to be carried out, and any other lands or places provided by the client / employer / engineer for the purpose of the contract.
- v) **“Materials”** means all equipment, components, fittings and other materials including raw materials which form part of the permanent works.
- w) **“Test”** means such test as prescribed in the contract or by the engineer or engineers representative whether performed by the contractor or by the engineer or his representative, or any agency approved by the engineer.
- x) **“Approval or Approved”** means approval in writing including subsequent written confirmation previous verbal approval.
- y) **“Defect Liability Period”** means the specified period of defects liability from the date of completion of the work as certified by the engineer.
- z) **“Letter of Acceptance”** means the letter from the Employer or the Engineer to the Contractor, Conveying acceptance of the Tender.
- aa) **“Month”** means Gregorian calendar month.
- bb) **“Day”** means the calendar day.
- cc) **“Time”** expressed by hours of the clock shall be according to the Indian Standard Time.
- dd) **“Tender Date”** means closing date fixed for received of Tedner as per Notice Inviting Tender or extended by subsequent notification.
- ee) **“Rupees”** (or or Rs. In abbreviation) shall means Rupees in Indian Currency.
In case, there is an ambiguity in any definition, the decision of IRCON regarding the interpretation shall be final and binding.
- ff) **Commencement Date:** - The date of commencement shall be the date of issue of Letter of Acceptance.
- gg) **Time for Completion:** - Means the time for completing the work or a section with any extension calculated from commencement date

1.1 Heading and marginal notes

- a. The top heading and marginal notes given in the tender or contract documents are solely for the purpose of facilitating reference and shall not be deemed to be part thereof and shall not be taken into consideration in the interpretation or consideration thereof.

b. Notices, Consents, Approvals, Certificates and Determination.

Where ever in the contract provision is made for giving or issue of any notice, consent, approval certificate for determination, it shall be in writing and the words notify, certify or determine shall be construed accordingly.

1.2 SINGULAR, PLURAL AND GENERAL

Words importing the singular only also include the plural and vice versa where the context requires. Similarly, words importing masculine gender also include feminine gender.

1.3 COMMUNICATION AND LANGUAGE OF CONTRACT

1.3.1 Communication to be in writing

All notices, communications, references any complaints by either party to the contract shall be in writing in English or Hindi. Communication from only authorized representative of the contractor shall be entertained.

1.3.2 Language of Contract

The contract document shall be drawn up in English.

2.0 INSPECTION OF SITE AND SITE DATA:

2.1 To obtain first-hand information on the assignment and local conditions, the bidders must visit the site at their own cost. For assistance such as any field related information/site visit, required in this connection, Project Head/SRRP, IRCON INTERNATIONAL LIMITED, Siliguri may be contacted at the following address-
**Project Head/SRRP,
IRCON INTERNATIONAL LIMITED,
New Railway Colony,
Nearby Sivok Railway Station,
Sivok, Pin Code 734320
Dist. Darjeeling (West Bengal)**

It shall be deemed that the tenderer has undertaken the visit to the site and is aware of site conditions at the time of submission of tender.

2.2 The Employer will, wherever applicable, make available, as far as possible, to the Contractor all the data in connection with present tender available with IRCON and attached as Volume II (Technical Documents), which have been obtained by or on behalf of the Employer from investigations for the Works. The accuracy or reliability of the data/studies/reports and of any other information supplied at any time by the Employer or Engineer-in-charge shall be ascertained by the Contractor. The Contractor shall be responsible for interpreting all data and shall conduct any further investigations considered necessary by him, at his own cost. The Contractor shall be deemed to have inspected and examined the Site, its surroundings, the above data and other available information, and to have satisfied himself before submitting the Tender, as to:

-
- a The form and nature of the Site, including the sub-surface conditions;
 - b The hydrological and climatic conditions;
 - c The extent and nature of the work, Plant, and Materials necessary for the execution and completion of the Works and the remedying of any defects;
 - d The means of communication with and access to the Site and the accommodation he may require; and

2.2.1 The Contractor shall be deemed to have obtained all necessary information as to risks, contingencies and all other circumstances, which may influence or affect the Tender

- 2.3 The Employer/Engineer shall make available with tender Documents such data on hydrological and sub-surface conditions, if any, obtained from investigations undertaken relevant to the works. The tender shall be deemed to have been based on such data, if provided, but the contractor shall be responsible for his own interpretation of all such data.
- 2.4 The Contractor shall be deemed to have inspected and examined the site and information available in connection therewith and to have satisfied himself fully before submitting his bid about the sub-surface conditions, the hydrological and climatic conditions, the extent and nature of work and materials necessary for the completion of the works, the means of access to the site and accommodation he may require. He shall also be deemed to have obtained all necessary information regarding risks, contingencies and all other circumstances which may influence or affect the contract.
- 2.5 The alignment traverses through steeply sloping, highly undulating hill slopes of younger Himalayas.
- 2.6 The regional Geology and tectonic framework of the area indicates that the region is capable of generating earthquake. The area falls in high risk seismic zone-IV of Indian standard seismic zoning map of the country. No claim regarding bad climatic condition shall be entertained during the course of contract.

3.0 **CONTRACTOR'S UNDERSTANDING**

The contractor shall be deemed to have satisfied himself, before tendering, as to the correctness and sufficiency of his tender for the works and of the rates and prices stated in the Bill of Quantities, all of which shall except in so far as it is otherwise provided in the contract, covers all his obligations under the Contract and all matters and things necessary for the proper execution, completion and maintenance of works.

4.0 **PERFORMANCE SECURITY & RETENTION MONEY:**

4.1 **PERFORMANCE SECURITY**

- i) The successful bidder shall submit a Performance Guarantee (P.G.) in the form of irrevocable bank guarantee on the Performa annexed as Annexure-XI of SCC from any Scheduled Bank for an amount of 3% (Three percent) of the contract value. This PG shall be initially valid up to 60 days beyond the stipulated date of completion. In case, the time for completion shall get extended, the contractor shall get the validity of P.G extended to cover such extended time for completion of work plus 60 days. The value of P.G. to be submitted by the contractor will not change for variation up to 25% (either increase or

decrease). In case during the course of execution, value of contract increases by more than 25% of the original contract value, an additional Performance Guarantee amounting to 3% (Three percent) for the excess value over the original contract value should be deposited by the contractor. On the other hand, if the value of the contract is reduced by more than 25% of the original contract value, original performance Bank Guarantee (PBG) shall be returned to the contractor as per his request after submission of PBG amounting to 3% of the reduced contract value.

- ii) The Successful bidder shall have to submit a Performance Guarantee (PG) within 21 (twenty one) days from the date of issue of Letter of Acceptance (LOA), but before signing of the contract agreement. Extension of time for submission of PG beyond 21 (twenty-one) days and up to 60 days from the date of issue of LOA may be given by the Authority who is competent to sign the contract agreement. However, a penal interest of 12% per annum shall be charged for the delay beyond 21 (twenty one) days, i.e. from 22nd day after the date of issue of LOA. Further, if the 60th day happens to be declared holiday in the concerned office, submission of PG can be accepted on the next working day.

In all other cases, if the Contractor fails to submit the requisite PG even after 60 days from the date of issue of LOA, the Contractor is liable to be terminated. In case a contract is terminated Employer shall be entitled to ban the contractor for participating in the tenders for 2 years and forfeit other dues payable against that contract.

- iii) No payment under the contract shall be made to the contractor before receipt of performance security.

4.2 RELEASE OF PERFORMANCE SECURITY:

- a. Performance Security shall be returned to the Contractor, subject to the issue of Completion Certificate by the Engineer in accordance with contract conditions. This shall not relieve the Contractor from his obligations and liabilities, to make good any failures, defects, imperfections, shrinkages, or faults that may be detected during the defect liability period specified in the Contract.
- b. Wherever the contract is rescinded, the security deposit shall be forfeited and the Performance Security shall be cashed and the balance work shall be got done independently without risk and cost of the failed contractor. The failed contractor shall be debarred from participating in the tender for executing the balance work.

If the failed contractor is a JV or partnership firm, then every member/partner of such a firm shall be debarred from participating in the tender for the balance work either in his/her individual capacity or as a partner of any other Partnership firm.

- c. The Engineer shall not make a claim under the Performance Guarantee (P.G.) except for amounts to which Ircon International Limited is entitled under the contract (not withstanding and/or without prejudice to any other provisions in the contract agreement) in the event of: -
- i) Failure by the contractor to extend the validity of the P.G. as described herein above, in which event the Engineer may claim the full amount of the P.G.

- ii) Failure by the contractor to pay Ircon International Limited any amount due, either as agreed by the contractor or determined under any of the Clauses/Conditions of the agreement, within 30 days of the service of notice to this effect by Engineer.
- iii) The contract being determined or rescinded under provision of the General Conditions of Contract (GCC) the P.G. shall be forfeited in full and shall be absolutely at the disposal of the Engineer.

4.3 RETENTION MONEY

- i) Retention money for all contracts shall be recovered from on account/ final bills of the Contractor @ 10% of gross value of each bill upto 5% of the contract value of the work. The entire Retention Money may be deposited in the form of irrevocable Bank Guarantee issued by any scheduled Bank also in the Contract valuing more the Rs. 10 Crore after signing of the Contract Agreement, but before payment of 1st on account bill. Provided that validity of the B.G. shall be extended from time to time depending upon extension of the contract.
- ii) No interest shall be payable to the Contractor on the amount retained in cash towards retention money.

4.4 RELEASE OF RETENTION MONEY:

- i) The Retention Money shall be released to the Contractor after preparation of final bill and acceptance of the same by the Contractor and after the expiry of the defect liability period specified in the Contract, reckoned from the date on which the Engineer shall have issued the Certificate of Completion comprising the whole of works. The retention money shall be released after all failures, defects, imperfections, shrinkages and faults have been rectified by the Contractor to the satisfaction of the Engineer and Defect Liability certificate is issued by the Engineer.
- ii) **Release of 50% Retention Money against Bank Guarantee/FDR:**
 - (a) **For Contracts valuing Rs.30 Crores or more:** If requested by the contractor, 50% of the Retention Money may be released at a stage when full amount of retention money (as if 5% of the contract value) has been recovered at the stage when not less than 50% financial progress has been achieved against submission of Bank Guarantee for an equivalent amount by the contractor in the Performa annexed as **Annexure- XIII** from any schedule Bank in India. This Bank Guarantee shall be kept valid till the period of three months beyond the expiry of Defect Liability Period.
 - iii) Where different defect liability periods are applicable to different parts of the works, the expression - "expiration of the defect liability period" shall for the purpose of this clause be deemed to mean the expiry of last of such periods.

5.0 INSURANCE

Before commencing of works, it shall be obligatory for the Contractor to obtain, at his own cost, insurance cover in the joint name of the Contractor and Employer from reputed companies for the following requirements:

- a) Contractor's All Risk (CAR) Policy, which will cover the third party damages if any (to the houses/structure in vicinity of the site) and the compensation if any to the residence/local bodies shall be paid under CAR policies.

- b) Liability for death of or injury to any person or loss of or damage to any property (other than the work) arising out the performance of the Contract.
- c) Construction Plant, Machinery and Equipment brought to site by the Contractor.
- d) Workmen Compensation Policy.
- e) Contractor should suitably ensure to cover the executed works under appropriate insurance against natural and un-natural calamities.
- f) Any other insurance cover as may be required by the law of the land.

All insurance policies entered into by the contractor under the contract, shall stipulate that the proceeds of all claims shall be payable to the Engineer (IRCON International Ltd.) The Engineer shall reimburse such claims to the contractor when the contractual obligations are completed by him.

All insurance covers referred to in the Contract shall be effected with an Indian Insurance Company incorporated and registered in India.

The Contractor shall provide evidence to the Employer/Engineer before commencement of work at site that the insurance covers required under the contract have been effected and shall within 60 days of the commencement date, provide the insurance policies to the Employer/Engineer. The Contractor shall, whenever, called upon, produce to the Engineer or his representative the evidence of payment of premiums paid by him to ensure that the policies indeed continue to be in force.

The Contractor shall also obtain any additional insurance cover as per the requirements of the Contract.

The Employer/Engineer shall not be liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the Contractor or his sub-contractor or petty contractor. The Contractor shall indemnify and keep indemnified the Employer/Engineer against all such damages and compensation for which the Contractor is liable.

The Insurance Policies of the Contractor shall remain in force throughout the period of execution of the works and till the expiry of the defect liability period except for any specific insurance covers necessary for shorter period.

If the Contractor fails to effect or keep in force or provide adequate cover as acceptable to the Engineer in the insurance policies mentioned above, then in such cases, the Engineer may effect and keep in force any such insurance or further insurance on behalf of the Contractor.

The recovery shall be made at the rate of 1.5 times the premium/premiums paid by the Engineer in this regard from the payment due to the Contractor or from the Contractor's Performance Security. However, the Contractor shall not be absolved from his responsibility and/or liability in this regard.

6.0 COMMUNICATION BETWEEN EMPLOYER/ENGINEER AND CONTRACTOR

6.1 Instructions in Writing: Instructions given by the Engineer shall be in writing, provided that if for any reason the Engineer considers it necessary to give any instructions orally, the contractor shall comply with such instructions. Confirmations in writing of such oral instructions given by the Engineer, whether before or after carrying out of the instructions

shall be deemed to be instructions within the meaning of these sub-clause. The contractor shall also be bound to carry out any instructions issued by client as confirmed in writing by the Engineer.

Communication to be in writing, all notices, communications, references and complaints by either party to the Contract shall be in writing in English or Hindi. Communication from only authorized representative of the Contractor shall be entertained.

- 6.2** All certificates, notices, written orders or letters, to be given by the Employer or the Engineer to the Contractor, shall be deemed to have been served, if the same are delivered to the Contractor or his authorized representative, or delivered or left at or posted by speed post/registered post to the given address of the Contractor or Contractor's registered office or principal place of business and essentially delivering the same by e-mail to the Engineer duly attached with scanned copy of such certificates, notices, written orders or letters and Proof of Dispatch (POD) with a copy to Employer on nominated e-mail address. Such documents shall be deemed to have been received on the day they are left or delivered, or in the case of postal transmission, on the day they would ordinarily have reached but not exceeding 7 days from the date of posting inclusive of day of posting, in any case. The contractor shall furnish the postal address/registered office address and e-mail address for communication.
- 6.3 Notices or letters to Employer and Engineer:** All notices or letters to be given by the contractor to the Employer or to the Engineer, under the terms of the contract, shall be served by sending by Speed/Registered post or by delivering the same, to the respective nominated addresses and essentially delivering the same by e-mail to the Engineer duly attached with scanned copy of such notice(s) or letters and Proof of Dispatch (POD) with a copy to Employer on nominated e-mail address.
- 6.4** Subject as otherwise provided in this contract all notices to be given on behalf of IRCON and other actions to be taken on its behalf may be given or taken by the Engineer or any officer for the time being entrusted with the functions, duties and powers of the Engineer.
- 6.5** The Contractor or his representative shall be in attendance at the Site(s) during all working hours and shall superintend the execution of the works with such additional assistance in each trade as the Engineer may consider necessary.
- 6.6** Orders given to the Contractor's representative shall be considered to have the same force as if they had been given to the Contractor himself.
- 6.7** Site inspection register will be maintained by the Engineer or his representative in whom the Contractor or his agent will be bound to sign day to day entries made by the Engineer or his representative. The Contractor is required to take note of the instruction given to him in site inspection register and should comply within a reasonable time. The Contractor will also arrange to receive all the letters/Field Note etc. issued to him at the site of work.
- 6.8 Change of Address:** Either party may change the nominated address by prior written notice to the other party. However, either party shall not change their email address during currency of the contract without obtaining prior mutual consent for doing so.
- 6.9 Change in Constitution of Firm:** In case of any change in the constitution of Contractor's firm, the same shall forthwith be notified by the Contractor to the Engineer and the Employer.
- 7.0 DUTIES OF ENGINEER AND ENGINEER'S REPRESENTATIVE**
- 7.1 Duties and Authority of Engineer:** The Engineer shall carryout the duties specified or implied in the Contract including issue of instructions, decisions, certificates and orders,

as are specified in the contract, or necessary for the observance/administration of the Contract and expeditious and timely completion of the work.

7.2 Duties and authority of Engineer's Representative: The Engineer's Representative shall be responsible to the Engineer. His duties are to supervise the work and to test and any materials to be used or workmanship employed in connection with the works. He can issue day to day instructions to the Contractor in Site Order Book, which should be noted and complied by the Contractor. He shall have no authority to relieve the Contractor of any of his duties or obligations under the Contract, except as expressly provided hereunder or elsewhere in the Contract, to order any work involving delay or any extra payment by the Employer, nor to make any variation of or in the works. He is authorized to measure the works for the purpose of payment.

8.0 GENERAL OBLIGATIONS OF THE CONTRACTOR

8.1 General Responsibility of the Contractor: The Contractor shall comply with the provisions of the Contract with due care and diligence design (to the extent provided for in the Contract), execute, complete and maintain the works and remedy the defects in accordance with the provisions of the Contract. The Contractor shall provide all superintendence, labour, materials, plant, & Equipment and all other things, whether of a temporary or permanent nature, required in and for such design, execution, completion and maintenance of works and rectification of any defects, as directed by the Engineer or his Representative.

8.2 Site Operations and Methods of Construction: The Contractor shall take full responsibility for the adequacy, stability and safety of all site operations and method of construction, provided that the Contractor shall not be responsible for the design and specifications of Permanent works or for the design or specifications of any temporary works provided by the Engineer. Where the Contract expressly provides that part of the Permanent Works shall be designed by the Contractor, he shall be fully responsible for that part of such works, notwithstanding any approval by the Engineer.

8.3 Appraisal of Errors / Omissions in the Drawings: The Contractor shall promptly inform in writing to the Engineer of any error, omission, fault and other defects, in the design, drawings or specifications for the works which are noticed while reviewing the Contract documents or in the process of execution of the works.

8.4 Compliance with Regulations and Bye-laws: The Contractor shall comply with the statutory provisions relating to the works, regulations and by-laws of any local authority and undertaking, including those controlling the utilities such as water supply, sewerage, telephones, power supply, etc., in whose jurisdiction the work is to be executed. The Contractor shall be bound to give all notices required by statute, regulations or bye-laws, as aforesaid. It shall be responsibility of the Contractor to arrange all necessary clearances and approvals from the concerned authorities or undertakings before the work is taken up. However, assistance, if any, may be provided by Employer/Engineer/Client.

8.5 Contract Agreement: The Contractor shall enter into and execute the Contract Agreement in the form of agreement (**Annexure-I**) within 21days after the date of issue of Letter of Acceptance. The stamp papers of the requisite value as per the prevailing

laws shall be provided by the Contractor at his own cost. Original agreement shall be retained by the Employer/Engineer and a certified copy shall be made available to the Contractor.

8.6 Contractor's Representative: When the Contractor is not in a position to be present, he shall keep responsible representative at site or work place during all working hours, who shall, on receiving a reasonable notice, present himself to the Engineer, Engineer's Representative or their Assistants. The instructions and orders given to the Contractor's representative shall be deemed to have the same force as if they have been given to the Contractor. The Contractor should furnish the necessary Power of Attorney in favour of his representative for the purpose of this clause. Further failure on part of the Contractor to comply with this provision shall constitute a breach of Contract and may lead to action as per contract conditions.

9.0 SUB-CONTRACTING:

9.1 The prior consent of IRCON shall be obtained for any major Sub-Contractors;

- i. The Contractor shall not subcontract the whole of the works. Except where otherwise provided in the Contract, the Contractor shall not subcontract any part of the works without the prior consent of the Engineer in writing. Any such consent shall not relieve the Contractor from any of his liability or obligation under the Contract and he shall be responsible for the acts, defaults and neglects of any subcontractor, his representative, servants or workmen as fully as if they were the acts, defaults or neglects of the Contractor.
- ii. Provided that the Contractor shall not be required to obtain such consent for:
 - a) The provision of labour, or
 - b) The purchase of materials which are in accordance with the specifications/standards specified in the Contract, or
 - c) The subcontracting of any part of the works for which the subcontractor is named in the contract.
 - d) The purchase of Plants and Equipment for execution of the works.
 - e) The hiring of Plants and Equipment for execution of the works.

Any breach of the above conditions shall entitle the Employer/Engineer to rescind the contract.

- f) Provided always that execution of specific works by petty contractors, or on piecework basis, under the personal supervision of the Contractor, shall not be deemed to be subcontracting under this clause.

10.0 MINIMUM LIST OF KEY PERSONNEL:

10.1 A list of Minimum Key Personnel/ Engineer having experience in Earth work in cutting in Hilly terrain, Construction of RE Wall, protection works required for completion of work should be submitted along with tender document.

10.2 A list of Minimum Key Personnel/ Engineer having relevant experience required for completion of the work within the time frame is given hereunder. Bidders are free to evaluate and work out the additional requirement at their own.

Appendix-III- List of Minimum Key Personnel/Engineers Having Bridge Execution

Experience Required.

Sl.No	Designation		Qualification	Professional Experience in Relevant Field
1	Project Manager	1	Graduate Civil Engineer	15 years professional experience in bridge construction. Project Manager for at least 1 major bridge construction project. The Project Manager shall attend monthly progress review meetings, shall be empowered by the Contractor to handle all financial issues.
	Name 1:			CV 1 at Page no.:
2	Construction/Bridge/Structural Engineer	2	Graduate Civil Engineer	12 years of professional experience. At least 10 years professional experience as a bridge engineer.
	Name 1:			CV 1 at Page no.:
3	Fabrication Engineer	1	Graduate Civil/Mechanical/Structural Engineer	12 years of professional experience. At least 10 years professional experience as a bridge engineer.
	Name 1:			CV 1 at Page no.:
4	QSS Engineer	1	Graduate Civil Engineer	10 years of professional experience as a quantity surveyor for major bridge projects.
	Name 1:			CV 1 at Page no.:
5	Quality Engineer	1	Graduate Civil Engineer	10 years total professional experience. At least 8 years of professional experience as a Quality Engineer.
	Name 1:			CV 1 at Page no.:
6	HSE Engineer	1	Graduate in HSE Engineer	10 years of professional experience on major construction projects. At least 5 years as a safety manager for bridge/flyover/high rise building/ work on height / structural erection projects.
	Name 1:			CV 1 at Page no.:

7	Sr. Site Engineer	2	Graduate Civil Engineer	8 years of professional experience in construction of bridges. At least 5 years' experience in Truss Girder Bridge Bridge.
	Name 1:			CV 1 at Page no.:
8	Site Engineer	4	Graduate Civil Engineer	At least 5 years professional experience in Bridge/Flyover project & earthwork including RE Work.
	Name 1:			CV1 at Page no.:
	Name 2:			CV2 at Page no.:
9	Surveyor	1	Diploma in Civil / Surveying	10 years of professional experience for surveying of hilly region. Handling Experience of Total Station and DGPS is desirable.
	Name 1:			CV1 at Page no.:
10	Bridge Foreman	4	ITI/DCE	At least 6 to 8 years' experience in Bridge/Fly over construction and at least 4 years' experience of major bridge project applicable previous experience includes work as a foreman and machine operator. He shall have been involved construction of at least 30m of through type girder bridge work.
	Name 1:			CV1 at Page no.:
	Name 2:			CV2 at Page no.:

10.3 EMPLOYMENT OF QUALIFIED ENGINEERS

The Contractor shall employ sufficient number of technical staff who shall be qualified Graduate Engineers and Diploma holders as required for setting out alignment, taking the established bench marks and the cross-section levels plotting the cross-section levels, computation of quantities, taking measurements, preparation of bills and also for efficient supervision of various works at different work spots. The list of names, qualification and experience of these personnel should be furnished along with the tender documents as per **FORMAT –3** to Instructions to Tenderers. The Contractor should also submit a list of names of graduate Engineers and diploma holders with their bio-data to IRCON within 15 days from the date of issue of letter of acceptance for approval by the Engineer. Any further changes should be advised and got approved and enforced without any extra cost.

The Contractor's technical staff should be available at site to take instructions from the Engineer. In case the Contractor fails to employ sufficient number of qualified technical staff, IRCON reserves its right to take necessary action under provisions of the General Conditions of Contract.

10.4 DEDUCTION OF PAYMENT ON ACCOUNT OF NON-DEPLOYMENT OF KEY PERSONNELS:

- a) The Key personnel will be those for which the CV's have been approved by Engineer –in charge indicated above and at Format 3 to Instructions to Tenderers.
- b) The effective date of recovery will be 28 days of issue of Letter of Acceptance.
- c) Absence for more than 15 days in a month will be considered as equivalent to non deployment of manpower.
- d) This deduction will be independent from the other deductions applicable as per contract.
- e) The maximum limit of deduction on account of non-deployment of Key Personnel's will be 1% of Original Contract Value.
- f) The certification of Engineer-in-charge for non-deployment of Key personnel will be sufficient ground for effecting deduction from each on account bill.
- g) The rate of recovery per month for non-deployment of Key personal will be as under: under:

Position	Unit	Nos.	Deduction per Month Per Person (in INR)
Project Manager	No	1	1,50,000.00
Construction/Bridge/ Structural Engineer	No	2	1,00,000.00
Fabrication Engineer	No	1	50,000.00
QSS Engineer	No	1	35,000.00
HSE Engineer	No	1	35,000.00
Quality Engineer	No	1	1,00,000.00
Safety Engineer	No	1	50,000.00
Sr. Site Engineer	No	3	35,000.00
Site Engineer	No	2	50,000.00
Surveyor	No	1	50,000.00
Bridge Foreman	No	4	35,000.00

Appendix – IV A – List of Plant & Machinery

Details of Plant and Machinery already available with the firm and proposed to be deployed on the project-

S. No.	Type & Make of Plant / Equipment	Number	Age of plant & machinery	Capacity of plant & machinery	Work on which it is being used	Date by which machinery / equipment will be spared for use on this work	Mode of Mobilization
1							
2							

The firms are required to give the Mode of Mobilization for each Plant & Equipment as under

- i) Plant & Equipment already owned by the firm (supported by documental evidence)
- ii) Plant & Equipment to be purchased by the firm
- iii) Plant & Equipment to be arranged from other sources by the firm

11.0 PROGRAMME OF WORK

11.1 Programme of execution of works shall be submitted by the Tenderer/s along with the technical bid in line with the mile Stone mentioned hereunder:

Key Dates for Contract:

Activity ID	Stage	Calendar Days	Remarks
LOA	Letter of Acceptance	D	D = Date of issue of LOA
Mile Stone 01	Mobilization of manpower & machinery and start of excavation	D+30	
Mile Stone 02	Submission of detail design, drawing and construction Methodology and its proof check & approval for RE wall.	D+60	
Mile Stone 03	Completion of 50% of BOQ Qty for excavation.	D+360	
Mile Stone 04	Completion of 50% of BOQ Qty for RE wall	D+360	
Mile Stone 05	Completion of all works and handing over.	Contractual Date of Completion	

11.2 The Contractor shall submit the programme in line with Key dates as above for completion of work to the Engineer for his approval within 15 days from the date of receipt of letter of acceptance considering completion period as indicated in appendix to tender. The contractor can elaborate the working program anticipating the start / end of the mentioned activities according to its need regarding the interaction of said activities Unless otherwise directed, the programme shall be in the form of Bar-Chart showing proposed execution of quantities of principal items of work. The programme shall be related to the capability of equipment proposed to be deployed and site conditions. **Programme so submitted and agreed by IRCON will become part of the contract agreement.** The Contractor shall also provide in writing methodology for execution of major items of work as desired by the Engineer. The submission and approval of such programme shall not absolve the Contractor of any of his duties or responsibilities or obligations under the contract. The Engineer shall have full power and authority during the progress of work, to issue such instructions as may be necessary for the proper and adequate execution of the work.

11.2 **Key Date & Mile Stones:** Within 07 days of award of contract, the Contractor shall submit to IRCON for approval a Detailed Supply/Completion Programme with Milestones/Key dates based on completion period as indicated in Appendix to Tender. These shall be incorporated in the Contract Agreement after approval by Engineer in charge.

The contractor is expected to achieve the subsequent Mile Stone by enhancing the rate of progress and shall put all his effort to make up the delay in so that the entire work is completed within the stipulated time of the contract. In case the work not completes, after Date of completion of contract, Liquidated Damages shall be imposed on the Contractor in terms of Indian Railway General Conditions of Contract July 2020.

- 11.3 **Deployment of resources:** Within 15 days of award of contract, the contractor shall also submit resource deployment program i.e. key personnel, manpower, Plant & Machinery and Other resources deployment program. These shall be to be incorporated in the Contract Agreement after approval by Engineer in charge
- 11.4 Within 15 days of award of contract, the contractor shall also submit Cash flow statement and cumulative monthly progress plan (in the form of S curve). These shall be to be incorporated in the Contract Agreement after approval by Engineer in charge.
- 11.5 Within 18 days of award of contract, the Contractor shall submit to IRCON Method statement for various activities and Quality Assurance Plan (QAP) and start the work after their approval.
- 11.6 Within 15 days of the award of the contract, the contractor shall submit to IRCON, Organization chart of the project with the CV of the key personnel's (Appendix-III of ITT) to be deployed at the project site. The scrutiny of the same will be done by the IRCON and will be approved by the Engineer.
- 11.7 Within 21 days the contractor should start the work and complete the work in all respect within agreed time schedule as approved by IRCON.
- 11.8 Within a period of 60 days, from the date of issue of LOA or the start of construction activity at site (whichever is earlier), the contractor shall provide & maintain for duration of the project a web based PMIS (PROJECT MANAGEMENT INFORMATION SYSTEM) application with integrated GIS, with central server specially for the project (Contractor shall host PMIS in a Tier Three Level Data Centre anywhere in India) and provide online access to IRCON officials to monitor the progress. The contractor will prepare the baseline program in direct relation to the time of completion and ensure weekly updating of progress by their staff. The contractor will also develop different dashboards for monitoring at three different levels, i.e. at Project Level, At Co-ordinating office level and at Corporate office, i.e. Director's level. The format of the dashboard is to be developed in consultation with Engineer-in-charge. The contractor shall provide necessary terminal licences of the software deployed for project management (5 nos) for monitoring by IRCON. The contractor shall also carry out necessary changes to the work program as per directions of IRCON.

The PMIS application shall provide web-based input of Activity Data, Tunnel/Flyover Attribute Data and automatically create reports for Progress and Cost monitoring in comparison with Schedule & Budget. PMIS Mobile Application with GIS and photo application for Android shall also be provided. The system should have the facility to send progress via phone messages and emails. PMIS shall also include Drawing & Document management system; on which contractor shall upload all important documents and drawings. The contractor shall provide three personnel at Main Project office to do Project management data update and also uploading of Documents and Drawings for the duration of the project till final handing over. On successful handing over of project the PMIS system including Hardware and Software and all data shall be handed over to IRCON for subsequent access of data. The cost of setting up the system shall be included in the quoted rates for the work and nothing extra shall be payable.

12.0 CONTRACT AGREEMENT:

The Contractor shall enter into and execute the Contract Agreement in the form of agreement (Annexure–X) within 28 days after the date of issue of Letter of Acceptance. The stamp papers of the requisite value as per the prevailing laws shall be provided by the Contractor at his own cost. Original Agreement shall be retained by the Employer/Engineer and a certified copy shall be made available to the Contractor.

13.0 COMMENCEMENT OF WORK:

13.1 The Contractor shall commence the works within time limit as specified in the Letter of Acceptance.

13.2 Handing Over of the Site/Start of Work:

The site shall be made available by the Engineer gradually and progressively in parts. No claim whatsoever for not giving the site on award of works and for giving the site in parts by parts shall be tenable except for the purpose of extension of time, wherever, justified. Site for execution of works shall be made available as soon as the work is awarded. In case, it is not possible for the Engineer to make the entire site available due to any reason, the land shall be made available by the Engineer gradually and progressively in parts. The Contractor shall have to adjust his work program accordingly. No claim whatsoever for not giving the site on award of works and for giving the site in parts shall be tenable except for the purpose of extension of time, where justified.

For some stretch land may not be available or acquired by IRCON/Railway. The land will be made available to contractor on proportion at as is depending upon the progress of contractor on the stretch, wherever land has been made available for the work.

13.3 Handing over of Drawing:

The drawing shall be made available by the Engineer gradually and progressively. No claim whatsoever for not giving the complete drawing on award of works and for giving the drawing progressively shall be tenable except for the purpose of extension of time, wherever, justified. Drawings for execution of works shall be made available as soon as the work is awarded. In case, it is not possible for the Engineer to make the entire drawings available due to any reason, the drawing shall be made available by the Engineer gradually and progressively. The Contractor shall have to adjust his work program accordingly. No claim whatsoever for not giving the complete drawing on award of works and for giving the drawing progressively shall be tenable except for the purpose of extension of time, where justified.

It should be specifically noted that some of the detailed drawings may not have been finalized by the IRCON/Railway and will, therefore, be supplied to the contractor as and when they are finalized on demand. No compensation whatsoever on this account shall be payable by the Railway/IRCON Administration.

No claim whatsoever will be entertained by the IRCON/Railway on account of any delay or hold up of the works(s) arising out of Delay in approval of drawings, changes, modification, alteration, additions, omission and site layout plan or detailed drawings and design and or late supply of such materials as are required to be arranged by the Railway/IRCON or due to any other factor on IRCON/Railway account.

13.4 Photo Record of Construction Work:

13.4.1 The contractor is required to take pre-condition survey of the existing conditions of buildings, Nallahs and Roads by means of photos or videos prior to the starting of work.

The Contractor is required to take and supply to the Engineer colored photographs on construction activities. The digital photographs shall be taken by the Contractor of all the construction activities pertaining to the work at regular intervals as directed by the Engineer. All photos shall be provided to the Engineer in digital forms. Three sets 5" X 3" prints of each snap shall be supplied. The quantum shall involve a minimum of 20 snaps per month. Out of the above the Contractor shall be required to supply as directed by the Engineer, blow up size coloured prints of up to 36" X 24" size of 5 photographs per month. The soft copy of all the photographs taken shall also be supplied to the Engineer. The Contractor shall show extreme promptness in taking and supplying the photographs on the action of the Engineer.

- 13.4.2 The Contractor shall keep a record of the construction activities on the site(s) by having DVD/VCD. This shall be having script approved by the IRCON and shall have suitable editing, background music and with special effects so as to have a final 45 minutes to 60 minutes (or as directed by the Engineer) version of the CD giving the details of the construction activities right from the beginning to the end for construction site. IRCON shall be supplied the master copy of the above documentary.
- 13.4.3 All the cost of reels & CD, taking and recording, developing and printing extra shall be deemed to have been included in rates quoted against various items and nothing extra shall be paid for the item of work under this Clause as above.
- 13.4.4 IRCON shall have full ownership and copyright of all the photographs, Video, CD and the Contractor shall indemnify IRCON against any claim of any sort

14.0 ACCESS TO SITE OF WORK

14.1 Access to Engineer

The Engineer or the Engineers Representative, shall at all times have access to the works and all workshops and places, where work is being performed and from where materials, manufactured articles or Machineries are being obtained for the works and the Contractor shall afford every facility and every assistance in obtaining the right to such access.

14.2 Access Road

The Contractor shall provide necessary access roads to the site of work, from the nearest public thoroughfare/right of way , at his own cost, unless otherwise provided for in the contract

14.3 MAINTENANCE OF APPROACH ROADS

- 14.3.1 Maintenance of approach roads for work access site during the construction shall be the responsibility of the contractor.
- 14.3.2 Contractor should maintain the existing approach roads as above, including pot holes filling, regularly grading with grader in required profile, watering, rolling, compacting, maintaining the grade and profile of the roads with contractor's labour, tools, plants, material, all lead and lift, loading, unloading, transportation of materials, complete as per directions of Engineer-in-charge for smooth movement of Inspection vehicles and also construction equipment & heavily loaded trucks and trailers carrying equipment and materials.

- 14.3.3 Regular sprinkling of water by mechanical means to ensure dust free, movement of vehicles to meet the requirement of safety & environmental norms of IRCON shall be the responsibility of Contractor.
- 14.3.4 Maintenance and cleaning of road side existings drains is also covered in the scope of the Executive Agency/Contractor at their own cost.
- 14.3.5 If any utilities (water line, HT line, fiber optic cable etc) near to the project area are required to be relocated for construction of road (other than approach road), establishment etc. The responsibility of same lies with contractor at his own cost.
- 14.3.6 Vehicle movement of the contractor may be restricted on NH-31A/ NH10 as per local authority. Contractor shall conduct traffic survey on NH-31A/ NH10 and hence should plan their maximum movements during minimum traffic time period of the day. Contractor shall submit the NH-31A/ NH10 utilization plan before starting the works.

15.0 SETTING OUT

The Contractor shall be responsible for the true and proper setting out of the works using his own survey instruments, appliances and labour. If at any time during the progress of works, any error appears or arises in any part of the work, the contractor on being required to do so by the engineer, shall at once rectify such error, to the satisfaction of the Engineer. The Contractor shall also provide all necessary assistance in the form of labour and materials to Engineer or his representatives for checking the set out with his own instruments. The checking of any setting out, or of any line or level by the Engineer's representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof. The contractor shall carefully protect and preserve all bench marks, reference pillars, pegs, and other things used in setting out the works.

16.0 TEMPORARY WORKS

- i. All temporary works necessary for the proper execution of the works shall be provided and maintained by the Contractor at his own cost. All detailed working drawings, design, design calculations and fabrication drawings for important temporary works as decided by the Engineer, shall be prepared by the Contractor at his own cost and forwarded to the Engineer at least 30 days in advance of actual constructional requirements for his approval. Such approval shall not, however, relieve the Contractor of any of his responsibility in connection with the temporary works.
- ii. When the temporary works are no longer required, the Contractor shall remove the same at his own cost. In the event of failure on the part of the Contractor to remove the temporary works, the engineer will cause them to be removed and cost incurred for removal, supervision, and other incidental charges shall be recovered from Contractor.

17.0 SPECIFICATION AND DRAWINGS

17.1 The Contractor Shall keep at site in good condition one copy of latest approved Specifications and Drawings and also such other Contract documents as may be necessary and make them available to the Client/employer/Engineer or his Representative at all reasonable times. Any specifications & drawing shall not be used on any other work or communicated to a third party by the Contractor.

17.2 **Adherence to Specifications and Drawings:** The work shall be executed in perfect conformity with the specifications and drawings of the Contract issued to the Contractor by the engineer from time to time. If the Contractor does any work or part of work in a

manner contrary to the specifications or drawings without the approval of the Engineer, he shall bear all the costs arising there from including dismantling and reconstructions and drawings and shall be responsible for all the losses/delays to the Employer/engineer. The term drawings in this sub-clause also includes the drawings prepared by the Contractor and approved by the Engineer.

17.3 Meaning & Intent of Specifications and Drawings: If any ambiguity arises as to the meaning and intent of any portion of the specifications and drawings or as to execution or quality of any work or material or as to the measurement of the works, the decision of the Engineer thereon shall be final and binding.

18.0 INDEMNITY BY THE CONTRACTOR

18.1 Indemnity against all actions of Contractor: The Contractor shall hold and save harmless and indemnify the client/Employer/Engineer and their Employees, from all actions, suites, proceeding loss Costs, damages, charges, claims and demands of every nature and description brought against or recovered from the client/employer/engineer and their employees by reason of any act or omission of contractor and /or his representative and/or his Employees and /or his subcontractor in the execution of the works or in the guarding of the same. All the sums payable by clients/employer/engineer by way of compensation under any of this conditions, shall be recovered from the dues of the contractor, without reference to the actual loss or damage sustained, and whether or not any damage shall have been sustained.

18.2 Indemnity against all claims of patent rights and Royalties: The Contractor shall hold and save harmless and indemnify the Client/Employer/Engineer, his Officers and Employees from and against all claims and proceedings for or on account of infringement by the contractor of copy right, any patent rights, design, trademark or name, secret process, patented or unpatented invention, articles or appliances manufactured or used for or in connection with the works and fro and against all claims, proceedings cost, damages charges and expenses whatsoever in respect thereof or in relation thereto. The contractor shall pay all Royalties, Taxes, rent and other payments or compensation, if any, forgetting the materials required for the works and due fulfilment of the contract and indemnify client /employer/engineer against any claims in this regard.

18.3 Indemnity Bond for performance of Reinforced Soil Wall

The Contractor shall effect and maintain professional indemnity insurance for the amount in INR equal to the contract cost of design and construction of Reinforced Soil Wall based on format approved by IRCON. The Contractor shall provide the evidence of coverage of the professional indemnity insurance before any payment is released. The insurance which shall ensure the contractors liability by reasons of professional negligence and errors in the design shall be valid from the date of commencement of works till 15 years after the defect liability period . The indemnity shall be in favour of IRCON.

19.0 DAMAGE TO LIFE AND PROPERTY

The contractor shall be responsible for all risk to works, nearby existing structures and life of his supervisors and workmen has also those of Employer/Client or any

trespassers from whatever cause in connection with works until these areas taken over by Client/Employer/Engineer. The Contractor shall make good at his own expenses all loss or damages to life and property.

20.0 SAFETY OF PUBLIC AND PUBLIC UTILITIES

- i. Existing road or water course or any other utility shall not be blocked, cut through, altered, diverted or obstructed in any way by the contractor, except with the permission of the Engineer. All compensation claimed by any Department/Organization for any unauthorized closure, cutting through, alteration, diversion or obstruction to such roads or water courses by the Contractor or his staff shall be recovered from any moneys due to the Contractor.
- ii. During progress of work in any street or thoroughfare, the Contractor shall make adequate provision for the passage of traffic, for securing safe access to all premises approach from such street or thoroughfare and for any damage. Water supply, sewer lines, electrical line and telecommunication cables/wires etc. which may be interrupted by reason of execution of works shall be protected/diverted and maintained by the contractor at his own cost. Barriers, lights and other safe guards as prescribed by the engineer for the regulation of the traffic including watchmen necessary to prevent accidents shall be provided by the Contractor at his own cost.
- iii. The Contractor shall be responsible for taking all precautions to insure safety of the public utilities and public in the vicinity of works and shall post such watchmen at his own cost as may, in the opinion of the engineer, be necessary to comply with the regulations applied to the work and to ensure safety.
- iv. Should the Contractor fail to implement the provisions as required in the above sub-clauses, the engineer may provide necessary arrangements and the cost of the same shall be recovered from the Contractor's payment/dues.

21.0 OTHER SAFETY PROVISIONS

- 21.1 Safety of labour and others:** The Contractor shall, at his own expenses, arrange for the safety provisions as required by any law in force, in respect of the labour employed directly or indirectly for performance of the works, and shall provide all facilities in connection therewith.
- 21.2 Safety of works:** The Contractor shall provide and maintain at his own cost, all lights, guards, signage, signalmen, fencing and watching arrangements when and where necessary, or as required by the Engineer for the protection of the works or for safety and convenience of those employed on works or of the public.
- 21.3** Mere observance of these precautions shall not absolve the contractor of his liability in case of loss or damage to the property, or injury to or death of any Employee/labour of contractor /client or Employer/ Engineer or any member of the public.
- 21.4 Recovery of the cost from the contractor:** Should the contractor fail to implement the provisions as required in the preceding sub- clauses 21.1 and 21.2, the engineer may provide necessary arrangements and the cost of the same shall be recovered from the contractors Payments /Dues.

22.0 PROTECTION OF ENVIRONMENT

During execution of works, the contractor and his sub-contractors, petty contractors shall abide at all times by all existing enactments on environmental protection and rules made thereunder, regulations, notifications and bye-laws of the state or central

Government or local authorities and any other law, bye-law, regulation that may be issued in this respect in further by the state or central government or local authority. Salient features of some laws that applicable are given below:

- i. **The Water (Prevention and control of pollution) Act 1974:** This provides for the prevention and control of water pollution and maintaining and restoring of all wholesomeness of water. Pollution means such contamination of water or such alteration of the physical, Chemical or Biological Properties of water or such discharge of any sewage or trade effluent or any other liquid, gases or solid substance into water (whether directly or indirectly) as may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agriculture or other legitimate uses, or to the life and health of animals or plants or of aquatic organisms.
- ii. **The Air (Prevention and Control of Pollution) Act 1981:** This provides for prevention, control and abatement of air pollution. "Air Pollution" means the present in the atmosphere of any "air pollutant", which means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.
- iii. **The Environment (Protection) Act, 1986:** This provides for the protection and improvement of environment and for the matters enacted therewith, and the prevention of hazards to human beings, other living creatures, plants and property. Environment includes water, air and land and the inter-relationship which exists among and between water, air and land, other living creatures, plants, micro-organism and property.
- iv. **Protection of Trees:** The Contractor must organize his work in such a way that the ecology of the area is not affected. The instructions issued in this regard will have to be carefully followed. The Contractor or his workers are prohibited to cut trees. Cutting of trees as required under the items of works indicated in the tender schedules may be carried out strictly as directed by the Engineer of the work. All necessary clearance from Central / State Government for cutting of trees will be obtained Railway/IRCON. Contractor will render assistance to Railway/IRCON in obtaining forest clearances for which no extra payment will be paid. The contractor shall store/stack so cut trees in railway/forest/IRCON store as directed by Engineer. Unauthorized cutting/felling of trees will result in legal action for which Contractor shall be responsible.
- v. **The Public Liability Insurance Act, 1991:** This provides for public liability insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling hazardous substances and for matters connected herewith or incidental thereto. Hazardous substance means any substance or preparation which is defined as hazardous substance under the environment (Protection) act, 1986, and exceeding such quantity as may be specified by notification by the Central Government.
- vi. The Contractor shall implement not only limited to the Environmental Management plan during entire period of construction to maintain Socio-economic environment/ Nature / ecology / landscape/Water Climate / air, soil, agriculture, forestry/Flora-Fauna etc as per the **Annexure C** in order to mitigate and prevention of offset impacts resulting from the Contractor's presence and activities relating to the project, contractor

23.0 CARE OF WORKS

From the commencement of the work until completion, acceptance and final takeover of the works by the Engineer, the Contractor shall take full responsibility for the care of all works including temporary works. In case any damage, loss or injury happens to the work or to any temporary works for any cause whatsoever, the contractor shall at his own cost repair and make good the same so that for completion and at the time of final takeover, the work shall be in good condition and in conformity in every respect with the requirements of the contract and the Engineers-instructions.

24.0 USE OF EXPLOSIVES

It is Contractor responsibility to obtain license, storage and safety procedures as per latest Explosive Rule if blasting required. Explosives shall not be used on the works or site by the Contractor without the written permission of the Engineer and only in the manner and to the extent such permission is given. When explosives are required for works they shall be stored in a special magazine, to be provided by the Contractor at his own cost, in accordance with the provisions of law on Explosives. The Contractor shall take all precautions in using the explosives and prevent damage to nearby properties and utilities. The Contractor shall also obtain necessary license for the storage and the use of explosives from the concerned authorities. All operations in which or for which explosives are used shall be at the risk and responsibility of the Contractor and the Contractor shall indemnify the Client /Employer/Engineer and their employees in respect thereof.

25.0 OCCUPATION AND USE OF LAND

No land belonging to or in the possession of the Client/Employer/Engineer shall be occupied by the Contractor without written permission or the Engineer. The Contractor Shall not use, or allow the site to be used for any purpose other than that of executing the work.

26.0 EXCAVATED MATERIAL

The Contractor shall not use, sell or otherwise dispose off, or remove, except for the purpose of his contract sand, clay, ballast, earth, stone, rock or any other substance or materials, which may be obtained from any excavation made. All such items shall be the property of the client. The Contractor may be permitted by the engineer to use the same or the purpose of works on mutually agreed payment terms.

27.0 RELICS AND TREASURES

All Gold, Silver, Coins, Oil and other minerals of any description, and precious stones of all kinds, treasures, antiques, fossils and other similar things, which shall be found in or at site, shall be the property of the client and the contractor shall duly preserve the same to the satisfaction of the engineer, and from time to time deliver the same to such person or persons, as the client / engineer may appoint to receive the same.

28.0 CO-OPERATION WITH OTHER CONTRACTORS

The Contractor shall in accordance with the requirements of the Engineer, cooperate with and afford all reasonable opportunities for carrying out the work by other Contractors engaged by the Client/Employer/Engineer or any other Authority.

29.0 WORK DURING NIGHT

Unless specifically provided elsewhere in the Contract, the Contractor shall not carry out any work between sunset and sunrise without the prior permission of the engineer. In case of any grave emergency or in order to avoid any risk to property and life or to prevent damage to utilities or to restore them, work may be done at night also without the prior permission of the Engineer, but intimation to this effect should be sent to him immediately. No increase in rates or extra payment shall be admissible for the night work. The Contractor shall make adequate lighting and safety arrangement for night working. He shall also be responsible for any claim on account of any injury to or loss of life, of anyone, arising out of inadequate lighting, safety arrangements, or due to any other failure of the Contractor.

30.0 SHEDS, STORES, YARDS

The Contractor shall at his own expense provide and maintain sheds, store-houses and yards at such locations and in such numbers as in the opinion of the engineer are necessary for carrying out the works. The Engineer and the Engineer's representatives shall have free access to the sheds, store-houses and yards at any time for the purpose of inspecting the stock of materials and plant so kept in hand. Any materials or plant which the engineer may object to shall not be brought upon or used in the works and shall forthwith be removed from the sheds, storehouses or yards by the Contractor.

31.0 SUPPLY OF MATERIALS BY IRCON

Contractor shall make his own arrangements at his cost for all materials required for execution, completion and maintenance of all items of work included in his scope of work to the complete satisfaction of the Engineer. Engineer shall not supply any materials nor shall assist for procurement of any materials required for execution, completion and maintenance of works.

32.0 SUPPLY OF TOOLS, PLANT AND EQUIPMENT

Except for any specific item mentioned in the contract, the Contractor shall have to make his own arrangements, at his own cost, Plant, Machinery and Equipment required for execution and completion of all works to the entire satisfaction of the Engineer. This shall also include all other associated equipment, tools/tackles, spare parts, POL, consumables, stores, manpower as required for the execution of works.

32.1 The quoted rates shall be deemed to be inclusive of all charges of such plant & machinery as well as manpower required to operate such plant and machinery.

32.2 If during the course of execution of works, it is found that the plant and equipment mobilized by the contractor are inadequate for the timely completion of works, the contractor shall undertake to augment the supply of plant and equipment to the satisfaction of Engineer- in-charge.

32.3 The contractor should also make sure that he has ready access to expert manpower to operate the plant and machinery efficiently and effectively and indicate accordingly in his offer.

32.4 The contractor shall not remove from the site of works any plant and machinery mobilized by him without prior written permission of the Engineer- in- charge during the course of or on completion of works.

33.0 PLANT AND MATERIALS OF THE CONTRACTOR

- 33.1 Contractor's plant/materials at site to be exclusive to the work:** All constructional plant and materials brought on the site by the Contractor be deemed to be exclusively intended for the execution of the work or part of the work and the Contractor shall not remove the same without the permission of the Engineer till completion of work or part of work.
- 33.2 Removal of constructional plant/materials from site:** Upon completion of the works, the Contractor shall remove from the site all the said constructional plant remaining thereon and unused materials belonging to the Contractor.
- 33.3 Loss or damage to constructional plant/materials:** The Employer/Engineer shall not at any time be liable for the loss of or damage to any of the said constructional plant, temporary works or materials.
- 33.4 Assistance to Contractor for re-export of plant:** In respect of any constructional plant which the Contractor shall have imported for the purposes of the works, the Employer/Engineer may assist the Contractor, where required in procuring any necessary government consent for re-export of such constructional plant by the Contractor after the completion of the works.
- 33.5 Assistance to Contractor for customs clearance:** The Employer/Engineer may assist the Contractor, where required, in obtaining clearance through the customs of constructional plant, material and other things required for the works. This shall not dilute in any way the Contractors' obligations and responsibilities under the contract.
- 34.0 CONTRACTOR TO KEEP SITE CLEAR:**
During the progress of works, the Contractor shall keep the site reasonably clean and free from obstructions and shall store neatly construction plant and materials.
- 35.0 HEALTH AND SANITARY ARRANGEMENT FOR WORKERS**
- 35.1** No quarters shall be provided by the Employer/Engineer for the accommodation of Contractor or any of his staff employed on works.
- 35.2 Provision of Labour camp:** The contractor shall at his own expense, make adequate arrangement for the housing, supply of drinking water, electricity, canteen and provision of latrines and urinals, for his staff and workmen employed on the work, directly or through petty Contractor or sub-contractor and for temporary crèche (Bal- mandir) where 50 or more Women are employed at a time. All camp site shall be maintained and clean and good sanitary condition by the contractor at his own cost.
- 35.3 Compliance with rules for employment of labour:** The Contractor shall comply with all laws, bye-laws, rules and regulations in force pertaining to employment of local or imported labour, and shall take all necessary precaution ensure and preserve the health and safety of all staff /workmen, employed on the works directly or through petty contractor or by sub-contractor.
- 35.4 Medical facilities at site:** The Contractor shall, at his own cost, provide First Aid and Medical facilities at site as may prescribed by Engineer.
- 35.5 Use of Intoxicants:** No sale of alcoholic drinks and /or intoxicating drinks or drugs shall be permitted by the contractor at or near the site. The contractor shall also ensure that no labour or employ is permitted to work at the site in an intoxicated state or under the influence of any drugs or drinks.
- 36.0 ENGAGEMENT OF LABOUR:**
The Contractor shall make his own arrangement for the engagement of all labour, accept as provided otherwise in the contract.
The Contractor shall not employ any labour below the age prescribed in any labour legislation, directly or through petty contractors or sub-contractors for execution of work.

37.0 WAGES OF LABOUR

37.1 Wages under relevant laws: In dealing with labour and employees, the contractor and his sub-contractors (including piece rate and petty contractors) shall comply fully with all laws and statutory regulations such as:

- i. Workmen Compensation Act, 1923
- ii. Payment of Gratuity Act, 1972
- iii. Employees Provident Funds and Miscellaneous Provisions Act, 1952
- iv. Maternity Benefits Act, 1951
- v. Contract Labour (Regulations and Abolition) act, 1970
- vi. Minimum Wages act 1948
- vii. Payment of Wages Act 1936
- viii. Equal Remuneration Act 1979
- ix. Payment of Bonus Act 1965
- x. Industrial Dispute act 1947
- xi. Industrial Employment (Standing Orders) Act, 1946
- xii. Trade Union Act, 1926
- xiii. Child Labour (Prohibition and regulation) Act, 1986
- xiv. Inter-state migrant Workmen (Regulation of Employment and Conditions of services) Act, 1979
- xv. The Buildings and other constructions workers (Regulation of Employment and Conditions of Service) Act, 1996 and Cess Act of 1996.
- xvi. The Factory Act, 1948

And others laws or regulations framed by competent legislative authorities from time as may be applicable. In accordance with the various acts and regulations with all up to date amendments, the contractor shall ensure that he and his subcontractors (including petty and piece rate contractors) observe strictly interalia the following:

- a) Wages paid are not less than those prescribed.
- b) Wages and other dues are paid regularly and in time.
- c) Lines / licenses are obtained as required under any of the acts or regulations.
- d) Maintain prescribed records, submits necessary statements to authorities concerned and display required notices.
- e) Take prompt action on any instructions/directions from the authorities under various labour laws.

37.2 Claims on account of violation of labour laws: If any moneys shall as a result of any instructions, directions or decisions from the authorities or claim or application mad under any of the labour laws or regulations be directed to be paid by the Engineer because of any failure of the Contractor, such moneys shall be deemed to be moneys payable to the engineer by the Contractor and on failure of the contractor to repay the engineer any moneys paid or to be paid as aforesaid within seven days after the same shall have been demanded, the engineer shall be entitled to recover the amount from any moneys due or becoming due to the contractor under this or any other contract with the employer. The engineer shall not be bound to contest any such claim or demand unless the contractor makes a written request for it, and contractor's reasons for contesting are considered reasonable by the Engineer and the Contractor deposit the full cost that the engineer may have to incur in contesting the case.

38.0 REPORTING ACCIDENTS INVOLVING LABOUR.

The Contractor shall be responsible for safety of all employees /labour employed by him on works, directly or through petty contractors or subcontractors and shall report accidents, occurring on works to the Engineer or the engineer's representative, and shall make every arrangement to render all possible assistance and to provide prompt and proper medical attention. In case of fatal accident, it will be contractor's responsibilities to report accident to police keeping the Engineer advised of the same. The compensation of affected workers or their relatives shall be paid by the contractor in such cases with utmost expeditions in accordance with the Workmen's Compensation Act.

39.0 SUPPLY OF WATER AND ELECTRIC POWER.

Unless otherwise provided elsewhere in the contract, the contractor shall be responsible for making arrangement at his own cost to obtain supply of water and/or electric power, necessary for execution of the works and during defect liability period. In the event the Engineer is in a position to supply water or electrical power, or both, required for works, such supply shall be given only at one point. The cost of making necessary arrangements to the Engineer's distribution system and laying of necessary pipe line, specials valves, meters etc. for water supply or the laying of underground / overhead conductor, circuit protection, electric power meters and transmission structures in case of electric power shall be borne by the contractor. The Contractor shall also bear the running cost of water and power supplied, the rates for which shall be determined and notified by the Engineer. The decision of the Engineer on such cost shall be final and binding. Any increase in water /power tariff by supplying agencies shall also be borne by the contractor.

40.0 REPAIR TO DAMAGES

The contractor shall be responsible for rebuilding/repairs of any damage by any reason not attributable to the design defect (where design is supplied by Engineer or client) during execution of works or defect liability period. In case the contractor is unable or unwilling to execute such repair works promptly, the Engineer may get the same done by engaging another agency or using labour, materials and resources as may be considered necessary and the cost of such remedial works shall be recovered from contractor bill. The decision of Engineer regarding reasons of the damage shall be final and binding.

41.0 IMPLEMENTATION OF QUALITY, SAFETY, HEALTH, AND ENVIRONMENTAL MANAGEMENT SYSTEM

41.1 QUALITY MANAGEMENT SYSTEM: IRCON is an ISO certified company in Quality Management System and aspects the contractor to work as per standards.

41.1.1 The contractor shall follow and implement Quality management system as per IS/ISO 9001:2015 and quality policy of IRCON. The contractor already holding QMS certificate need to add swiftly to keep it updated and full fill various requirements at site.

41.1.2 The contractor shall develop the Quality Assurance Plan (QAP) and inspection and testing plan (ITP) and get it approved from Project Head/Engineer. The records of test to be conducted as per ITP and tests done actually shall also be kept by the contractor.

41.1.3 The contractor shall ensure the timely calibration of all measuring and testing equipment at his own cost from reputed laboratory and the hard copies of the Documented Information are to be kept ready for any time inspection by the Engineer.

- 41.1.4 The contractor shall ensure maintenance and overhauling of all plants and machineries deployed for the works as per guidelines issued by manufacturer / supplier / vendor / legal departments / Engineer.
- 41.1.5 The contractor shall keep the hard copies of the documented information of manufacturer's test certificates (MTCS) and third party test certificates, from approved laboratory at his own cost, as required, for all the materials supplied by him. This records shall be checked any time by the Engineer.
- 41.1.6 The contractor shall ensure the use of materials (manufactured either tailor made or available off the shelf) of branded make/manufactured by reputed companies. (materials like rebar, structural steel, cement, chemicals such as admixtures, retarders, accelerators, curing compounds, de-shuttering oils, bituminous materials- modified, cationic emulsions, cutbacks, glass, paints of all types, bolts and nuts, all types of fasteners, etc.). To ensure quality output the contractor shall get his batching plant, crushing plant, other Mixing Plants and Hot Mixing Plants certifying from third party existing in the approved list of Quality Council of India, New Delhi.
- 41.1.7 The contractor shall provide work instructions /checklist for proper execution of work. The contractor shall also maintain all relevant records and documents properly and same shall be made available to the Engineer as required. The quality checklist developed by quality department management of IRCON shall also be followed.
- 41.1.8 All QAP, ITP, Laboratory formats and other documents related to quality should wear the logo of IRCON along with that of the contractor.
- 41.2 SAFETY, HEALTH, AND ENVIRONMENTAL MANAGEMENT SYSTEM:**
IRCON is an ISO certified company in the areas of occupational Health and Safety, and Environment standards
- 41.2.1 The contractor shall execute the work as per Safety, Health, and Environmental standards of IRCON (attached with the tender paper). Contractor shall provide and ensure the use of required personnel protective equipment (PPEs) for all workers/staff and Engineers. The contractor shall provide and erect safety barricades as required, display safety posters and instructions regarding safety.
- 41.2.2 The contractor shall prepare a project safety, health and environment manual (SHE manual) and get it approved by the project head. The contractor own the ultimate responsibility of all aspects of safety, health and environmental, upkeep of the work place and its surrounding.
- 41.2.3 The contractor will facilitate safety checks, health and environment checks and checks on compliance to all the norms as per the SHE Manual and same shall be checked by PH or the nominated safety officer at regular interval. IRCON has developed the checklist on safety, health and environmental issues and expects the contractor to follow the same.
- 41.2.4 All checklist and other documents related to SHE should wear the logo of IRCON along with that of the contractor.
- 41.2.5 The employer may, at their discretion undertake such corrective measures as deemed fit for immediate restoration of safe conditions at work place at the cost of the contractor and recover the cost from Contractors running bills. The contractor will keep the Employer indemnified against any corrective action by the Employer. In addition to such recourse, the penalty for each violation will be enforced as under, without issuing any show cause notice for the same:

S. No.	Nature of Violation	Penalty
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1.0	Non preparation of site safety plan before the first running bill.	Rs. 10,000.00
2.0	Violation of safety norms pointed out by inspecting officials, such as lack of supervision/process control etc.	Rs. 10,000.00 for each violation subject to maximum 1% of the contract value in all.
3.0	Injury to worker leading to stoppage of work.	Rs. 25,000.00 for each case.
4.0	Fatalities to workers at work related accidents	Rs. 5.00 Lakh for each mortality.
5.0	Repetition of violation	May lead to termination of work.

- 41.3** The Contractor shall arrange timely calibration of all his measuring and testing equipment at his own cost from reputed laboratory and supply of calibration certificates to the engineer.
- 41.4** The contractor shall ensure maintenance and overhauling of all his plant and machinery as per guidelines issued by manufacture/Vendor/Engineer.
- 41.5** The contractor shall arrange the test certificates issued by manufactures of materials supplied by him and also arrange the testing of materials from approved laboratory at his own cost, as required, and submit the test certificates to the Engineer.
- 41.6** The contractor shall provide work instructions/check lists for proper execution of work. The Contractor shall also maintain all relevant records and documents properly and same shall be made available to the Engineer as required.

41.7 Safety Procedures

The Contractor shall

- (i) Comply with all applicable safety regulations,
- (ii) Take care for the safety of all persons entitled to be on the Site,
- (iii) Use reasonable efforts to keep the Site and Works clear of unnecessary obstruction so as to avoid danger to these persons,
- (iv) Provide fencing, lighting, guarding and watching of the Works until completion and taking over, and
- (v) Provide any Temporary Works (including roadways, footways, guards and fences), protection of existing embankment, track, and bridges which may be necessary, because of the execution of the Works, for the use and protection of the public and of owners and occupiers of adjacent land.
- (vi) The Contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, masks etc. to the workers, staff and also for consultants, employer, visiting officers/guests etc.

42 PROCUREMENT OF MATERIALS

42.1 CEMENT

Cement for use in the works will be procured by the contractor from the reputed manufacturers/authorized dealers of OPC-43/53 grade (Ambuja, Ultratech, ACC, JK Super) confirming to relevant IS Specification from the authorized dealers only. Cement shall be brought in bags, weight of each bag shall be deemed to be 50 Kg nominal.

The Contractor shall submit the proof of procurement of cement from the agency approved by the Engineer. The Contractor shall also submit the test certificates regarding the quality of the materials.

42.2 STEEL FOR REINFORCEMENT

Generally Reinforcement steel (Fe500 D) shall be procured by contractor at their own cost conforming to IS: 1786 of SAIL, TATA or equivalent etc.

The Contractor shall procure reinforcement steel from the approved manufacturers in accordance with the specifications of the contract. The Contractor shall submit the proof of procurement of reinforcement steel. The Contractor shall also submit the test certificates regarding the quality of the steel. Binding wires used for binding the reinforcement shall be of approved quality soft annealed iron wire not less than 1 mm (18 SWG) size, conforming to IS Specifications.

42.3 However as per guide lines of Railway Board Circular no. 2007/CE-I/CT/8 dated 1st May2012, all Reinforcement Steel (TMT Bars) and Structural steel shall be procured as per specifications mentioned in BIS's documents IS: 1786 and IS: 2062respectively. Independent tests shall be conducted, wherever required, to ensure that the materials conform to the specifications.

This steel shall be procured only from those firms which are Established, Reliable, Indigenous & primary producers of Steel having Integrated Steel Plants (ISP), using iron ore as the basic raw materials and having in-house iron rolling facilities, followed by production of liquid steel and crude steel , as per Ministry of Steel's guidelines .

Only certain isolated sections of structural steel, not being rolled by ISPs, can be procured from the authorized re-rollers of ISPs or authorized licensee of BIS having traceability system and who use billets produced by ISPs. Traceability shall be ensured by an officer specially authorized by the Engineer-in-Charge on case to case basis for this purpose.

In all cases of such procurement prior approval is necessary from the Engineer-in-Charge.

The contractor has to arrange at his own cost cement & steel after taking approval from engineer-in-charge for samples he intends to use. The material must be conforming to the specifications and suitability of the site.

42.4 TEST CERTIFICATES:

The contractor shall submit the test certificates of Cement, Reinforcement Steel, Structural steel, Pre stressing steel, admixtures etc. The testing shall be done from Government approved laboratories/Institutions. IRCON reserves the right to get the above construction materials (even the stone aggregates, sand, water etc.) tested from any Government approved lab/Institutions, as and when required at Contractor's cost.

42.4 STORAGE AND CONSUMPTION OF MATERIALS AT SITE.

- a) The Engineer shall not be responsible for providing any storage accommodation for the materials arranged by the Contractor. In case of any materials being provided or arranged by the Engineer, the Contractor shall make his own arrangements for storage of same.
- b) Cement in bags shall be stacked by the contractor in godowns constructed by him with weatherproof roofs, suitable floors and walls as approved by the Engineer.
- c) Contractor shall construct suitable Godowns at site of work for storing other materials ensuring safety against damage by sun, rain, dampness, fire, theft etc. at his own cost and also employ necessary watch and ward establishment for the purpose at his cost.
- d) Materials brought to the site by the Contractor shall be deemed to be the property of the Engineer and will be under the control of the Engineer. Contractor shall not remove these materials from the site without the written permission of the Engineer.

43.0 REMOVAL OF IMPROPER MATERIALS AND WORKS

- i. The Engineer shall have the authority to order in writing from time to time:
 - a. The removal from site within specified time, of any material, which in the opinion of the Engineer, is not in accordance with the Specifications and Conditions of the Contract.
 - b. The substitution of defective material by approved quality material; and
 - c. The removal and proper re-execution, notwithstanding any previous decision or interim payment thereof, of any work which in respect of materials or workmanship is not, in the opinion of the Engineer, in accordance with the contract.
- ii. In case of default on the part of the Contractor in carrying out such order, the Engineer shall be entitled to get the same done by engaging another agency or by deploying labour, materials and other resources. All such cost shall be recovered from the Contractor's dues.

44.0 EXAMINATION OF WORK BEFORE COVERING UP

No work or part of work shall be covered up or put out of view, without the prior approval of the Engineer or the Engineer's representative. If any work shall be covered up or put beyond the reach of inspection/measurement without the prior approval of the Engineer or Engineer's representative, the same shall be uncovered by the Contractor at his own cost.

45.0 SUSPENSION OF WORKS ORDERED BY THE ENGINEER: As per IRGCC July-2020

46.0 DELAY AND EXTENSION OF CONTRACT PERIOD

46.1 Delay & Extension of Time shall be governed by IRGCC July 2020 Cl 17 A & 17 B.

46.2 While applying for extension, a Bar Chart showing the work already done and the program for the work to be done shall be prepared and shown in juxtaposition with the bar chart submitted under Clause 11.2 of SCC, giving reasons for slippage activity-wise. IRCON may agree to such extension of time of completion, if they consider justified

46.3 Engineer's decision on compensation payable being final

The decision of the Engineer as to the compensation, if any, payable by the Contractor under this clause shall be final and binding.

46.4 Time to continue to be treated as the essence of contract in spite of extension of time.

It is an agreed term of the contract that notwithstanding grant of extension of time under any of the sub-clauses mentioned herein, time shall continue to be treated as the essence of contract on the part of the Contractor

47.0 DETERMINATION OF CONTRACT: As per IRGCC July 2020.

48.0 DEATH OF CONTRACTOR / PARTNER

If the Contractor is an individual or a sole proprietary concern, and the individual or a sole proprietor dies, or if the Contractor is a partnership concern and one of the partners dies, in that case, unless the Employer/Engineer is satisfied that the legal representative of the

individual Contractor or of the sole proprietor, as the case may be, or in the case of partnership firm, all surviving partners are capable of carrying out and completing the contract, the Employer/Engineer shall be entitled to rescind the contract as to its incomplete part. In that event, the Employer/Engineer shall not be liable to pay any compensation to the legal heirs of the deceased Contractor and / or to the surviving partners of the Contractor's firm, on account of such cancellation of contract. The Engineer's decision as to whether the legal representatives of the deceased Contractor or surviving partners of the Contractor are capable of carrying on and completing the contract shall be final and binding on the parties. Provided further that the legal representatives of the deceased Contractor or the surviving partners shall also not be liable to pay any damages, alleged or actually suffered by the Employer/Engineer, in respect of incomplete part of the contract. Any liability incurred by the deceased Contractor, or by the deceased partner of the contracting firm, before his death, shall be recovered from the legal representatives of the deceased Contractor or from the surviving partners of the said contracting firm as the case may be.

49.0 EMPLOYMENT OF RETIRED OFFICERS/ENGINEER OF EMPLOYER/ENGINEER

No Officer/Engineer of the Employer is allowed to work as a Contractor or his employee for a period of two years after his retirement/resignation from the service of the Employer without the prior permission of the Employer.

50.0 MODIFICATION TO CONTRACT

In the event of any provisions of the contract requiring to be modified after the agreement has been signed, the modifications shall be made in writing and signed by the Employer/Engineer and the Contractor or his authorised representative. Such modifications will not be effective until the same have been signed by both the parties. Any verbal or written arrangements for abandoning, modifying extending, reducing or supplementing the contract, or any of the terms thereof shall be deemed to be provisional and shall not be binding on the Employer/Engineer unless and until the same are incorporated in a formal instrument and signed by the Employer/Engineer and the Contractor.

51.0 MODIFICATIONS TO WORK

The Engineer shall be competent to order in writing to enlarge or extend, diminish or reduce the works or make any alterations in their design, character, position, site, quantities, dimensions or in the method of execution or use of materials for the execution thereof and to any additional works to be done or any work not to be done.

The enlargement, extension, diminution, reduction, alterations or additions, referred to above shall in no way affect the validity of the contract, but shall be performed by the Contractor as provided therein and be subject to the same conditions, stipulations, obligations and rates as if they had been originally and expressly included and provided for in the Bill of Quantities, specifications and drawings, and the amount to be paid therefor shall be calculated in accordance with accepted rates and other extra items of works at the rates, determined as per contract. However, the rates of quantities exceeding 25% of those provided in Bill of Quantities shall be finalized as per clause 54.0 of these conditions.

52.0 RATES FOR ITEMS OF WORK TO BE ALL INCLUSIVE

- i. The rates entered in the accepted Bill of Quantities of the Contract, shall be all-inclusive and provide for works duly and properly completed in accordance with terms and conditions of the Contract and processes as mentioned in specifications and drawings (including revised drawings), relevant codes whether mentioned or not in the nomenclature of the item in Bill of Quantities. All rates quoted in the tender shall also deemed to include except specifically provided otherwise in the Contract:
 - All materials, labour, tools and plant, stores, centering, shuttering, etc.
 - Construction/Erection, maintenance and removal of all temporary works.
 - All watching, lighting, pumping and draining unless otherwise provided for.
 - All barriers and arrangements for safety of the property, utilities, public or employees/workers during the execution of works.
 - All sanitary and medical arrangements for labour camps.
 - The setting out of all works of construction, repair and up-keep of all center lines, benchmarks, reference pillars etc.
 - Site clearance except specifically provided otherwise in the Contract.
- ii. Nothing extra shall be payable over the quoted rates, except as specifically provided in the Contract.
- iii. The Contractor shall get registered with the concerned Goods and Services Tax Department of the relevant state(s) of the project and submit a copy of the same to the Employer/Engineer. He shall be responsible for filling Goods and Services tax returns and assessments, as necessary as per relevant Laws, Rules and Regulations and shall also furnish necessary certificates to Employer/Engineer from time to time.
- iv. Wherever certain exemptions/benefits are available on custom duty the Contractor shall consider the same while quoting his rates. For instance, materials/ Plant and Machinery etc. used for execution of the projects financed by International organizations enjoy exemption from custom duty under Foreign Trade Policy as Deemed Export on fulfilling the conditions as per Govt. notifications. Similarly the Contractor shall ensure that whenever any benefits are available under any other law, these shall be considered while quoting the rates.
- v. All rates quoted in the Bill of Quantities shall be deemed to be inclusive of all types of taxes, duties and levies imposed by Central/State Govt. and local bodies such as IGST/CGST/SGST/UTGST, compensation Cess, labour Cess, custom duties, royalties and other levies. No additional amount shall be paid or claim be entertained on this account by Employer/Engineer.
- vi. If there is any change to the existing rates of statutory taxes of central governments are levy of any new type of statutory taxes/duties or substitution of existing taxes/duties after the last date of submission of tender shall be borne by employer/Engineer. The increase or decrease in the liability on this account will be dealt with accordingly. Increase in liability shall be reimbursed as per actual on submission of computation of increased liability statement with the documentary evidences in the form of challans/returns of the contractors/suppliers to the satisfaction of Employer/Engineer.

Similarly, in case of reduction of taxes/duties by either of central due to change in the rate of taxes/duties or due to introduction of new tax or substitution of existing taxes the benefits of reductions in the liability shall be passed on the Employer/Engineer immediately commencing from the first periodical return falls due. Computation of decrease in liability shall be submitted by the contractors/suppliers/service providers, examined and agreed by Employer/Engineer. All the changes in the rules and consequent payments should be supported by documentary evidences.

- vii. In case the contractor fails to intimate and does not pass on benefits to employers, he may be liable to a penal interest for the period for which benefits has not been passed on at the rate of SBI MCLR+3%. In addition to this penalty equal to 10% of amount of benefit shall also be levied in case benefit fallen due has not been intimated to Employer.
- viii. The contractor/suppliers/service providers who is liable to get registered under the GST Act shall submit a copy of the registration certificates with GST number and such other details as desired by Employer/Engineer for compliance under the CGST/IGST/SGST/UTGST and compensation Cess act. The contractor/supplier/Service provider shall be responsible for issuing of Tax invoices, filing of Statutory monthly return and deposit of statutory taxes within the time limit as prescribed in Law. Any interest/penalty/Taxes, (non-availment of input tax credit due to mismatch in GSTR2) which is required to be paid by Employer/Engineer due to the default by the contractor/supplier/service provider to comply with the above mentioned activities/ provisions as prescribed in laws, rules and regulation shall be recovered from the contractor/supplier/service provider and adjustment shall be made when mismatch is attended and solved and credit is extended to Employer/Engineers.
- ix. The Contractor/Supplier/Service provider who is not liable to get registered under the GST Act or who has opted for composition scheme under the GST Act shall submit documentary evidence in support of the above.
- x. In case of unregistered contractor/Supplier/Service provider, Employer/Engineer shall deduct applicable GST under reverse charge from the payment released by back calculation method. GST deducted shall be deposited the concerned authority.
- xi. Employer/Engineer shall deduct Cess at prescribed rate as per provision of the building other Construction Work Welfare Cess Act 1996.
- xii. The Contractor shall bear the cost of all royalties, fees and other payments in respect of patents, patents right and license(s) which may be payable to patentee, licensee or other person or corporation and shall obtain all necessary licenses/ permissions. In case of any breach (whether willfully or inadvertently) by the Contractor of this provision, the Contractor shall indemnify Employer, Engineer and their employees against all claims, proceedings, damages, costs, charges, loss and liability which they or any of them may sustain, incur or be put to by reason or in consequence directly or indirectly of such breach and against payment of any royalties, damages or other money which the Employer/Engineer may have to make to any persons or pay in total to the patent rights in respect of the users of any machine, instruments, process, articles matter or thing constructed, manufactured, supplied or delivered by the Contractor under this contract.

- xiii. The contractor shall be liable to submit the Royalty payment receipt as per the applicable norms and the prevailing rate to the extent materials are used on the project. IRCON shall be free to deduct suitable amount from RA Bill of the contractor if the Royalty payment receipt is not submitted by the contractor before releasing payment. Amount deducted by the Engineer on account of Royalty shall only be released on submission of Royalty payment receipt/Royalty Clearance Certificate by the contractor. However, contractor shall be liable to submit Royalty Clearance Certificate from the concerned authority before releasing the final bill.
- xiv. Upon implementation of GST any reduction in Tax on supply of Goods or Services or the benefits of input tax credit shall be passed on to Employer/Engineer by way of commensurate reduction in prices.

53.0 ACCEPTED RATE APPLICABLE TILL THE COMPLETION OF WORK

The rates as per the accepted Bill of quantities, shall be firm and hold good till the completion of the works, and no additional claim or amount shall be admissible on account of fluctuations in market rates, increase in taxes, levies, fees royalties etc. unless specifically provided for in the Contract.

54.0 VARIATION IN QUANTITY OF ITEMS COVERED BY THE BILL OF QUANTITIES

- i) The quantities of items shown in the Bill of Quantities are approximate, and liable to vary during the actual execution of the work. The Contractor shall be bound to carry out and complete the stipulated work, irrespective of the variations in individual items, specified in the Bill of Quantities.
- ii) Such variations in quantities shall be paid for in the manner laid down under **Clause No. 41 & 42, Part (2) of GCC Railways, July 2020.**

55.0 ITEMS NOT INCLUDED IN THE BILL OF QUANTITIES

- 55.1** If any item of work not provided for in the accepted Bill of Quantities and required to be executed for completion of work, the Contractor on receipt of instructions from the Engineer, shall be bound to carry out such items of work at the rates to be decided as per sub-clause 55.2 and 55.3.
- 55.2** The rate for such extra items shall be derived from rate for similar items available in the accepted Bill of Quantities.
- 55.3** In case rates cannot be derived from the accepted bill of Quantities, the rate may be worked out on the following basis:
 - a) Cost of materials and consumables at current market rates, as actually utilized in the final finished permanent work, including a reasonable percentage for wastage and cost of loading, unloading and transportation.
 - b) Cost of labour required for the work.
 - c) Hire charges for plant and machinery, scaffolding, shuttering, forms etc. required to be used at the sites of the work.
 - d) An amount of 10% of items (a), (b) and (c) above to allow for contractor's overheads, profits and other contingencies.

55.4 In all cases where extra items of work are involved, for which there are no rates in the accepted Bill of Quantities, the Contractor shall give a notice to the Engineer, of at least 7 days before the need for their execution arises.

Such a notice shall not however be necessary If the Engineer has already instructed in writing to take Engineer has already instructed in writing to take up such an item of work. To decide the rate, the Contractor shall furnish detailed analysis of the rates on the lines mentioned in sub clauses 55.2 and 55.3 above and attend a meeting with Engineer to settle the rate as and when called for. The Contractor shall be bound to furnish the requisite details and to attend the meeting.

55.5 Provisional payment for extra items.

In case mutually agreeable settlement of rates is not arrived at between the Engineer and the Contractor, the Contractor shall be bound to carry out the works at rates to be decided by the Engineer. In the absence of a finalized rate for a new item, the Engineer shall be entitled to certify payment to the Contractor based on a provisional rate fixed by the Engineer for the work done under the new items. This shall be subjected to upward or downward adjustment after the rate is finalized by the Engineer for that item.

55.6 The decision of the Engineer under this clause shall be final and binding.

56.0 LIEN IN RESPECT OF CLAIMS IN OTHER CONTRACTS

Any moneys due to the Contractor either alone or jointly with others, including the performance guarantee amount returnable to him may be withheld or retained or encashed by exercise of lien by the Client/ Employer/Engineer against any claim of the Client/ Employer/Engineer or any other branch, office department or subsidiary of the client/ Employer/Engineer in respect of a sum of money arising out of or under any contract other than the present contract made by the Contractor alone or jointly with the client/ Employer/Engineer or any other branch, office, department or subsidiary of the client/ Employer/Engineer. It is agreed term of contract that the sum of money so withheld or retained under this clause by the client/ Employer/Engineer, shall be kept withheld or retained till the claims arising out of or under the contract, are either mutually settled or determined by the Arbitrator, or by the competent court, as the case may be and that the Contractor shall have no claim for interest or damages whatsoever on this account or any other account, in respect of any sums of money withheld retained, under this clause and duly notified to the Contractor.

57.0 MEASUREMENTS OF WORK AND PAYMENTS

57.1 Measurements

The Contractor shall be paid for the works at rates in the accepted Bill of Quantities of the contract and extra items of work at rates determined under clause 55.0 of these conditions. The measurement shall be taken by the Engineer or his representative in the presence of the Contractor or his authorized representative.

57.2 Measurement of work at regular intervals

The measurements of the work shall be taken in accordance with the contract during progress of work and at such intervals, as in the opinion of the Engineer or Engineer's Representative shall be proper, having regard to the progress of the work. On an agreed

date and time, the Engineer or his Representative shall take the on account or final measurements in the presence of the Contractor or his authorized representative. The Engineer or his authorized representative shall sign the measurements, which shall also be signed by the Contractor or his authorized representative as an acceptance of the measurements. If the Contractor or his representative fails to turn-up at the time of taking measurements in spite of notice to do so, the Engineer or his representative shall be entitled to record the measurements ex-parte and these shall be final and binding on the Contractor.

57.3 Measurement of works as per records and drawings

- i. For the purpose of measuring such permanent works, as are to be measured by records and drawings, the Contractor shall prepare records and drawings at regular intervals and submit to the Engineer or Engineer's representative for his scrutiny.
- ii. In case, there is a discrepancy in the measurements of work done and the measurements as per drawings, measurements for the minimum of the two shall only be accounted for, provided the executed work is acceptable to the Engineer.
- iii. The Engineer or the Engineer's representative shall have the right to rectify any incorrect measurements and delete/correct any measurements if it is found at a later stage that the work is incomplete, defective and/or not conforming to the specifications.

58.0 ON ACCOUNT PAYMENTS

58.1 The Contractor shall be entitled to be paid from time to time, by way of "On-account" bills, only for such works, as in the opinion of the Engineer, the Contractor has executed in terms of the contract. Such payments shall be made at intervals to be decided by the Engineer depending upon the progress of work. Payment shall be made only on submission of bills along with measurements and necessary documents by the Contractor for scrutiny of the Engineer. The amount certified shall account for all deductions, including statutory deductions as for sales tax, income tax, etc., recoveries for advances and any amounts due from the Contractor. Such payments made by the Engineer shall not constitute any final acceptance of the measurements. In case of any discrepancy, the Engineer shall have the right to alter, modify, reduce or diminish the quantities or classification entered in the Measurement Books. In such cases, the Engineer shall have the right to recover any amount paid in an earlier bill/bills from any subsequent bill/bills and should the amount to be recovered be more than the amount of the subsequent bills, the Contractor shall on demand from the Engineer immediately refund the amount to the Engineer within 7 days, failing which he shall have to pay interest @1% per month till the said extra amount is paid back by him.

58.2 For materials brought to site by the Contractor, the Engineer may allow (Interest free) payment @ 75% cost of major materials brought to site for use in the works as secured advance which will normally be paid along with next on account payment. The payment of secured advance shall be made without any bank guarantee but on written request of the Contractor alongwith indemnity bond indemnifying Employer/Engineer against any loss and /or damages to the materials for which secured advance is sought by the Contractor. The indemnity bond shall be submitted on a non-judicial stamp paper of minimum value of

Rs 10/- duly notarised as per the format approved by the Engineer. The Contractor should supply necessary vouchers etc as evidence that payment has been made by the Contractor for all the materials brought to site for which secured advance is sought by the Contractor. Secured advance shall be paid at the rates derived from the accepted rate of the item (s) for which the materials are to be consumed and procurement rates, whichever is lower. The Engineer's decision as to the Quality, Quantity and value of the materials for which such secured advance is payable will be final and binding on the Contractor. The recovery of secured advance so made will be made from the subsequent on account bills to the extent the materials are consumed in the work

58.3 The Engineer may on specific request and authorisation by the Contractor in writing release payments directly to the Suppliers, sub-contractors or petty contractors of the Contractor from the amount (s) certified, passed and due for payment to the contractor.

58.4 In case of default by the Contractor, the Engineer may without any notice to the Contractor, release payments directly to the suppliers/sub-contractors and / or petty contractors of the Contractor. All such payments shall be recovered with interest @ 1.25% (including administrative charges) per month from the payments due to the Contractor.

58.5 In exceptional circumstances, if the Contractor is not able to make prompt payments to his suppliers affecting supplies of materials and progress of work, the Engineer may (but shall not be obliged to) give assurance to the suppliers for payment against supply of materials / consumables to the Contractor. In this case, the Contractor shall give to the Engineer an understanding in writing that cost of such materials if not paid by him may be directly paid to his suppliers and recovered from his dues. Such payments shall only be made after receipt of materials at site and verification of the payments by the Contractor. The recovery of such payments shall be made with interest @ 1.25% (including administrative charges) per month from the next payment due to the Contractor. Total payments so made on behalf of the contractor shall not exceed 5% of the Contract value during the entire contract period.

58.6 The decision of the Engineer regarding exceptional circumstances and payments to be made to the suppliers, sub-contractors and petty contractors under the clause nos 58.3, 58.4 and 58.5 shall be final and binding on the Contractor. Such payments shall also not relieve the Contractor from any of his liabilities or obligations under the Contract.

58.7 No payment under the contract shall be made to the Contractor before receipt of performance security. The Engineer shall also be entitled to withhold payments under the above sub-clause in case the Contractor fails to get himself registered under sales tax/labour laws or fails to fulfil his obligation under the Contract.

59.0 FINAL MEASUREMENTS AND PAYMENTS

As soon as possible after completion of work, the Contractor shall submit the final bill along with detailed measurements of work done, account of the materials, plant and machinery issued by the Engineer and all other statements, supporting documents required for finalization of the bill. The final bill, measurements and documents submitted by the Contractor shall be scrutinized by the Engineer or his representative and in case the same are found not in order, the Engineer shall direct the Contractor to re-submit the final bill along with all details. On receipt of all requisite details and final bill from the Contractor, the Engineer shall have the final measurements taken, recorded and signed jointly. An

accountal of any plant, equipment and materials issued by the Engineer to the Contractor, shall also be prepared and signed jointly. Based on the final measurements and materials and plant and equipment accountably statements, the Engineer shall prepare the final bill.

The Contractor shall sign the Engineer's copy of the Final Bill Account in token of acceptance of the full and final value of the works performed under the contract, and submit a "No Claim Certificate" on the prescribed Performa along with a list of unsettled claims, if any. The Engineer shall then arrange to make payment against the final bill.

60.0 PAYMENT TERMS

- 60.1** The contractor shall be allowed one Running Account payment each month upon submission of GST invoice as specified in the Act. Payment shall be made upon verifications of measurements and works carried out in conformity with specifications and quality requirements after deducting dues on account of mobilization advance paid to the contractor, security deposit, Income Tax at sources etc. and any other dues that may have accrued.
- 60.2** Double the amount of GST paid in earlier bills will be withheld from subsequent bill if credit of the same has not been passed on to IRCON due to any reason. The amount thus withheld will be released only when the credit is available to IRCON.
- 60.3** The GST amount will be paid upon submission of proof of GST deposited and filing of due GST return.
- 60.4** All items of work having a financial value shall be entered in Measurement Book, Level Book etc., and maintained by IRCON so that a complete record is obtained for all work performed under the contract. The Contractor shall be authorized to depute his representative for joint measurement of works.
- 60.5** Running Account payments to the contractor shall be through NEFT/RTGS. The contractor shall provide NEFT/RTGS code of their banks with A/c No for release of payments.
- 60.6** The rates for any item of work not included in the (Schedule of rates and quantities) and which the contractor may be called upon to do by IRCON shall be fixed by the supplementary written agreement between the contractor and the IRCON before the particular item or items of work is/are executed. In the event of such agreement not being entered into and executed the IRCON may execute these works by making alternative arrangements. IRCON will not be responsible for any loss or damages on this account.
- 60.7** Payment for the work done will be made to the contractor only when the formal agreement has been executed between the parties.

60.8 Mode of Payment:

All payments to the Contractor shall be made through Electronic Clearing System (ECS). The contractor shall furnish his Banker's details in addition to his own bank account details. All amounts payable to the Contractor shall be directly credited to his bank account.

- a. In case, the contractor is having his account with a bank not having Electronic Clearing System (ECS), the Contractor may open a bank account with the bank having this facility.
- b. All payments to the Contractor shall be made by above means only unless specifically otherwise agreed by the Engineer in special circumstances for petty payments.

60.9 Tax deduction at source (TDS) & Other Duties and Cess

Income tax shall be deducted from the payments credited/released by Employer/Engineer to the contractor/Supplier/Service provider against execution of work as per the Income Tax Act, 1961. The deductions shall be made as per prescribed rates prevalent from time to time unless a tax exemption certificate is produced by the contractor. Amount of tax deduction shall be deposited with the concerned authorities and tax deduction certificate shall be issued by Employer/Engineer. The Employer/Engineer shall deduct at source taxes/duties under any other law/statute as may be applicable at the time of making payments. The contract shall furnish to the Engineer PAN (for TDS), as applicable. The deductions towards income shall be made at source from the payments due to the non-resident Contractor/Supplier/Service provider as per section 195 of the Income Tax Act, 1961.

60.10 Payment through Discounting of Bills on TReDS Exchange:

- a. With introduction of MSME TReDS platform by the Ministry of Heavy Industries & Public Enterprises, IRCON has entered into Master agreement with M/s. RXIL (Receivable Exchange of India Limited) for setting up TReDS Exchange where MSEs vendors of IRCON have the option to realize their payment before due date by discounting their bills on MSME TReDS Exchange platform of M/s RXIL.

If MSEs vendors are willing to avail facility of discounting their bills through TReDS Exchange, they will first have to enter Master Agreement with M/s. RXIL and share a copy of Agreement with IRCON.

- b. In such cases, after logging in to TReDS Exchange, MSEs vendor is required to create a factoring unit on the basis of invoice after deductions/ recovery of all statutory dues. It may be noted that the factoring unit shall be verified by IRCON for net payable amount only, i.e. after recovery /deduction of statutory dues and as per terms and conditions of the Contract Agreement.
- c. In case, the factoring unit gets financed by financiers in the RXIL's TReDS platform Exchange, IRCON's payment liability towards MSEs vendors ceases to be existed. In such cases IRCON, shall make payment to the ultimate financier on the due date of payment as per terms of the Contract Agreement.
- d. In the event of a factoring unit remains unfinanced, IRCON shall make the payment directly to the MSEs vendor's account through ECS mode as per sub-clause no 60.8.a. of the SCC.
- e. IRCON shall not be liable for any damages, losses, claims and liabilities (including

-
- legal cost) resulting from any of the following :
- (i) MSEs vendor's inability to use RXIL's TReDS platform or it's services.
 - (ii) Any defect in services on the TReDS platform from any participant or any other third party through the site.
 - (iii) Unauthorized access by third parties to data or private information of any user/participant.
 - (iv) Any matter relating to services however arising, including negligence.

61.0 COMPLETION CERTIFICATE

61.1 As soon as the work is completed, the Contractor shall give notice of such completion, whether of the whole of the works, or of any part of the work, for which a separate date of completion is stipulated in the contract, to the Engineer, and the Engineer, within 30 days of receipt of such notice, shall inspect the work and also arrange for carrying out of such tests as may be prescribed under the contract or ordered by the Engineer. If the Engineer notices any incomplete item of work or any defect, which is to be rectified by the Contractor, or if any part or whole of the work fails to pass the specified tests, the Engineer shall furnish to the Contractor, the list of all such incomplete items of work, deficiencies, defects, failure to pass tests, etc., and may refuse to issue a Certificate of Completion to the Contractor. If in the opinion of the Engineer the work has been satisfactorily completed and has satisfactorily passed final test or tests that may be prescribed, the Engineer shall issue a certificate of completion showing the date of completion in respect of the work. The defect liability period, if any, shall commence from the date of completion indicated in such certificate. Provided that the Engineer may issue such a certificate with respect to any part of the works, before the completion of the whole of the works, which has been so completed and/or used by the Client/Employer/Engineer. When any such certificate is given in respect of a part of the work, such part shall be considered as completed and the defect liability period of such part shall commence from the date of completion indicated in such certificate.

61.2 Completion certificate not to absolve the Contractor from his Responsibilities:

The Certificate of Completion of Works referred to in sub-clause 61.1 shall not absolve the Contractor from his liability to make good defects, imperfections and shrinkages or faults, which may appear during the defect liability period specified in the contract, arising in the opinion of the Engineer from materials or workmanship being not in accordance with the Contract. These shall be rectified and made good by the Contractor at his own cost. In case of the default on the part of the Contractor, to so make good the defects or deficiencies, the Engineer may employ labour, plant and machinery and materials or appoint another agency or Contractor, to make good such defects, imperfections, shrinkages and faults, and all expenses consequent and incidental thereto, shall be recovered from any money due to the Contractor under the contract including the Performance Security amount or from any money payable to the Contractor by the Employer/Engineer, under any other contract.

61.3 Completion/As Built Drawings & Documents:

Contractor shall be in his quoted rates prepared and submit detailed completion drawings of all the works executed by him, prepared in Auto CAD, in three copies of tracing sheet six copies on paper sheets and three copies pen drive /hard disk. **Drawings may be submitted in phased manner as the works get completed as directed by Engineer.** However, all the drawings shall be submitted within 30 days of date of completion. The completion certificate shall not be issued by the Engineer in the event of the Contractor's failure to furnish the aforesaid Completion/ as Built Drawings& documents.

61.4 Contractor to study drawing and specifications etc. and his liability:

The contractor shall be responsible for close scrutiny of approved drawings supplied by the IRCON. For discrepancies, error or omissions in the drawings or in other particulars indicated therein, the contractor shall approach to IRCON immediately for rectification of such discrepancies, errors and omissions. If any dimensions / figure /features etc on approved drawings or plans differ from those drawings or plans issued to the contractor at the time of calling of the tender, the dimension as figured upon the approved drawings or plans shall be taken as correct. No claim shall be entertained on this account and decision of IRCON shall be final, binding and conclusive on the contractor.

62 CLEARANCE OF SITE ON COMPLETION

On completion of works, the Contractor shall clear and remove from site all constructional plant, surplus materials, rubbish and temporary works of every kind, and leave the whole of the site of work clean, tidy and in a workman like condition to the satisfaction of the Engineer. This will be one of the pre-conditions for making the final payment to the Contractor. Such clearance may be made by the Engineer through any other agency at the expense of the Contractor in the event of the Contractor's failure to comply with this provision within 7 days after receiving notice to that effect from the Engineer.

63 POST PAYMENT AUDIT

It is an agreed term of the contract, that the Employer reserves to himself the right to carry out a post payment audit or technical examination of the works, and the final bill including all supporting vouchers, abstracts, etc. If as a result of such examination, any over payment to the Contractor is discovered to have been made in respect of any work done, the Contractor will be bound to refund the same to the Engineer or may be adjusted against any dues of the Contractor. If any under payment is discovered, the same shall be paid by the Engineer to the Contractor. Such payments or recoveries, however, shall not carry any interest.

64 DEFECT LIABILITY CERTIFICATE

64.1 In the contract, the expression "Defect Liability Period" shall mean the period of defect liability prescribed elsewhere in the contract, commencing from the date of completion of the works, as certified by the Engineer.

The Contractor shall maintain, rectify and make good at his own cost any defects/deficiencies, which may develop in the work or as notified by the Engineer during Defect Liability Period. However, maintenance during Defect Liability Period shall not include day to day upkeep, cleaning, custody and security of the work.

64.2 The contract shall not be considered as completed, until a Defect Liability Certificate has been issued by the Engineer stating that the works have been completed and maintained to his satisfaction. Defect Liability certificate shall be issued by the Engineer, upon expiry of Defect Liability period or as soon thereafter as any works ordered during such period, have been completed to the satisfaction of the Engineer.

64.3 No certificate other than “Defect Liability Certificate” shall be deemed to constitute final approval of the work or part of the work for which it is issued.

64.4 Defect Liability Period shall be 12 Months from issue of Completion Certificate, as certified by the Engineer.

65 UNFULFILLED OBLIGATIONS

Notwithstanding the issue of Defect Liability Certificate, the Contractor and the Engineer shall remain liable for the fulfilment of any unfulfilled obligations under the provision of the contract, prior to the issue of the Defect Liability Certificate, and for the purpose of determination of the nature and extent of any such obligation, the contract shall be deemed to remain in force between the parties thereto.

66 FORCE MAJEURE as per Indian Railway GCC July 2020

67 JURISDICTION OF COURTS:

Jurisdiction of courts for disputes resolution shall be New Delhi.

68 ORDER OF PRIORITY OF CONTRACT DOUMENTS

The documents forming the Contract are to be taken as mutually explanatory of one another. For the purposes of interpretation, the priority of the documents shall be in accordance with the following sequence, i.e. a document appearing earlier shall override the document appearing subsequently:

1. Contract Agreement
2. Letter of Acceptance of Tender
3. Addendum(s) / Corrigendum(s), if any
4. Notice Inviting Tender
5. Instructions to the Tenderers
6. Appendix to Tender
7. Form of Bid
8. Special Conditions of Contract
9. Indian Railways Standard General Conditions of Contract, July 2020 (GCC)
10. Technical Specifications
11. General Technical Specification (USSOR Specifications)
12. Relevant Codes and Standards
13. Technical Documents (Drawings & Reports)
14. Bill of Quantities

69 SITE OFFICE FOR USE BY IRCON/ RLY AND IRCON'S NOMINATED REPRESENTATIVES

69.1 The contractor shall be required to provide Temporary Site office for officers of IRCON/Rly. and IRCON's nominated representatives at his own cost. This should be provided by the contractor within 4 months from the date of award of the work or prior to start of physical work whichever is earlier, fully functional site office for Engineer made of Ferro-cement concrete element or any other superior quality material, as per drawing attached and as per specifications listed below.

69.2 SCOPE OF WORK FOR TEMPORARY SITE OFFICE:

The work consists of construction of temporary site office using precast cement concrete including Ferro-cement components or superior material as per plans, drawing, specifications and stipulations given in tender documents.

- (i) Superstructure of Brick wall panels and roof panels (of I/C section) and R.C.C. columns /Steel Column and joists as per enclosed plans and drawing.
- (ii) Construction of open foundation using plum concrete as per specifications and drawings (including excavation).
- (iii) Suitable anchorage between superstructure and foundation, between roof panels and columns/joists.
- (iv) Provision of PVC water storage tanks one each on overhead on erected supports with suitable pipeline connections, electric motor etc. (as per specifications).
- (v) Sanitary installations:
Following sanitary fittings shall be provided in each unit separately with cistern.
TOILET (1 Nos.): - White vitreous glazed W.C. pan with cistern of approved brand (western style) and 'S' trap etc. complete. Wash basin (white vitreous) with water pipe etc. complete. Looking glass in PVC frame fixed over wash basin, CP brass bib cock (2 Nos.), CP brass pillar cock (1 No.), single valves (2 Nos.), with suitable connecting pipes to cistern and wash basin complete, floor trap/jail of CP brass (2Nos.) and one no. 20 liter geyser for hot water shall also be provided in each toilet with all its accessories.
- (vi) Electrical installations:
The contractor shall be responsible for internal fittings, illumination, wirings starting from the main switch board and the main switch board will be provided with suitable MCB as per requirement.
- (vii) Assembling of various pre-cast components at site in case of pre-cast construction and finishing work including various fixtures as per specifications.
- (viii) Provision of ferro-cement /FRP septic tanks underground with suitable connection to the building and drainage.
- (ix) The safe design of structure as whole and its individual components will be solely the responsibility of contractor. Contractor may suitably modify the drawing in case considered necessary with the approval of Engineer-in-charge.
- (x) Providing and fixing fixed wire mesh and M.S. grills on windows, ventilators as directed by Engineer-in-charge.

-
- (xi) Providing water and electricity to site offices during currency of the contract including defect liability period at his own cost.

The drawing of site office attached with tender is indicative only.

69.3 GENERAL REQUIREMENT FOR THE TEMPORARY OFFICE BUILDING

Materials required for the works shall be arranged by the contractor himself including wire mesh /Chicken mesh /Binding wire/G.I. wire and other chemicals required for Ferrocement work/Brick work as per specifications. All materials arranged by contractor will be tested at contractor's cost, if required by engineer-in-charge.

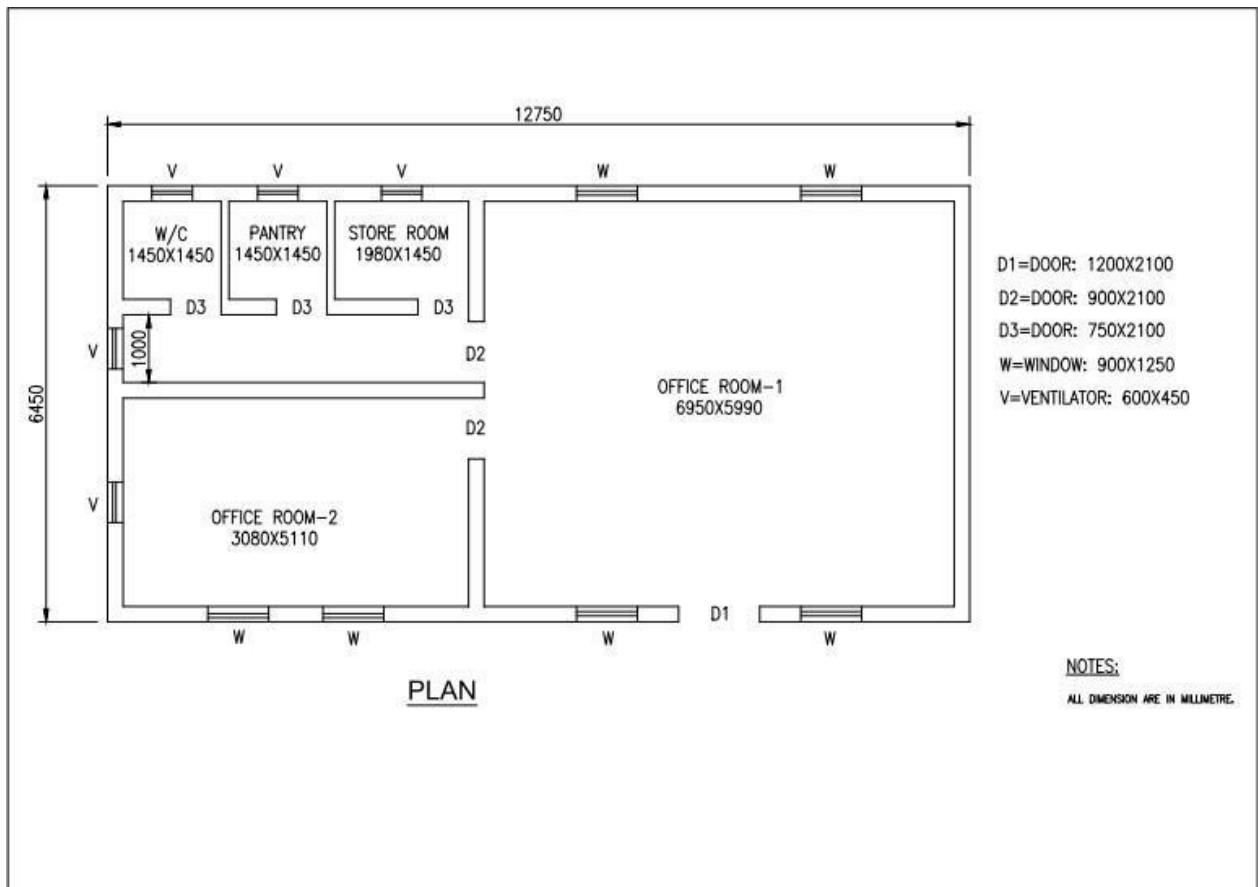
69.4 MAINTENANCE OF SITE OFFICE

The Contractor shall arrange to maintain the site office during currency of contract and defect liability period which shall include petty repairs to various parts of the building, electrical fittings, water supply, sanitary fittings including periodic white/ colour washing of building, replacing broken window/door/ventilator glasses, etc. **The Contractor shall also provide supply of water, sanitary installation & electricity to site offices during currency of contract at his own cost.**

69.5 PAYMENT CONDITIONS

The cost of temporary site offices, including their furnishing as specified in relevant clause and maintenance of site offices shall be deemed to have been included in rates quoted for various items of Schedule of Items & Quantities (BOQ) and as such nothing extra shall be payable for this work.

69.6 PLAN OF TEMPORARY SITE OFFICE FOR USE BY IRCON, NF RLY AND IRCON'S REPRESENTATIVES



Note: Plan of site office is indicative only for reference and it can vary as per site requirement.

70.0 MOBILISATION ADVANCE

70.1 Conditions of Payment

If requested by the Contractor in writing, the Employer/Engineer shall make an interest bearing mobilization advance payment to the Contractor for an amount not more than 10 (Ten) percent of the original contract value. The Mobilization advance shall be interest bearing at the rate of 10% per annum on Cost plus basis projects of Indian Railways as effective on the date of approval of payment of Mobilization Advance by the Competent Authority. Interest will be compounded annually on reducing balance. Payment of such advance shall be made after fulfilment of the following conditions to the satisfaction of the Engineer: -

- i. Execution of the Agreement between the Engineer and the Contractor.
- ii. Submission of Performance Security by the contractor in accordance with Clause 4.0 of Special Conditions of Contract.
- iii. Submission of an unconditional Bank Guarantee in the format annexed as Annexure XII from Nationalized Bank in India for an amount equal to 110% of the Mobilization Advance being paid and amount of interest for one year. **The Bank Guarantee may be split into separate Bank Guarantees & each having a minimum value of 2.5% of the original contract value.** Such Bank Guarantee shall remain effective until the advance payment along with the interest has been recovered from the Contractor. Bank Guarantee(s) for the amount recovered from the Contractor shall be released to the Contractor progressively.

70.2 Payment: After fulfilment of the pre-conditions as described in para 70.1 above, the mobilization advance shall be released to the contractor in following stages:

Stage –I Maximum 5% of contract value on fulfilment of the conditions described in clause 70.1 above.

Stage –II Maximum 5% of contract value on establishment of site camp and offices, mobilization of necessary plant and machinery and manpower and other facilities for commencement of work.

Satisfactory Utilization certificate from the contractor for Stage-I mobilization advance should be obtained before releasing stage-II advance.

70.3 Recovery

The recovery of mobilization advance along with upto date interest thereon shall commence from the Contractor’s on account bills when the value of the work executed under the contract reaches 15% of original contract value, and shall be completed when the value of work executed reaches 85% of the original contract value. The instalments on each “on account bill” shall be on pro-rata basis.

In the event of amount of outstanding advance with interest thereon becoming more than the available B.G. the Contractor shall have to provide a fresh B.G. with increased amount or provide a separate B.G. to cover additional amount likely to be overdue beyond the existing value of Bank Guarantee.

70.4 Calculation of Interest

Interest shall be compounded on diminishing balance basis on the amount of advance outstanding. The date of issue of cheque shall be reckoned as the date on which the recovery has been made for purpose of computing the outstanding advance and working out the interest.

71.0 PROPOSED MINIMUM LIST OF PLANT AND MACHINERY:

A list of minimum Plant & Machinery required for completion of the work within the time frame is given hereunder. Bidders are free to evaluate and work out the additional requirement at their own.

Appendix-IVB- Minimum List of Plant and Machinery proposed to be deployed for this project

S. No.	Description	Capacity	Numbers Required
1	Poelain	-	3
2	Concrete Vibrators	2HP	4Nos.
3	Form vibrator	500watts	2Nos.
4	Vibratory Roller	8-10 Ton	1
5	Tippers	5 Ton	8
6	JCB	0.25 Cum	3
7	Water Tanker	2000 Ltr.	2

8	Crane with grabbing tool including all accessories	-	3
9	Concrete Batching Plant	30 Cum/Hr	1
10	Crane for lifting of girders of required capacity based on launching Methodology.		2
11	Transit Mixer	---	4
12	Needle Vibrator	60 mm/ 40 mm	10
13	Concrete Pump with boom placer	10 to 20 HP with 40 m pipe length	1
14	Welding Machine	300 Amp/ 3Kvto5KV	4
15	Gas Cutting Set	-	4
16	Generator	45 KVA (3 Phase)	2
17	Generator	15 KVA (3 Phase)	2
18	Submersible pump	40HP	2
19	Compressor with jack hammer		2
20	Hydraulic Excavators	1.5-2cum	2
21	Dozers	0.75cum	2
22	Front end loaders	1.0cum	3
23	Tippers	9.0cum	3
24	Reinforcement Steel Cutting Machine		1No.
25	Reinforcement Steel Bending Machine		1No.
26	Hydra12.0T capacity crane		1No.
27	Concrete Funnel Bucket		1No.
28	Air Compressor	100 to150cum	1 No.
29	Explosive van (Duly licensed)		1No.
30	Portable explosive magazine (Duly licensed)		1No.
BRIDGE GIRDER/TRUSS LAUNCHING EQUIPMENT			

All necessary equipment for launching of bridge girder including allied structures considering high ethics of safety concern as required to complete the launching of bridge. Equipment should be of latest model with technology upgraded to date.			
Sr. No	Equipment / facility description	Type / size/ capacity	Required No./Set
A	Earthwork/Access Road		
1	Excavators	0.9 to 1.5 cum	1
2	Dumpers	1	2
3	Dozers	165	1
4	Vibratory rollers/soil compactor	8-	1
B	PILING		
1	Crawler Mounted Hydraulic Rotary Drilling Rig for pile boring in moderately weathered/medium to hard rock/River Bed Boulder.	Minimum 1.2 mtr to 1.5 mtr dia	2
2	Conventional Baler-Chiesel Rigs for pile boring in weathered rock	1.2 m to 1.5 m dia pile	2
3	Rock/Concrete Breakers	-	3
C	CONCRETE PRODUCTION, TRANSPORT &		
1	Concrete batching plant with all accessories	30 Cum/hr to 45 Cum /hr	1
2	Transit mixers	4 - 6 cum	4
3	Concrete Pump	30 cum/ hr	2
4	Concrete Pump with high lift capacity	BP1800 HDR or similar	1
5	Surface/Plate Vibrators	-	3S
6	Needle Vibrators (0.6m needle or	40 mm / 60 mm	2 Nos
7	Slip form shuttering for hollow pier	Height of pier 90 mtr-	As required to complete the work within the
8	Concrete Mixers with Hopper	4 – 6 cum/hr	2
9	Launching of Structure	All equipment shall be arranged depending on launching methodology adopted as per site condition.	
10	Screening cum stone crushing machine of required capacity	For crushing & screening of Earth/Muck/Boulder excavated from formation cutting and muck from nearby tunnel excavation development area and nearby existing Tunnels.	

Note: Above list of equipment is indicative only, contractor has to make assessment and shall be responsible for deployment if works demand to complete the project in stipulated time.

72.0 Laboratories:

- 72.1** Contractor shall have to provide a field laboratory for carrying out all tests require, as per specifications or as stated elsewhere in the contract, including supply of laboratory equipment and also provision of adequate number of qualified personal, erection, maintenance and running of laboratory including all consumable during execution of works. Storage space shall also be arranged for all material and samples. If so desired by Engineer-in-Charge the tests may also be carried out in Government approved labs at a place chosen by the Engineer-in-charge. The tests shall be conducted in the presence of IRCON and contractor's representative.
- 72.2** Contractor will keep deployed sufficient survey team with TOTAL STATION & DGPS SURVEY INSTRUMENT of approved configuration with all accessories for exact and precise setting out of all the works at his own cost. Contractor shall also have to make/maintain adequate numbers of secondary reference survey pillars/points/towers/Stone Slabs of suitable dimensions at his own cost. No additional payment shall be given on this account.
- 72.3** The design mix, shall be done well in advance, by the contractor and got approved by IRCON. IRCON reserves the right to suggest changes in the job mix submitted by the contractor and no claim on account of these changes shall be entertained from the contractor. The approved mix design would be strictly followed by the contractor.
- 72.4** The contractor shall also be responsible for carrying out all test at site and getting approval from the client for the same. For site testing all the materials equipment, consumable, stationary and samples etc. including manpower will be arranged by contractor at his own cost.
- 72.5** The contractor shall also be responsible for the collection of the samples at source or in the field and it's submission at the central lab/any third party lab for the test to be done at central lab/any third party lab.
- 72.6** All materials to be incorporated in the permanent works for which the testing facility is not available in this central laboratory, will be tested from IRCON's approved institute /Laboratory. All the cost of such testing and it's arrangements /witnessing by the Engineer/Clients, will be borne by the contractor. Nothing extra will be payable on this account.
- 72.7** The contractor shall furnish samples of the all materials indicating the date, location and all sources and obtained the approval of source before proceeding with execution of works.
- 72.8** The contractor shall be fully responsible for obtaining all approvals of all sources as well furnished works from IRCON, as directed by the Engineer and /or other than what has been specifically maintain elsewhere.
- 72.9** In case of failure on the part of the contractor to provide above facilities, IRCON shall arrange and provide the same and recover all direct/indirect cost from the contractor's payment. No claim shall be entertained all this account.
- 72.10** The contractor must get the on time calibration of all his testing equipment, lab equipment, instrument etc from Govt./approved agencies from time to time. He should

submit all the calibration certificate or his instruments/equipment before the use of these equipment/instrument to IRCON and take prior permission for their use from the Engineer or his representative. All this equipment/instrument shall have calibrated within prescribed time and as per the instructions of the Engineer if any immediate calibration is required. These all calibration shall be carried out by the contractor at his own cost without charging/claiming any amount to IRCON.

- 72.11** Testing facilities for other construction materials as per direction of Engineer.
- 72.12** The contractor should make his own arrangement for taking samples to approved laboratory, testing centers including to the site laboratory as directed by the Engineer at their cost.
- 72.13** The contractor shall provide all tools, plants and equipment and skilled and un-skilled labour for collecting the test samples, their handling at his own cost as directed by Engineer/his representative.
- 72.14** The contractor shall nominate one Engineer exclusively for the quality control that would be responsible for co-ordination with Engineer and for maintenance of quality records as per ISO 9001-2000 requirement at no extra cost.
- 72.15** The contractor has to provide a field laboratory and/or laboratories within 30 days of issue of Letter of Acceptance, adjacent to site of the subject work for carrying out various tests as required, as per Specifications or as stated elsewhere in the contract, including supply of laboratory equipment and also provision of adequate number of qualified personnel, skilled/unskilled workers, erection, maintenance and running of laboratories including all consumable like chemicals and reagent. The laboratory shall be equipped with necessary equipment to carry out various tests such as sieve analysis, compression tests on cubes, slump test, workability test etc on aggregates, cement, water and concrete as required for ensuring the required quality and standard conforming to codal provision and specifications. All the pressure gauges, machines, equipment and other measuring and testing equipment of lab shall be got checked /calibrated regularly as directed by Engineer and necessary certificates furnished to him.
- 72.16** The Contractors site laboratory equipped with at least following apparatus and equipment of standard ISI mark shall function under the guidance of Engineer. This list is indicative and not exhaustive.

- ✓ Digital Hydraulic Cube Testing Machine (200 T Capacity)
- ✓ Aggregate Impact Test – Apparatus
- ✓ Abrasion Testing Machine
- ✓ Flakiness Index Apparatus
- ✓ Sieve Set – Coarse & fine aggregate
- ✓ Drying oven (300° C)
- ✓ Slump Cone Set
- ✓ Weighing balances
- ✓ Hot plate
- ✓ Cube moulds (sufficient numbers)
- ✓ Sand pouring cylinder
- ✓ Core cutting equipment
- ✓ Stop watch
- ✓ Measuring Jar (1000 ml to 50 ml)
- ✓ Thermometer
- ✓ Direct Shear Test apparatus
- ✓ Triaxial Stress Test apparatus
- ✓ Sand replacement apparatus
- ✓ Modified Proctor test apparatus

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- ✓ PH meters
 - ✓ Other field density measuring apparatus
 - ✓ Requisite furniture
 - ✓ Cement testing equipment as per direction of Engineer.
 - ✓ The laboratory should minimum equipped with the equipment required for modern Civil Engineering Construction with digitally recordable as available in the construction industry.
 - ✓ Any other equipment / items as required by Engineer.

72.17 The contractor must get the calibrations of all his testing equipment, lab equipment, instrument etc. from Govt./ Govt. approved agencies. He should submit all the calibration certificate of his instrument/equipment before the use of these instruments/equipment to IRCON and take prior permission for their use from IRCON. All this equipment / instrument shall be calibrated on quarterly basis or earlier if required and as per the instructions of IRCON as and when calibration is required. These all calibration shall be carried on by the contractor at his own cost without charging any amount to IRCON.

72.18 Charges for testing: No payment shall be made to the contractor for setting of laboratory, unless otherwise stipulated in BOQ. No payment shall be made for getting any test from any external laboratory approved by the Engineer and rate quoted in Bill of Quantities shall be deemed to include all testing and other cost.

73.0 PRICE ADJUSTMENT

73.1 Price variation clause (PVC) is applicable.

73.2 The rates for each items quoted by the contractor in his tender and accepted by the IRCON shall hold good till the completion of the work.

73.3 Fluctuation in market rates/conditions taxes additional levies or any other changes in the cost of an item as a whole or in the cost of a component of expenditure constituting that item shall be taken into account and payment to contractor shall be adjusted as if increased/decreased, in accordance with the provisions of clause number **46 A of IR General Conditions of Contract July-2020**. No other claims on account of which disputes shall be admissible.

73.4 The total amount payable to the contractor for the payments made through on account /final bills for the work done in a particular quarter shall be adjusted i.e. increase / decrease in various price Indices publish by the Reserve Bank of India from time to time or a mentioned.

For adoption of percentage of labour component, material component, fuel component etc. in this contract this work shall be considered as "**other work**".

74.0 COMPLETION PERIOD.

The work is requiring to completed within a period as specified in the Appendix to Tender from the date of issue of letter of acceptance. The work shall be completed in phased manner if specified.

The work has to be executed in co-ordination with other agencies working on or near the project. In case of any delay in the completion period the extension of the same shall be dealt as per the clause 46.0 of Special Conditions of the Contract (SCC).

75.0 VITIATION OF CONTRACT

The aspect of vitiation of tender with respect to variation in quantities should be checked and avoided. In the event of vitiation occurring due to increase or decrease in quantities among the 1st, 2nd & 3rd lowest valid tenderers, the vitiation shall be on contractor's account. The total value of the work done shall be calculated at the rate offered by the three lowest valid tenderers (L1, L2 & L3) and the amount payable shall be limited to lowest aggregate value as worked out amongst the three. The clause will be applicable to the agreement as a whole, for variations in quantities in all contract schedules except new/additional items if any."

76.0 DEFECT LIABILITY PERIOD

The Contractor shall maintain, rectify and make good at his own cost any defect /deficiencies, which may develop in the work or as notified by the Engineer during Defect Liability Period as specified in the **Appendix to Tender**. However, maintenance during Defect Liability Period shall not include day to day upkeep, cleaning, custody and security of the work.

77.0 ROYALTIES AND PATENT RIGHTS

The Contractor shall defray the cost of all royalties, fees and other payments in respect of patent rights and licenses which may be payable to any patentee, licensee or any other person or corporation and shall obtain all necessary licenses unless otherwise stated in the special conditions. In case of any breach (whether willfully or inadvertently) by the Contractor of this provision, the Contractor shall, indemnify the Railway/IRCON and their officers, staff, representatives against all claims, proceedings, damages, cost charges, acceptances loss and liability which they or any of them sustain, incur or be put by reason or in consequence directly or indirectly of any such breach and against payment of any royalties, damages and other monies which the Railway / IRCON may have to make to any person or any machine, instruments, process, articles, matters, or thing constructed, manufactured, supplied or delivered by the Contractor to his order under this contract.

78.0 ROYALTY OF EARTH, BALLAST, SAND, MOORUM AND AGGREGATE

The minerals being used by the contractor should be purchased from valid authorized lease/permit holders/authorized dealers.

78.1 The Railway/IRCON shall do the following step to prevent evasion of royalty and illegal mining.

- i. Bill preferred by works contractor in which minor minerals have been used, must be accompanied with an affidavit form 'M' with particulars in form 'N' of the Rules along with a photocopy of said affidavit and particulars. Bill should not be entertained unless accompanied with aforesaid documents.
- ii. The photocopy of the affidavit and the particulars received with the bill should be sent to District Mining Officer/Assistant Mining Officer within whose jurisdiction the mineral was allegedly purchased, for verification. If the said affidavit or information is found wrong, Mining Officer may take necessary/ appropriate action against the contract as per rules.

78.2 Any increase in royalty after Tender Opening/Negotiation date shall be payable by the Railway. Similarly, any decrease in Royalty shall be deducted from the contractor's bills by the Railway.

78.3 No claim for idle labour and or idle machinery etc. on any account will be entertained. Similarly, no claims shall be entertained for business loss or any such loss.

78.4 Registration in West Bengal/Sikkim :The tenderer for carrying out any construction work in West Bengal/Sikkim must get themselves registered from the registering officer under Section 7 of the Building and other Construction Workers Act, 1996 and rules made there to by the WB/Sikkim Govt. and submit certificate of registration issued from the registering officer of the WB/Sikkim Govt. (Labor Department.). For enactment of this Act, the tenderer shall be required to pay cess as applicable on the cost of construction work to be deducted from each bill.

79.0 UPDATATION OF LABOUR DATA ON INDIAN RAILWAY SHRAMIK KALYAN PORTAL BY CONTRACTOR

79.1 Contractor shall abide by the provisions of Payment of Wages Act & Minimum Wages Act in terms of SCC clause no 37.0 : “Wages of Labour” . In order to ensure the same, an application has been developed and hosted on website www.shramikkalyan.indianrailways.gov.in. Contractor shall register his firm/company etc and upload requisite details of labour and their payment in this portal. These details shall be available in public domain. The Registration/up dation of Portal shall be done as under:

- a. Contractor shall apply for onetime registration of his company/firm etc. in the shramik kalyan portal with requisite details subsequent to issue of Letter of Acceptance. Engineer shall approve the contractor’s registration on the portal within 7 days of receipt of such request.
- b. Contractor once approved by the Engineer, can create password with login ID (PAN No) for subsequent use of portal for all LOAs issued in his favor.
- c. The contractor once registered on the portal, shall provide details of his Letter of Acceptances (LOA)/Contract Agreements on shramik kalyan portal within 15 days of issue of the LoA for approval of the concerned Engineer. Engineer shall update (if required) and approve the details of LoA filled by contractor within 7 days of receipt of such request.
- d. After approval of LoA by the Engineer, Contractor shall fill the salient details of contract labours engaged in the contract and ensure updating of each wage payment to them on shramik kalyan portal on monthly basis.
- e. It shall be mandatory upon the contractor to ensure correct and prompt uploading of all salient details of engaged contractual labour & payments made therefor after each wage period.

79.2 While processing payment of any ‘On Account bill’ or ‘Final bill’ or release of ‘Advances’ or Performance Guarantee / Security Deposit’ , contractor shall submit a certificate to the Engineer or Engineer’s representatives that “I have uploaded the correct details of contract labours engaged in connection with this contract and payments made to them during the wage period in Railway’s Shramikkalyan portal at ‘www.shramikkalyan.indianrailways.gov.in’ till _____Month , _____Year.

80. Claims & Arbitration :

Not Applicable in this contract.

Annexure-C

ENVIRONMENTAL MANAGEMENT PLAN DURING CONSTRUCTION

The Environmental Management Plan requires the Contractor to implement mitigation measures to prevent, minimize or offset impacts resulting from the Contractor's presence and activities relating to the project. Mitigation measures for impacts due to Contractor activities are considered for:

- (A) Socio-economic environment
- (B) Nature / ecology / landscape
- (C) Water
- (D) Climate / air, soil, agriculture, forestry

(A) Management of Socio-Economic Environment

ACTIVITY	IMPACT	MITIGATION MEASURES BY THE CONTRACTOR
Establishment and running of Contractors' workers' camps, site clearance	Accident risks from mobilizing construction equipment	Avoid mobilization of heavy equipment at night Oversize vehicles shall display warnings such as flashing lights Warning and/or precaution signs on safety Use of Personal Protective Equipment (PPE) Instruction on health and safety First aid facilities at the construction sites Fencing-off of site
	Health and social well-being of local population due to the introduction of workforce from other places	Induction for all site workers on environmental, occupational safety and health requirements; control that induction is carried out. Instruct workers not to interfere with local affairs or quarrel with local people. HIV/AIDS education for locals and site workers. Employ and train local persons to work on the project. Establishment of grievance mechanism for local persons. Allow local population close to the construction camp to make use of camp medical facilities. Concrete batching and aggregate crushing plants shall be located on the down wind direction of sensitive areas such as schools, hospitals or human settlement etc. In unavoidable circumstances, the time of the operation of the plant shall be limited. Shielding of crushing plants and other loud plant with noise barriers or shielding of nearby sensitive

ACTIVITY	IMPACT	MITIGATION MEASURES BY THE CONTRACTOR
		receptors Restriction of work between 10 pm and 6 am
	Outbreak of disease	<p>HIV/AIDS, COVID -19 and other infectious diseases education for locals and site workers.</p> <p>Medical check on all workers after their arrival on site and unhealthy workers shall not be allowed to remain on site.</p> <p>Necessary vaccinations shall be given to the workers and vaccination records shall be maintained.</p> <p>Provide enough water supplies for workers, and ensure sufficient sanitation for the camp: the proper drainage systems, and the proper locations for solid waste disposal.</p> <p>Medical treatment for Malaria should be available on site.</p> <p>Provide workers with mosquito nets.</p> <p>Stagnant water anywhere on site shall be prevented, e.g., by filling in of borrow pits.</p>
	Depletion of natural resources through demand for building materials, fuel, and food for workers	<p>Where local materials must be used, make agreements with local communities about the areas or the volume that can be harvested without significant impact.</p> <p>Support community development by paying an adequate price for any local resources used.</p> <p>Do not allow construction camps to become permanent settlements.</p> <p>Camps will be removed and the area brought back to pre-construction condition prior to project completion unless directed otherwise by the Engineer.</p> <p>Upon completion of construction, consideration will be given to transfer camp structures to local people for community or government use.</p>
	Occupational health and safety	<p>The Contractor is required to comply with all the precautions as required for the safety of workmen as per the International Labour Organization (ILO) Convention No. 62, as far as those are applicable to the Contract.</p> <p>Workers shall be provided with appropriate personal protective equipment (PPE) such as safety shoes, hard hats, safety glasses, ear plugs/mufflers (as per Factory Act requirements), gloves, etc.</p> <p>All workers shall receive an induction on health</p>

ACTIVITY	IMPACT	MITIGATION MEASURES BY THE CONTRACTOR
		<p>and safety related to their activities as well as on the proper use of PPE. All visitors to the Contractor who intend to move around site must also receive a health and safety induction. The Contractor shall maintain records of environmental, health and safety inductions.</p> <p>All visitors to the Contractor must be supplied with PPE before they move around site. These visitors must be accompanied by Contractor personnel.</p> <p>The use of PPE shall be monitored.</p> <p>Where worker exposure to traffic cannot be completely eliminated, protective barriers shall be provided to shield workers from construction vehicles. Another measure is to install channeling devices (e.g., traffic cones and barrels) to delineate the work zone. This applies to the construction areas.</p> <p>Provision of distinguishing clothing or reflective devices or otherwise conspicuously visible material when there is regular exposure of workers to moving vehicles.</p> <p>The following facilities shall be provided at the workers' camps:</p> <p>Washing facilities and showers.</p> <p>Toilets/sanitation facilities with proper flushing provisions in accordance with local regulations to prevent any hazard to public health or contamination of land, surface or groundwater. These facilities shall be well maintained to allow effective operation.</p> <p>Accommodation for taking meals and for shelters during interruption of work due to adverse weather conditions.</p> <p>First aid room or station headed by qualified first aid personnel or a nurse should be provided at a readily accessible place for treatment of minor injuries and as a rest place for seriously sick or injured workers. The first aid unit shall include an adequate supply of sterilized dressing material and appliances shall be provided as per the requirements under the Factory Act. Depending upon the number, the health facilities shall be arranged as WHO norms.</p> <p>Construction equipment shall be operated by workers who have received appropriate training in accordance with national laws and regulations.</p>

ACTIVITY	IMPACT	MITIGATION MEASURES BY THE CONTRACTOR
		<p>The drivers and operators of vehicles and materials handling equipment shall be medically fit, trained and tested and of a prescribed minimum age as required by the government rules and regulation.</p> <p>Safety provisions shall be brought to the notice of all concerned by displaying a notice board at a prominent place at the work locations.</p> <p>The Contractor shall be responsible for observance, by his sub-contractors, of all health and safety provisions.</p> <p>All vehicles used in the construction yard should have reverse horns.</p> <p>Work areas should be properly demarcated with sign boards. The sign boards should be in local language and English.</p> <p>Suitable warning should be displayed at all places where contact with or proximity to electrical equipment can cause danger.</p> <p>Persons having to operate electrical equipment should be fully instructed as to any possible danger of the equipment concerned.</p> <p>All the electrical equipment should be inspected before it is taken into use to ensure that it is suitable for its purpose.</p> <p>Secure storage areas should be provided for flammable liquids, solids and gases such as liquefied petroleum gas cylinder, paints and other such materials in order to deter trespassers.</p> <p>Smoking should be strictly prohibited and no smoking notices be predominantly displayed in all places containing readily combustible or flammable materials.</p> <p>Only suitably protected electrical installations and equipment, including portable lamps, should be used.</p> <p>Oil rags, waste and clothes or other substances liable to spontaneous ignition should be removed without delay to a safe place.</p> <p>Fire-extinguishing equipment shall be provided at construction camps, asphalt plants, storage areas for combustible materials and other areas where fire hazards are found. Such equipment shall be properly maintained and inspected at suitable intervals by a competent person.</p>
	Public health and	Barriers (e.g., temporary fence), shall be installed

ACTIVITY	IMPACT	MITIGATION MEASURES BY THE CONTRACTOR
	safety risks	at construction areas to deter pedestrian access to the Bridge Project except at designated crossing points. The general public/local residents shall not be allowed in high-risk areas, e.g., excavation sites and areas where heavy equipment is in operation. Speed restrictions shall be imposed on Project vehicles and equipment when traversing areas with sensitive receptors (residential, schools, temples, etc.).
	Pollution due to use and storage of hazardous substances	Placement of hot-mix plants, quarrying and crushers, batch mixing plants and discharge of sewage from construction camps requires a No Objection Certificate (Consent to Establish and Consent to Operate) from the State Pollution Control Board prior to establishment.
	Encroachment on water supply systems	The Contractor will pay a fee to villagers for damage to water systems, based on number of days without water until the system is fixed.
	Disruption of existing traffic	Provide diversions where necessary/ possible Prevent landslides to the greatest extent through careful excavation and/or support measures; clear any landslides as quickly as possible Allow local population to use blacktopped / secured access roads
Construction and maintenance of access roads	Loss of vegetation and habitat at the quarries and borrow pits	No new quarries within provincial and district protected areas. In case of new quarries operation, the quarries will be approved by the relevant Environmental Monitoring Authorities.
Sourcing of materials	Visual impact spoil disposal, borrow pits, and quarries	Quarries will not be placed very near to the human settlement.
	Impact from extraction of construction materials	Pits may be reshaped and left flooded for water storage or fishponds. Conversion of borrow pits to fish ponds should be done in concurrence with the local population.
	Traffic disruption during construction	Employ “flag men” to regulate the traffic flow at every construction area and at key locations such as crossings or single-lane sections to minimize disturbance to local traffic.
Supply of	Accidental risk of	Install appropriate signs warning drivers to slow

ACTIVITY	IMPACT	MITIGATION MEASURES BY THE CONTRACTOR
materials to site / transport along access roads	injury or loss of life to people and livestock from increased traffic volume and speed from the construction vehicles	down in residential and livestock areas.
	Disturbance to local population at sensitive areas (e.g., schools)	Installation of noise barriers
	Damage to irrigation canals due to project	Dumping of spoils and fill materials into irrigation canals shall be avoided. In case of obstruction or damage, irrigation ditches and ponds shall be cleaned or repaired immediately to the maximum extent possible.
Open excavation, slope support works, bridges, stations	Location of noisy/dusty construction installations	Concrete batching plant and rock crushers shall be located at least 500 m from settlements, schools, and other sensitive receptors.
	Noise and vibration	All construction vehicles shall have working mufflers and they will be properly maintained. Inform people of the possible vibration before using vibrating rollers near settled areas. Construction yards shall be located away from settlement areas. Activities that will generate high noise levels shall be scheduled to coincide with periods when people are least likely to be affected. Construction activities will be strictly prohibited between 10 pm and 6 am in residential areas. Respect of religious holidays Shielding of sensitive receptors with noise barriers Welding machines operating on electricity and gas should be used during construction activities.
	Generation of wastage and wastewater	Proper maintenance of the construction equipment and material transportation trucks.
Excavated soil/rock disposal	Noise and vibration	All construction vehicles will have working mufflers and they will be properly maintained. Activities that will generate high noise levels will be scheduled to coincide

ACTIVITY	IMPACT	MITIGATION MEASURES BY THE CONTRACTOR
		<p>with periods when people are least likely to be affected. Construction activities will be strictly prohibited between 10 pm and 6 am in residential areas.</p> <p>Inform people of the possible vibration before using vibrating rollers near settled areas.</p>
	Respecting wishes of local population	Allow input of local population on re-cultivation and landscaping in accordance and coordinate work as appropriate

(B) Management of Nature / Ecology / Landscape

ACTIVITY	IMPACT	MITIGATION MEASURES
Establishment and running of Contractors' workers' camps, site clearance	Loss of land, buildings and livelihoods	Return of re-cultivated land to landowners after completion of project
	Biodiversity impact	<p>Planning of construction camp layout to ensure minimum encroachment</p> <p>Marked boundaries of camp</p> <p>Construction camp management plan.</p> <p>Site Waste Management Plan and its enforcement.</p> <p>Prevention of poaching of wild animals by construction workforce</p> <p>Plan and carry out post construction site clean-up.</p>
	Felling of trees	<p>Forest clearance from the Department of Forests is required for use of forest land for non-forest purposes. Prior permission is required from the WB Forest Department for work in forest areas and felling of trees. Cutting of trees needs to be compensated by afforestation as per the requirements of the Department of Forests.</p> <p>Labour force in the labor camps should be provided with LPG cylinders to avoid encroachment on forest area during construction phase.</p>
	Depletion of natural resources through demand for building materials, fuel, and food for workers	<p>Where local materials must be used, make agreements with local communities about the areas or the volume that can be harvested without significant impact.</p> <p>All supplies for building camps will be brought from outside the area.</p>

ACTIVITY	IMPACT	MITIGATION MEASURES
		<p>Camps will be removed and the area brought back to pre-construction condition prior to project completion.</p> <p>Upon completion of construction, consideration will be given to transfer camp structures to local people for community or government use.</p>
	<p>Impacts on wildlife through interruption of migratory routes and other habitat disturbances</p>	<p>Strict monitoring to prevent tree cutting and hunting.</p> <p>Restriction of vehicles and personnel to construction site</p>
	<p>Pollution due to use and storage of hazardous substances</p>	<p>Construction storage/stockpiles shall be provided with bunds to prevent silt run-off.</p> <p>Stockpile areas and storage areas for hazardous substances shall be located away from water bodies.</p> <p>Washing of machinery and vehicles in surface waters shall be prohibited.</p> <p>Hydrocarbon, toxic material and (explosives --- if blasting is necessary) will be stored in adequately protected sites to prevent soil and water contamination while vehicle maintenance and re-fueling will be confined to areas at construction sites designed to contain spilled lubricants and fuels.</p> <p>Fuel depot shall be provided with impervious flooring and bund/containment wall to keep spilled fuel/lubricant within the depot.</p> <p>Used oil and other toxic and hazardous materials shall be disposed of in an authorized facility off-site.</p> <p>Spill waste will be disposed at disposal sites approved by local authorities.</p> <p>All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations shall comply with all applicable statutory stipulations.</p> <p>The personnel in-charge of these sites will be properly trained and these areas will be access controlled and entry will be allowed only through authorization.</p>
<p>Construction and maintenance of access</p>	<p>Land-take</p>	<p>Minimize necessary land-take for access roads</p> <p>If agricultural land is fragmented, provide</p>

ACTIVITY	IMPACT	MITIGATION MEASURES
roads		accesses
	Landslides and destabilization of hill slopes	<p>Consideration of geological setting during excavation works and careful excavation.</p> <p>Implementation of slope support measures immediately after excavation</p> <p>earth disposal only in pre-defined locations</p> <p>Monitoring of destabilized hillsides</p>
	Rock fall	<p>Anchoring of large, un-jointed rock masses</p> <p>Strong netting covering slopes to prevent rock fall reaching roads</p>
Sourcing of materials	Loss of vegetation and habitat at the quarries and borrow pits	<p>Avoid unnecessary damage to vegetation.</p> <p>No new quarries within provincial and district protected areas.</p> <p>No cutting of trees outside of the construction zone.</p> <p>In case of new quarries operation, the quarries will be approved by the relevant Environmental Monitoring Authorities.</p> <p>Definition of site by perimeter fencing</p> <p>Stopping of work if wildlife habitats are discovered and abandoning these sites</p>
	Erosion and instability of cut faces and borrow pits	<p>Pile topsoil from digging of borrows pits carefully to one side, where it can be later used for reclamation.</p> <p>At the end of the construction phase, re-contour borrow pit walls, replace topsoil, and re-vegetate.</p> <p>Re-vegetate all cut slopes.</p> <p>For re-vegetation purposes, use native varieties according to the soil type, climate and ease of maintenance. Saplings shall be planted to coincide with appropriate season to ensure survival.</p>
	Degradation of quarries and borrow pits	<p>The contractor shall observe environmentally responsible procurement by sourcing materials from authorized quarries. According to the license conditions, the quarry sites should have an approved quarry site management and closure plan including an Environmental Management Plan (EMP).</p> <p>Priority must be given to the use of existing quarry sites, if they are available and suitable.</p> <p>If the contractor shall operate a quarry site, required environmental permits shall be secured prior to operation of quarry/borrow areas.</p>

ACTIVITY	IMPACT	MITIGATION MEASURES
		<p>Topsoil, overburden, and low-quality materials shall be properly removed, stockpiled near the site, and preserved for rehabilitation.</p> <p>Contractors shall ensure that borrow pits are left in a tidy state with stable side slopes and proper drainage in order to avoid creation of stagnant water bodies, which are favorable places for mosquito breeding.</p>
	Re-cultivation of quarries and borrow pits	<p>Re-cultivate borrow pits and quarries by with native species.</p> <p>Restoration of wildlife habitats</p>
	Visual impact spoil disposal, borrow pits, and quarries	<p>Where feasible, quarries will be sited away from the project area. Blasting and construction of crushing plants will be done away from the project. The plants will not be placed very near to the human settlement.</p> <p>At sites where quarries must be close to the project, trees and other vegetation will be left between the quarry/crushing plant sites and other working areas.</p> <p>As soon as construction work is over the surplus earth should be utilized to fill up low-lying areas. Loose earth should not be allowed to pile up near site.</p>
Supply of materials to site / transport along access roads	Loss of vegetation due to haulage routes and detours	Remove and store the topsoil of any important detours and it should be used for rehabilitation and re-vegetation of the area after construction.
	Injury / killing of wildlife	Enforcement of speed limits on access roads
Open excavation, slope support works, bridges, stations	Biodiversity impact	<p>Marked boundaries of work areas and enforcement of work only within these boundaries</p> <p>Perimeter fencing of construction area</p>
	Felling of trees	Afforestation in collaboration with WB Forest Department
	Land-take	<p>Minimize necessary land-take</p> <p>If agricultural land is fragmented, provide accesses</p>
	Landslides and destabilization of hill slopes	<p>Consideration of geological setting during excavation works and careful excavation.</p> <p>Implementation of slope support measures immediately after excavation</p> <p>earth disposal only in pre-defined locations</p> <p>Monitoring of destabilized hillsides</p>

ACTIVITY	IMPACT	MITIGATION MEASURES
	Rock fall	Anchoring of large, un-jointed rock masses Strong netting covering slopes to prevent rock fall reaching roads
Landscaping and re-cultivation of site	Re-cultivation of sites	Re-cultivation of all sites used by construction using topsoil excavated by the project and native plant species
	Landscaping of sites	Landscaping to merge the sites into the surrounding landscape

(C) Management of Water

ACTIVITY	IMPACT	MITIGATION MEASURES
Establishment and running of Contractors' workers' camps, site clearance	Stress on water resources	Store water on site; collected during periods when water is plentiful. Restrict use of local water resources to ensure that sufficient water is available to the local population, their livestock and for agriculture. Workers shall be provided with potable water supply.
	Water pollution	Contractor's Site Waste Management Plan and its enforcement Site construction camps at least 100 m away from rivers and as far as possible from local communities Construction materials shall be placed away from drains to prevent blocking of drainage systems. Materials containing fines shall be stored so as to prevent siltation. Surface water quality monitoring in accordance with monitoring plan and action if defined limit values are exceeded Construction camps shall be provided with adequate drainage to avoid accumulation of stagnant water. Water transport tanks, storage tanks and dispensing container should be designed, used, cleaned and disinfected at suitable intervals in a manner approved by the competent authority. Water that is unfit to drink should be noticeably marked by notices prohibiting workers from drinking it. Provision of appropriate sanitary facilities for workers Provision of drainage channels to intercept

ACTIVITY	IMPACT	MITIGATION MEASURES
		<p>polluted water Sedimentation basins to remove dust Water treatment plant</p>
	<p>Solid waste from the construction camps</p>	<p>Wastewater from the construction camps should be settled and treated prior letting it out. The wastewater should not be let down into nearby surface waters. Provision of appropriate sanitary facilities for workers</p>
	<p>Outbreak of disease</p>	<p>Provide enough water supplies for workers, and ensure sufficient sanitation for the camp: the proper drainage systems, and the proper locations for solid waste disposal. Stagnant water should be prevented.</p>
	<p>Pollution due to use and storage of hazardous substances</p>	<p>Hydrocarbon, toxic material and (explosives --- if blasting is necessary) shall be stored in adequately protected sites to prevent water contamination while vehicle maintenance and re-fueling shall be confined to areas at construction sites designed to contain spilled lubricants and fuels. Fuel depot shall be provided with impervious flooring and bund/containment wall to keep spilled fuel/lubricant within the depot. Used oil and other toxic and hazardous materials shall be disposed of in an authorized facility off-site. Spill waste shall be disposed at disposal sites approved by local authorities. Adequate precaution shall be taken to prevent oil/lubricant/ hydrocarbon contamination of channel beds. Spillage, if any, shall be immediately cleared with utmost caution to leave no traces. The personnel in-charge of these sites shall be properly trained and these areas shall be access controlled and entry shall be allowed only through authorization.</p>
	<p>Ground and water contamination by oil, grease, fuel, etc.</p>	<p>Collect, store and dispose of POL materials in accordance with local law or standard acceptable practice.</p>
<p>Construction and maintenance of access roads</p>	<p>Disturbance to surface water</p>	<p>Divert watercourses crossing access roads underneath the roads (culverts, bridges) Collect surface water in channels constructed at</p>

ACTIVITY	IMPACT	MITIGATION MEASURES
		the edges of access roads and provide cross-drainage to divert water underneath the roads into the nearest stream/nala Avoid construction of fords where possible
	Pollution of water along access roads	Immediate clear up of any spillage Disposal of excavated material only at pre-defined disposal areas; no disposal over slopes Avoid construction of fords where possible Monitoring of water quality at sensitive locations and action if defined limit values are exceeded
Sourcing of materials	Impact on downstream watercourses	Install settlement basins, which allow silt, pollutants and rubbish to settle out of runoff water before it flows into downstream water courses.
	Drainage of quarries and borrow pits	The contractors shall ensure that borrow pits and quarries are left in a tidy state with stable side slopes and proper drainage in order to avoid creation of stagnant water bodies, which are favorable places for mosquito breeding.
Supply of materials to site / transport along access roads	Risk of accidental spill of toxic materials	Immediate clear-up of any spills to ensure they do not enter any watercourses
Open excavation, slope support works, bridges, stations	Water quality impacts	Work in rivers will be scheduled during dry season and work during the monsoon months shall be minimized. Immediate stabilization of bare slopes. Construction storage/stockpiles shall be provided with bunds to prevent silt run-off. Stockpile areas and storage areas for hazardous substances shall be located away from water bodies. Washing of machinery and vehicles in surface waters shall be prohibited.
	Water pollution	Provision of drainage channels to intercept polluted water, water treatment plant.
Landscaping and re-cultivation of site	Landscaping changes to drainage systems	Creation of natural channels to discharge surface water into watercourses

(D) Management of Climate / Air, Soil, Agriculture, Forestry

ACTIVITY	IMPACT	MITIGATION MEASURES
Establishment and	Loss of land,	Return of re-cultivated land to landowners after

ACTIVITY	IMPACT	MITIGATION MEASURES
running of Contractors' workers' camps, site clearance	buildings and livelihoods	completion of project
	Biodiversity impact	Planning of construction camp layout to ensure minimum encroachment Marked boundaries of camp Construction camp management plan. Contractor's Site Waste Management Plan and its enforcement Prevention of poaching of wild animals by construction workforce Plan and carry out post-construction site clean-up.
	Felling of trees	Afforestation in collaboration with WB Forest Department
	Solid waste from the construction camps	Contractor's Site Waste Management Plan and its enforcement Provide garbage tanks and sanitary facilities for workers. Waste in tanks should be cleared regularly so that vector borne infections can be prevented. Wastewater from the construction camps should be settled and treated prior to discharge. The wastewater should not be let down into nearby surface waters. Garbage will be collected in a tank and be disposed of periodically. Special attention will be paid to the sanitary condition of camps.
	Depletion of natural resources through demand for building materials, fuel, and food for workers	Do not harvest wood resources within project area. Conduct awareness-raising campaigns on tree conservation to workers.
	Improper disposal of solid waste	Contractor's Site Waste Management Plan and its enforcement Segregation of waste shall be observed. Organic (bio-degradable) shall be collected and disposed of on site by composting (no burning on site). Recyclables shall be recovered and sold to recyclers. Residual and hazardous waste shall be disposed of at pre-defined disposal sites approved by local authorities.

ACTIVITY	IMPACT	MITIGATION MEASURES
	Ground contamination by oil, grease, fuel, etc. and other hazardous substances	Contractor's Site Waste Management Plan and its enforcement Collect, store and dispose of POL materials in accordance with local law / best practice.
Construction and maintenance of access roads	Dust/air pollution Emissions from vehicles	Maintain all construction vehicles to minimize toxic vehicle emission. Ensure catalytic converters are fitted to vehicles. Each vehicle being used for the project shall have a valid Pollution Under Control Certificate. Sprinkle water on the haulage routes to prevent dust emission at residential areas. Speed regulations should be strictly observed, in particular in residential areas or near schools. Air quality monitoring at sensitive locations in accordance with monitoring plan and action if defined limit values are exceeded
	Vehicular noise and vibrations	Limit construction works to between 6 am and 10 pm in or near villages. Avoid use of vehicles with excessive noise emission, install and maintain equipment silencers. Noise monitoring at sensitive locations in accordance with monitoring plan and action if defined limit values are exceeded
	Felling of trees	Afforestation in collaboration with WB Forest Department
	Soil erosion	Slopes excavated to pre-defined inclinations which are less than the soils' angles of friction Drainage channel at top of slopes to prevent water runoff over slope Planting of slopes to fix soil Use of geotextiles to prevent soil erosion
	Excavated materials	Re-use of uncontaminated rock and soil to the greatest extent possible (aggregate for concrete, stone walls, gabion production, landscaping)
Sourcing of materials	Opening of new quarry and borrow areas	No new quarries within provincial and district protected areas. No cutting of trees outside of the construction zone. Afforestation in collaboration with WB Forest Department to replace any felled trees
	Soil erosion and instability of cut	Minimize major earthworks during the rainy season.

ACTIVITY	IMPACT	MITIGATION MEASURES
	<p>faces and borrow pits</p>	<p>During construction, employ erosion prevention measures such as hay bales.</p> <p>Provide vegetative cover on erosion-prone areas.</p> <p>Install intercepting ditches at the top and at the bottom of slopes. Use gutters and spillways to control the flow of the water down slopes.</p> <p>Provide retaining structures such as gabions, riprap, or rock material embedded in a slope face, in combination with vegetation measures, as appropriate.</p> <p>Reinforce earth embankment walls as the earth fill is placed, with anchors compacted into the fill material.</p> <p>Provide cut off drains to catch water before it reaches critical areas, and diverging drains, to avoid excessive concentration of flow.</p> <p>Use of geotextiles to prevent soil erosion</p>
	<p>Impact of borrow pits, and quarries on air quality</p>	<p>Screens should be provided to prevent dust emissions.</p> <p>Air quality monitoring if any sensitive locations are nearby in accordance with monitoring plan and action if defined limit values are exceeded</p>
<p>Supply of materials to site / transport along access roads</p>	<p>Construction/traffic related dust and noise impacts in villages areas</p>	<p>Limit transport to between 6 am and 10 pm in or near villages.</p> <p>All vehicles delivering material to the site shall be covered to avoid material spillage.</p> <p>Avoid use of vehicles with excessive exhaust or noise emission, install and maintain equipment silencers.</p> <p>Maintain all construction vehicles to minimize toxic vehicle emission.</p> <p>Ensure catalytic converters are fitted to vehicles.</p> <p>Each vehicle being used for the project shall have a valid Pollution Under Control Certificate.</p> <p>Regularly sprinkle water on haulage routes in village areas during dry season, maintain the speed of the vehicles and maintain construction vehicles, cover haulage trucks with tarpaulins to prevent spillage.</p> <p>Speed regulations should be strictly observed, in particular in residential areas or near schools.</p> <p>Air quality monitoring at sensitive locations in accordance with monitoring plan and action if defined limit values are exceeded</p>

ACTIVITY	IMPACT	MITIGATION MEASURES
Open excavation, slope support works, bridges	Interference with agriculture	<p>Dumping of spoils and fill materials into irrigation canals shall be avoided.</p> <p>In case of obstruction or damage, irrigation ditches and ponds shall be cleaned or repaired immediately to the maximum extent possible.</p> <p>Provision of access to farmed land if the work site fragments land</p>
	Removal of topsoil	Removal and storage of topsoil in accordance with the guidelines set out in this report
	Felling of trees	Afforestation in collaboration with WB Forest Department
	Dust/air pollution	<p>Concrete batching plant and rock crushers shall be located at least 500 m from settlements, schools, and other sensitive receptors.</p> <p>Dust control through frequent water sprinkling, particularly in dry periods</p> <p>Use of dust and noise barriers</p> <p>Avoid use of vehicles with excessive exhaust or noise emission, install and maintain equipment silencers.</p> <p>Maintain all construction vehicles to minimize toxic vehicle emission.</p> <p>Ensure catalytic converters are fitted to vehicles.</p> <p>Each vehicle being used for the project shall have a valid Pollution Under Control Certificate.</p> <p>Air quality monitoring at sensitive locations in accordance with monitoring plan and action if defined limit values are exceeded</p>
	Ground compaction	<p>Restrict movements of heavy machinery</p> <p>Defined construction areas (perimeter fence)</p> <p>Control vehicle tyre inflation and use vehicles with large tyres</p>
	Excavated materials	Re-use of uncontaminated rock and soil to the greatest extent possible (aggregate for concrete, stone walls, gabion production, landscaping)
	Soil erosion and stability of steep slopes	<p>Slopes excavated to pre-defined inclinations which are less than the soils' angles of friction</p> <p>Implementation of support measures as per design</p> <p>Drainage channel at top of slopes to prevent water runoff over slope</p> <p>Planting of slopes to fix soil</p> <p>Use of geotextiles to prevent soil erosion</p>

ACTIVITY	IMPACT	MITIGATION MEASURES
		Monitoring of slope movement for unstable slopes
Landscaping and re-cultivation of site	Ground compaction and erosion	<p>Disposed earth shall be compacted in accordance with best practice guidelines as set out in this report</p> <p>Topsoil shall be re-used to re-cultivate slopes or terraces.</p> <p>Plantation (grasses) on slopes to maintain the soil stability.</p>

<i>Environmental issue</i>	<i>Mitigation Measure</i>
Site Clearance	All vegetation required to be cleared should be disposed at designated sites of Municipal Corporation/Project.
Generation of dust due to construction activities	<p>All vehicles delivering material to the site shall be covered to avoid material spillage.</p> <p>Construction site should be watered adequately and periodically to minimize fugitive dust generation so that SPM standards are not exceeded.</p> <p>All possible and practical measures to control dust emission during drilling operations shall be employed.</p> <p>Idling of delivery trucks or other equipment should not be permitted unnecessarily during periods of unloading or when they are not in active use.</p>
Emissions from construction equipment/vehicles	<p>Concrete batching plant is located at or near the project site so that there is no/minimum requirement of delivery trucks.</p> <p>Exhaust emissions from all construction equipment shall adhere to vehicle emission norms laid out by Central Pollution Control Board(CPCB)</p>
Escaping of dust from Storage Earthwork	All earthwork and construction material should be stored in such a manner so that generation of dust will be minimized
Generation of Noise due to construction activities	Welding machines operating on electricity and gas should be used during construction activities.

<i>Environmental issue</i>	<i>Mitigation Measure</i>
Noise from construction equipment required to be used	<p>The sitting of construction yard should be done leaving at least 500m distance from any residential areas. This will allow the noise to attenuate.</p> <p>Noise generating equipment to be used, shall adhere to emission norms as laid out by CPCB.</p> <p>Special acoustic enclosures (by way of noise shields, which can, be either brick masonry structure or any other physical barrier) should be provided for individual noise generating construction equipment such as Cement Concrete Mixers, Generators, Dumpers / Trucks, Bulldozers, Excavators. Damaged silencers to be promptly replaced by the Contractor.</p> <p>Operation hours for noise generating equipment such as pile driving, drilling and other construction activities, etc. shall be according to prevailing local laws and pre-approved by IRCON.</p> <p>Drilling operation should be done intermittently wherever possible.</p> <p>Construction activities involving noise-making equipment should be avoided during night-time, especially in the residential areas.</p>
Exposure to loud noise	Earplugs/ear mufflers should be provided to workers exposed to loud noise (As per Factory Act requirements)
Impact on drains	<p>Earth, stone or any other construction material should be properly stored away from drains so as not to block the flow of drainage system.</p> <p>Construction material containing fine particles should be stored in an enclosure such that sediment laden water does not drain into nearby water body.</p>
Siltation of water Body	Siltation of soil into Nalas near the Portals shall be prevented as far as possible by adapting soil erosion control measures such as turfing/pitching/stepping etc. on the slopes.
Waste collection, recycling and disposal during construction phase	<p>Construction waste includes waste arising from bridge construction, land excavation, site formation, civil / building construction, roadwork, renovation or demolition activities and mixed site clearance materials.</p> <p>The excavated material collected should directly be kept in the dumpers used for transportation. These dumpers carrying soil should not spill during transportation to the receiving point and they should be covered.</p> <p>The soil/earth construction spoils will be dumped at designated sites.</p>

<i>Environmental issue</i>	<i>Mitigation Measure</i>
Soil Erosion	<p>Top soil cover should be removed and kept aside to be later used to cover the fillings.</p> <p>Soil disposal site/ construction site should be compacted and re-vegetated.</p> <p>During filling operations both the edges should be protected by pitching /rip-raping/retaining wall as per the requirement.</p> <p>Adequate measures should be taken to control soil erosion and sedimentation.</p> <p>Government of India, Ministry of Railways guidelines for earthwork in Railway projects should be strictly followed.</p> <p>As soon as construction work is over the surplus earth should be utilized to fill up low lying area. Loose earth should not be allowed to pile up near site.</p>
Contamination by aqueous waste and sewage etc.	<p>No lubricants, oils, solvents or paint products should be allowed to discharge into water courses, either by direct discharge, or as contaminants carried in surface water runoff from the construction site.</p> <p>All aqueous wastes and site runoff should comply with the CPCB standards.</p> <p>Domestic sewage generated from any additional site toilets and washing facilities provided for construction workers should be collected separately and disposed off or appropriately treated to comply with statutory requirements.</p>
Sourcing materials quarry	<p>Quarry and borrow material such as sand, aggregates etc. should be collected only from the licensed quarries. According to the license conditions, the quarry sites should have an approved quarry site management and closure plan including an Environmental Management Plan (EMP).</p>
Providing Labour Camps and facilities	<p>The Contractor shall abide by the contract conditions and directions of DDC/Engineer with respect to sitting of labor camps, if provided.</p> <p>Labour camps should be provided with proper water supply sanitation, medical and educational facilities and labor welfare issues, etc.</p> <p>Labour force in the labor camps should be provided with LPG cylinders to avoid encroachment on forest area during construction phase.</p>
Occupational health and safety	<p>The Contractor is required to comply with all the precautions as required for the safety of workmen as per the International Labour Organization (ILO) convention No. 62, as far as those are applicable to the contract.</p>
Provision of safety accessories/appliances to each worker	<p>The Contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, masks etc. to the workers and staff.</p>

<i>Environmental issue</i>	<i>Mitigation Measure</i>
Safety precautions	Adequate precautions shall be taken to prevent danger from electrical equipment. All machines/equipment used shall confirm to the relevant Indian standards (IS) codes and shall be regularly inspected by the Safety officer.
Availability of first aid kit at construction site	A readily available first aid unit including an adequate supply of sterilized dressing material and appliances shall be provided as per the requirements under the Factory Act. Depending upon the number, the health facilities shall be arranged as WHO norms.
Workers and Commuters health and Hygiene	All anti-malarial measures shall be compiled which also including filling up of borrow pits. Railway works manual should be strictly followed.
Debris Disposal	Good disposal practices as recommended in design shall be followed. Temporary disposal of demolition debris, felled trees or stockyard beyond the project corridor must be avoided. The top soil from the stockpile shall be used to cover disturbed areas and also for re-development of borrow areas, landscaping and roadside plantation.

ENVIRONMENTAL MONITORING PLAN DURING CONSTRUCTION

<i>Environmental Component</i>	<i>Parameters</i>	<i>Standard</i>	<i>Location</i>	<i>Frequency</i>	<i>Duration</i>
Air Quality	Particulate Matter (PM _{2.5} , PM ₁₀) Sulphur dioxide (SO ₂) Nitrogen oxides (NO _x) Carbon monoxide (CO) Ammonia (NH ₃)	NAAQS	Batching plant Contractor's camp As otherwise directed by the Engineer	Twice a week, four weeks in a season and 3 seasons in a year (summer, winter, post monsoon).	As per CPCB guidelines
Noise	dB(A)	CPCB noise standards	At Contractor's yards near bridge site At batching plants As otherwise directed by the Engineer	Three times per year (not during monsoon) on days when site work is being carried out and as directed by the Engineer	As per CPCB guidelines. 24 hours monitoring in each season (summer, winter, post monsoon)

<i>Environmental Component</i>	<i>Parameters</i>	<i>Standard</i>	<i>Location</i>	<i>Frequency</i>	<i>Duration</i>
Water Quality (Surface water)	pH Total dissolved solids Total suspended solids Oil and grease Chemical oxygen demand Biological oxygen demand	CPCB, MoEF Standards	Sedimentation tanks at bridge construction areas Contractor's camps As otherwise directed by the Engineer	Once every season; summer, winter and post-monsoon.	As per CPCB guidelines
Drinking water	pH Odour Colour Turbidity Total dissolved solids Total hardness as CaCO ₃ Chlorides Alkalinity as CaCO ₃ Residual chlorine Calcium Magnesium Sulphate as SO ₄ Iron Fluoride Nitrate Lead Zinc Total coliform Faecal coliform	MoEF and CPCB standards	Springs/wells in nearby area Drinking water tanks As otherwise directed by the Engineer	Once every season; summer, winter and post-monsoon.	As per CPCB guidelines

<i>Environmental Component</i>	<i>Parameters</i>	<i>Standard</i>	<i>Location</i>	<i>Frequency</i>	<i>Duration</i>
Soil	Coarse fragments pH Electrical conductivity Calcium carbonate component Organic carbon component Exchangeable cations (calcium, magnesium, sodium, potassium) Available nitrogen Available phosphorus Available potassium	Once per year	Directed by the Engineer	Once in a year	-

<i>Environmental Component</i>	<i>Parameters</i>	<i>Standard</i>	<i>Location</i>	<i>Frequency</i>	<i>Duration</i>
Contamination of Excavated Material	<p>Inorganic Contaminants</p> <p>Arsenic (As)</p> <p>Lead (Pb)</p> <p>Cadmium (Cd)</p> <p>Chromium (Cr)</p> <p>Cobalt (Co)</p> <p>Copper (Cu)</p> <p>Nickel (Ni)</p> <p>Mercury (Hg)</p> <p>Zinc (Zn)</p> <p>Organic Contaminants</p> <p>Total organic carbon</p> <p>Hydrocarbon index</p> <p>Polycyclic aromatic hydrocarbon (Benzo(a)pyren component)</p> <p><i>Further / alternative parameters apply if a contaminant is geogenic.</i></p>	2008 Austrian Deposit Area Regulations	earth disposal areas	As required by the Engineer	-
Flora and fauna	<p>Vegetation mapping</p> <p>Number of felled trees</p> <p>Number of disturbed (wildlife) habitats</p> <p>Wildlife migration corridors</p>	-	Project area	As required by the Engineer	-

<i>Environmental Component</i>	<i>Parameters</i>	<i>Standard</i>	<i>Location</i>	<i>Frequency</i>	<i>Duration</i>
Slope stability	-	-	Unstable slopes in the project area	On a case-to-case basis as required by the Engineer and as directed by a geologist of the Engineer/DDC	-

(Fugitive Dust Mitigation Measures)

	Reporting	Reporting frequency	Reporting Period	Date of Submission	Report Reference
Contractor	Engineer	Quarterly			

Chainage	Current Construction Activity in Brief	Measures taken to control fugitive dust emission

Certified that the above information is correct.

For Contractor Monitoring Agency	/ For DDC	For Engineer

KEY ENVIRONMENTAL LEGISLATIONS IN INDIA

Name	Scope and Objective	Key Areas	Operational Agencies/Key Players
Water (Prevention and Control of Pollution Act,1974 as amended up to date)	To provide for the prevention and control of water pollution and enhancing the quality of water	Controls sewage and industrial effluent discharges	Central and State Pollution Control Boards
Air (Prevention and Control of Pollution Act (1981 as amended up to date)	To provide for the prevention and control of air pollution	Controls emissions of air pollutants	Central and State Pollution Control Boards
Forest Conservation Act,1980 as amended up to date	To halt India's rapid deforestation and resulting Environmental degradation	Restriction on de-reservation and using forest for non-forest purpose	Central government
Wildlife Protection Act,1972 as amended up to date	To protect wildlife	Creates protected areas (national parks/sanctuaries) categories of wildlife which are protected	Wildlife advisory boards; Central Zoo Authorities
Environment Protection Act,1986 as amended up to date	To provide for the protection and improvement of Environment	An umbrella legislation; supplements pollution laws	Central government nodal agency MoEF; can delegate powers to state department of Environment

ANNEXURE – X

FORM OF AGREEMENT

(To be executed on requisite value of stamp Papers)

AGREEMENT

THIS AGREEMENT made on _____ day of _____ (Month/year) between **IRCON International Limited, acting through-----**(Project Head and name/address of the Project-----) (hereinafter called “the Employer/Engineer”) of the one part and _____ (name and address of the Contractor) (hereinafter called “the Contractor”) of the other part.

WHEREAS the Employer is desirous that work of “.....” should be executed by the Contractor viz. **Contract No. _____** (hereinafter called “the Works”, and has accepted a Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

NOW THIS AGREEMENT WITNESSETH as follows:

1. In this Agreement, words and expressions shall have the same meaning as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement:
A. Volume I:
 - a). Letter of Acceptance
 - b). Notice Inviting Tender
 - c). Corrigendum (If any)
 - d). Form of Bid
 - e). Instructions to the Tenderers
 - f). Appendix to Tender
 - g). Special Conditions of Contract
 - h). General Conditions of Contract-Indian Railway, July 2020 (GCC)
 - i). Technical Specifications
 - j). Relevant codes and Standards
 - k). Drawings
 - l). Bill of Quantities
3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.

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

IN WITNESS whereof the parties hereto have caused this Agreement executed the day and year first before written.

(Name, Designation and address of the authorized signatory)

(Name, Designation and address of the authorized signatory)

Signed for and on behalf of the Contractor in the presence of:

Signed for and on behalf of the Employer in the presence of:

Witness:

Witness:

1.

1.

2.

2.

Name and address of the witnesses to be indicated

ANNEXURE-XI

(to be executed on a non-judicial stamp paper of ₹ 100/- only)

PERFORMANCE BANK GUARANTEE (UNCONDITIONAL)

To
IRCON INTERNATIONAL LIMITED,

[Acting through _____ (project Incharge) & Address of the Project]

WHEREAS _____ [name and address of Contractor] (hereinafter called “the Contractor”) has undertaken, in pursuance of Contract No. _____ dated _____ to execute the work of
“.....
.....
.....” (hereinafter called “the Contract.”);

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

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

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Contractor, up to a total of _____ [amount of Guarantee], _____ [amount in words], such sum being payable in the types and proportions of currencies in which the Contract Price is payable, and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of _____ [amount of Guarantee] as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

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

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

This guarantee shall be valid up to _____ (a date **60 days** from the date of completion of the work).

We, the Bank further agree that this guarantee shall be invokable at our place of business at New Delhi/NCR/Project HQ (Indicate detail address of branch with Code No.)*. The branch at New Delhi/NCR/Project HQ is being advised accordingly.

This Bank Guarantee shall be operative only if it is accompanied by a separate advice sent by (Name of Issuing Bank, with address) on (Name of Employer's Bank, with address) IFS Code through Structured Financial Messaging System (SFMS) and authenticated by the Employer's Bank

SIGNATURE AND SEAL OF THE GUARANTOR

Name of _____
Bank: _____
Address: _____
Date: _____

*The Bank should indicate detailed address of New Delhi/NCR/Project HQ branch along with its Code No.

ANNEXURE-XII

(to be executed on a non-judicial stamp paper of ₹ 100/- only)

BANK GUARANTEE FOR ADVANCE PAYMENT

To
IRCON INTERNATIONAL LIMITED

[Acting through (Tender Inviting Authority) & Address]

_____ [Name of Contract]

Gentlemen:

In accordance with the provisions of the Conditions of contract, Sub-Clause (“Advance Payment”) of the above-mentioned contract, _____
[name and address of the Contractor] (hereinafter called “the Contractor”) shall deposit with IRCON INTERNATIONAL LIMITED [name of Employer] a bank guarantee to guarantee his proper and faithful performance under the said Clause of the Contract in an amount of _____
[amount of Guarantee], _____ [amount in words].

We, the _____ [name of bank], as instructed by the Contractor, agree unconditionally and irrevocably to guarantee as primary obligator and not as Surety merely, the payment to IRCON INTERNATIONAL LIMITED on their first demand without whatsoever right of objection on our part and without his first claim to the Contractor, in the amount not exceeding _____
[amount of Guarantee], _____
[amount in words].

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

This guarantee shall remain valid and in full effect from the date of the advance payment under the Contract up to _____ (until IRCON INTERNATIONAL LIMITED receives/recovers full repayment of advance along with interest accrued thereon from the Contractor).

We, the _____ Bank further agree that this guarantee shall be invocable at our place of business at New Delhi/NCR/Project HQ (Indicate detail address of branch with Code No.)*. The branch at New Delhi/NCR/Project HQ is being advised accordingly.

This Bank Guarantee shall be operative only if it is accompanied by a separate advice sent by - _____ (Name of Issuing Bank, with address) on _____

(Name of Employer's Bank, with address) IFS Code _____ through Structured Financial Messaging System (SFMS) and authenticated by the Employer's Bank.

Yours truly,

SIGNATURE AND SEAL OF THE GUARANTOR

Name of Bank:

Address:

Date:

*The Bank should indicate detailed address of New Delhi/NCR/Project HQ branch along with its Code No.

ANNEXURE-XIII

(to be executed on a non-judicial stamp paper of ₹ 100/- only)

BANK GUARANTEE FOR RELEASE OF 50% OF RETENTION MONEY

To

IRCON International Limited,
Name & Address of Project.

[Acting through _____ (Project In charge) & Address of the Project]

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

AND WHEREAS it has been agreed by you in the said Contract that the Contractor has option to get release 50% of the Retention Money against un-conditional Bank Guarantee from a Scheduled Bank acceptable to you as security for compliance with Contractor’s obligation in accordance with the contract (Sub clause _____)

AND WHEREAS the Contractor has opted to get released the 50% of the retention money against an unconditional Bank Guarantee;

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Contractor, up to a total of _____ [amount of Guarantee], _____ [amount in words], such sum being payable in the types and proportions of currencies in which the Contract Price is payable, and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of _____ [amount of Guarantee] as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

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

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

This guarantee shall be valid up to _____ (till the IRCON International Limited certifies repayment of retention money in accordance with Sub-clause 8.5 of General Conditions of Contract).

We, the _____ Bank further agree that this guarantee shall be invokable at our place of business at New Delhi/NCR/Project HQ (Indicate detail address of branch with Code No.)*. The branch at New Delhi/NCR/Project HQ is being advised accordingly.

This Bank Guarantee shall be operative only if it is accompanied by a separate advice sent by _____ (Name of Issuing Bank, with address) on _____ (Name of Employer's Bank, with address) IFS Code _____ through Structured Financial Messaging System (SFMS) and authenticated by the Employer's Bank.

SIGNATURE AND SEAL OF THE GUARANTOR

Name of Bank: _____

Address: _____

Date : _____

***The Bank should indicate detailed address of New Delhi/NCR/Project HQ branch along with its Code No.**

ANNEXURE-XIV

UNDERTAKING BY TENDERER

1. Being duly authorized to represent and act on behalf of and having fully understood all the tender conditions and requirements for fulfilling eligibility criteria including residual / available bid capacity, the undersigned hereby declare that:
 - i) The information/ statements given in support of technical and financial capability as per Annexure-IV of ITT of tender document are true and correct in every detail.
 - ii) This tender offer is made in the full understanding that:
 - a) All information / documents submitted along with tender offers by tenderer/s will be subject to verification by IRCON or its any authorized representative who may conduct any inquiries or investigations to verify the statements, documents and information submitted in connection with the tender offer and to seek clarification from our bankers, clients regarding any financial & technical aspects;
 - b) In the event that the information/document submitted is found to be false or misleading, the tender shall be disqualified and the earnest money deposited shall be forfeited.
2. The client reserves the right to:
 - i) Reject or accept any application, cancel the tender and reject all applications.

Signed.....

Name.....

.....
For & on behalf of Name of
Firm/Company

SECTION- VII
INDIAN RAILWAY
GENERAL CONDITIONS OF CONTRACT July- 2020

General Conditions of Contract

The General Conditions of Contract, **July 2020** of the Indian Railways shall be followed with correction slips issued from Northeast Frontier Railway.

The General Conditions of Contract, July 2020 of Indian Railways, along with latest correction slips, will form part of the tender/contract documents.

Additional definitions mentioned in these tender documents elsewhere will be followed for GCC, July 2020 also.

In case, there is an ambiguity in any definition, the decision of IRCON regarding the interpretation shall be final and binding.

Wherever there is conflict in any condition between GCC and special condition mentioned in tender documents. The condition mentioned in special condition will prevail. However Engineer-in-charge decision in this connection shall be final and binding.

Copy of Standard General Conditions of Contract, July 2020 of Indian Railways is enclosed in a separate Booklet.

Definitions Given under Clause 1(1) of GCC may be read as under:		
Clause No	As given In GCC of Railway at Page 33	To be read as:
1. (1)	Definitions : In these General Conditions of Contract, the following terms shall have the meaning assigned hereunder except where the context otherwise requires :	Definitions : In these General Conditions of Contract, the following terms shall have the meaning assigned hereunder except where the context otherwise requires :
(a)	"Railway" shall mean the President of the Republic of India or the Administrative Officers of the Railway or of the Successor Railway authorised to deal with any matters which these presents are concerned on his behalf.	"Railway" shall mean the President of the Republic of India or the Administrative Officers of the Northeast Frontier Railway/IRCON or of the Successor Railway authorised or any other officer of IRCON authorized to deal with any matters which these presents are concerned on his behalf
(b)	"General Manager" shall mean the Officer in-charge of the General Superintendence and Control of the Railway and shall also include the General Manager (Construction) and shall mean and include their successors, of the successor Railway.	"General Manager" shall mean "Chairman and Managing Director" of IRCON International Limited.
(c)	"Chief Engineer" shall mean the Officer in-charge of the Engineering Department of Railway and shall also include Chief Engineer (Construction), Chief Signal & Telecommunication Engineer, Chief Signal & Telecommunication Engineer (Construction), Chief Electrical	"Chief Engineer" shall mean the Project Head of IRCON INTERNATIONAL Ltd. (Employer), Chief General Manager of IRCON or any other officer authorised by the Employer to act on his behalf and for the purpose of operating the contract.

Definitions Given under Clause 1(1) of GCC may be read as under:		
Clause No	As given In GCC of Railway at Page 33	To be read as:
	Engineer, Chief Electrical Engineer (Construction) and shall mean & include their successors, of the Successor Railway.	
(d)	"Divisional Railway Manager" shall mean the Officer in-charge of a Division of the Railway and shall mean and include the Divisional Railway Manager of the Successor Railway.	"Divisional Railway Manager" shall mean the Project Head of IRCON INTERNATIONAL Ltd. (Employer), Chief General Manager of IRCON or any other officer authorised by the Employer to act on his behalf and for the purpose of operating the contract.
(e)	"Engineer" shall mean the Divisional Engineer or the Executive Engineer, Divisional Signal & Telecommunication Engineer, Divisional Signal & Telecommunications Engineer (Construction), Divisional Electrical Engineer, Divisional Electrical Engineer (Construction), in executive charge of the works and shall include the superior officers of the Engineering, Signal & Telecommunication, and Electrical Departments of Railway, i.e. the Senior Divisional Engineer/Deputy Chief Engineer / Chief Engineer / Chief Engineer (Construction), Senior Divisional Signal & Telecommunication Engineer/Deputy Chief Signal & Telecommunication Engineer/Chief Signal & Telecommunication Engineer (Construction)/Senior Divisional Electrical Engineer/Deputy Chief Electrical Engineer/Chief Electrical Engineer (Construction) and Chief Administrative Officer (Construction) and shall mean & include the Engineer of the Successor Railway.	"Engineer" shall mean officer authorized by IRCON in direct charge of works.
(f)	"Engineer's Representative" shall mean the Assistant Engineer, Assistant Signal & Telecommunication Engineer and Assistant Electrical Engineer in direct charge of the works and shall include	"Engineer's Representative" shall mean the officer authorized by IRCON in direct charge of works.

Definitions Given under Clause 1(1) of GCC may be read as under:		
Clause No	As given In GCC of Railway at Page 33	To be read as:
	any Sr. Section/Junior Engineer of Civil Engineering/Signal and Telecommunication Engineering & Electrical Engineering Departments appointed by the Railway and shall mean and include the Engineer's Representative of the Successor Railway.	
(g)	"Contractor" shall mean the Person/Firm/Co-operative Society or Company whether incorporated or not who enters into the contract with the Railway and shall include their executors, administrators, and successors and permitted assigns.	"Contractor" shall mean the Person/Firm/Co-operative Society or Company whether incorporated or not who enters into the contract with the Railway and shall include their executors, administrators, and successors and permitted assigns.
(h)	"Contract" shall mean and include the Agreement of Work Order, the accepted Schedule of Rates or the Schedule or Rates of Railway modified by the tender percentage for items of works quantified, or not quantified, the General Conditions of Indian Railways Standard General Conditions Of Contract – July 2013 As On 30th June 2013 Page 24 Contract, the Special Conditions of Contracts, if any; the Drawing, the Specifications, the Special Specifications, if any and Tender Forms, if any.	"Contract" shall mean and include the Agreement or Letter of Acceptance, the accepted Bill of Quantities and Rates, the General Conditions of Contract, Special Conditions of Contract, Appendix to Tender, Form of Bid, and Instructions to the Tenders, Drawings, Specifications and other Tender Documents.
(i)	"Works" shall mean the works to be executed in accordance with the contract.	"WORKS" shall mean the works contemplated in the drawings and schedules set forth in the tender forms and required to be executed according to specifications.
(j)	"Specifications" shall mean the Standard Specifications for Materials & Works of Railway as specified by Railway under the authority of the Chief Engineer or as amplified, added to or superseded by Special Specifications, if any.	"SPECIFICATIONS" shall mean the specifications for materials and works mentioned in tender documents.
(k)	"Schedule of Rates of Railway" shall mean the Schedule of Rates issued under the authority of the Chief Engineer from time to time.	"Bill of Quantities (B.O.Q.)"/ "Schedule of Rates" means list of items of work, their quantities and rates as accepted and forming part of

Definitions Given under Clause 1(1) of GCC may be read as under:		
Clause No	As given In GCC of Railway at Page 33	To be read as:
		contract agreement.
(l)	"Drawing" shall mean the maps, drawings, plans and tracings or prints there of annexed to the contract and shall include any modifications of such drawings and further drawings as may be issued by the Engineer from time to time.	"Drawings" means the Drawings annexed to the Contract or referred in it and shall include any modifications of such Drawings and further Drawings as may be issued or approved by the Engineer.
(m)	"Constructional Plant" shall mean all appliances or things of whatsoever nature required for the execution, completion or maintenance of the works or temporary works (as hereinafter defined) but do not include materials or other things intended to form or forming part of the permanent work.	"Contractor" shall mean the Person/Firm/Co-operative Society or Company whether incorporated or not who enters into the contract with the Railway and shall include their executors, administrators, and successors and permitted assigns.
(n)	"Temporary Works" shall mean all temporary works of every kind required for the execution completion and/or maintenance of the works.	"Temporary Works" shall mean all temporary works of every kind required for the execution completion and/or maintenance of the works.
(o)	"Site" shall mean the lands and other places on, under, in or through which the works are to be carried out and any other lands or places provided by the Railway for the purpose of the contract.	"Site" shall mean the lands and other places on, under, in or through which the works are to be carried out and any other lands or places provided by the Railway for the purpose of the contract.
(p)	Period of Maintenance shall mean the specified period of maintenance from the date of completion of the works, as certified by the Engineer.	Period of Maintenance shall mean the specified period of maintenance from the date of completion of the works, as certified by the Engineer.
(q)	Railway Board	IRCON International Ltd. (Employer)

SEVOK-RANGPO RAIL LINE PROJECT

TECHNICAL SPECIFICATIONS

CONSTRUCTION OF MELLI YARD

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1. SITE INSTALLATIONS AND SERVICES

1.1 SCOPE OF WORK

- I) Site installations, site clearance (including removal), services shall be carried out in accordance with the provisions of the Technical Specifications for earthworks. The contractor shall include all the costs for such temporary works into the relevant unit prices unless specifically provided in the conditions, for the whole execution works on construction and for the whole period of construction.
- II) The Contractor shall be responsible for providing plant, equipment, materials and labour for the provision of all necessary Temporary Works and services adequate for the execution of the Work under this contract.
- III) The Contractor shall design, furnish, install, maintain and operate on the Site Constructional Plants as specified in this Chapter, including camps, workshops: warehouses, storage and assembly areas, all equipment, machinery, vehicles. Scaffolding, water and power supply etc.
- IV) Obtaining necessary clearance/ permission that are needed for construction, from various state/ central authorities for the equipment, water, power, sanitary and explosives shall rest with the contractor.
- V) Temporary Works and services carried out by the Contractor shall conform to the applicable Indian Standard I Codes / laws, regulations and statutory requirements including compliance to railways codes/manuals/guidelines etc. stipulated for such purpose In-case no National Standard is available, International Standards are to be applied as approved by the Client.
- VI) The design, construction, operation and maintenance of the Contractor's Temporary Works and services shall be subject to inspection and approval by the Client.
- VII) The rights or customs of adjacent property occupiers for access shall not be infringed by the Contractor.

1.2 SUBMITTALS

- I) Within 28 days from the commencement date, the Contractor shall submit to the Client, updated layout plans showing, to an adequate scale, the locations and arrangement of all enabling and temporary Works and facilities. These plans shall be consistent with the requirements of the Project as well as with any subsequent amendments and additions agreed to by the Client and the Contractor and shall include and not be limited to:-
 - a) Site offices, storages, parking areas, warehouses, materials yard, storage areas.
 - b) Concrete and material processing plants," including cement storage.
 - c) Temporary road, including public road diversions and temporary culvert.
 - d) Communication System.
 - e) Service vehicles.
 - f) Camps for Contractor's Employees.
 - g) Commercial Establishments.
 - h) Medical facilities.

- i) Power supply and illumination, telephone services (radio and cable).
 - j) Maintenance of Traffic.
 - k) Water supply.
 - l) Sanitation & sewerage, sewage treatment and disposal,
 - m) Waste & garbage disposal.
 - n) Security and safety arrangements.
 - o) Field laboratory along with list of equipment as required under Quality Assurance Programme.
 - p) Equipment tools and mechanical workshops.
 - q) Dumping areas, borrow, quarry and stockpile areas with development plans.
 - r) Explosive magazines.
 - s) Adequate back up power system.
 - t) Measures to comply with environmental norms and various conditions.
 - u) Muck disposal management.
 - v) Site Signage.
 - w) Drainage plan during construction.
 - x) Contractor Quality Plan.
 - y) Emergency Plan.
- II) Within 45 days from the commencement date, the Contractor shall submit to the Client the following:
- a) Detailed drawings to a scale ranging from 1:100 to 1:500 showing the camp layout, buildings, roads, recreation areas, all utilities etc. and drawings to a scale of 1: 50 to 1:100 showing typical building construction details.
 - b) Drawings and Specification for the establishment of primary first aid stations dispensary and ambulances.
 - c) Detailed design for industrial and potable water supply to the camps and working area as well as sewerage system, sewerage treatment and disposal with an estimate of number of people to be supplied with water. All the system shall comply with the environmental and pollution control norms as applicable.
 - d) Detailed layout drawings for electrical installations and distribution systems on the site, showing voltages, outlets and routing of power lines. The system should include necessary power back up arrangements for uninterrupted construction work.
 - e) Detailed design and drawings including manufacturer's drawings for concrete and materials processing plants, including details of equipment for transportation and placement of concrete in accordance with the requirements of the pertinent Chapters of these Specifications.
 - f) Details of the excavation, drilling and grouting equipment in accordance with the requirements set out in the relevant Chapter of these Specifications.
 - g) Details of Field laboratory to be set up at site by the contractor.

- h) Details of muck disposal and protection measures for compliance with Environmental Management Plan of the work specifications.
- i) The designs shall be consistent with the requirements of the Project as well as with any subsequent amendments and additions agreed to by the Client and the Contractor. (The Client reserves the right to require any additional information deemed necessary to be included in the submitted documents.)

1.3 DETAILS OF INSTALLATIONS AND SERVICES

The installations and services to be provided by the Contractor for the execution of Works under this Contract Shall include, but not limited to, the following:

1.3.1 Camps for Contractor's Employees

- I) The Contractor shall design, construct, provide furnishings, maintain and operate construction camps at the suitable locations. The construction camps shall provide for the housing, feeding and recreation of the Contractor's employees and those of his subcontractors. Kitchens with provision of LPG facility for cooking (Fire wood not to be used), dining rooms, outdoor and indoor recreation facilities, family dwellings, dormitories, sanitary facilities, medical service, places of worship, roadways, drainage, fire control, commercial centres and all utility services (potable water, power, lighting, heating ventilating, sewerage treatment and disposal, cleaning and sanitation, garbage collection and disposal, etc.) shall be provided. The camps shall be large enough to accommodate the anticipated peak work force. The construction labour camp should be as per BOCWA / BOCWR. The contractor has to provide bio-toilets (separate for male and female) at Camp site as well as at all the construction sites. The user ratio shall not be more than that specified in point (iv) below.
- II) Camp area shall be provided by employer subject to availability of land after accommodating all plants, materials, employer's office etc. at site. No camp construction shall commence until the Contractor's drawings and Specifications have been approved by the Client.
- III) All camp building shall be of sound construction and connected to all utility services.
- IV) Fixtures in the sanitary facilities shall be based on the following user ratios
 - a) 1 toilet for not more than 6 users
 - b) 1 tap for not more than 6 users
 - c) 1 washbasin for not more than 6 users.
- V) The sewerage from the labour camps, work sites is to be properly treated before discharge by providing septic tanks, soak pits etc. or any other treatment as per norms recommended by the concerned authority.
- VI) Canteen facilities shall be provided by the Contractor in properly equipped canteen buildings for all his and his subcontractor's employees.
- VII) The Contractor shall be responsible for keeping the camps and buildings within it, in good hygienic conditions. The standards regulations presently in force in the project area with regard to water treatment, sanitary conditions, and fire and accident prevention shall be duly taken into account.

1.3.2 Site Offices, Stores, Warehouses, Materials Yards

- I). The Contractor shall provide and equip, for his own and his subcontractors' use, main and secondary offices, warehouses, materials stock areas, fuel storage areas and explosive magazines, all of which shall be maintained in good condition until the completion of Works.
- II). The buildings, shops and warehouses expected to be constructed and equipped by the Contractor for use in the execution of the Works under this Contract, in addition to the facilities explicitly specified elsewhere in these Specifications shall be, but not limited to, the following:
 - a). Mechanical repair shop
 - b). Electrical repair shop
 - c). Metalwork fabrication and carpentry shop
 - d). Main warehouse and parts store
 - e). Bulk cement silo/cement store
 - f). Spare parts store.
- III). No dangerous goods, explosives, chemicals, fuels or similar items shall be brought onto the Site unless the Contractor has advised the Client of the intention to do so and has complied with all statutory requirements for its safe storage and security.
- IV). The Contractor shall minimize the use of the Site for the storage of fuels, explosives and other dangerous goods as may be required for the construction of the works and shall not use the site or allow access for any purpose not connected to the Contract.
- V). Dangerous Goods are only to be stored in nominated and approved storage areas and facilities which must comply with the Indian regulations governing such facilities.
- VI). The contractor has to make appropriate provision for material storage sheds and tarpaulin sheets for loose construction material.
- VII). The contractor has to make appropriate provision for dustbins and corresponding disposal of waste at labour campsite and at each work site.

1.3.3 Concrete and Materials Processing Plants.

- I). The Contractor shall install and erect all necessary material processing plants of sufficient capacity to meet the planned peak requirements during construction. The plants shall be subject to approval by the Client and shall be well designed and fabricated and kept in good running order to ensure compliance with the materials quality Specifications. All control and measuring equipment shall be regularly serviced and calibrated.
- II). The plants required to be assembled/erected by the Contractor shall be but not limited to the following:
 - a). Concrete plant (batching and mixing)
 - b). Concrete cooling plant (refrigeration and ice plant), if required.
- III) Concrete & material processing plants shall meet all environment guidelines, conditions imposed for construction of project by MOEF/ Government bodies/ State pollution control boards and other statutory bodies at no extra cost to The Employer.

1.3.4 Temporary Roads.

- I). The contractor shall construct temporary roads / hauls roads & culverts. Contractor shall develop detailed drawings for the above and accordingly construct the same after approval of Client.

1.3.5 Communication System

- I). Outside / Site Communication
- II). The Contractor shall install his communication system in the project area for national/ international voice and data communication. These facilities can be availed from the existing network of tele-communication or the contractor shall make arrangement for providing these facilities through existing telecom operators.

1.3.6 Service Vehicles

- I). The Contractor shall furnish, operate and maintain sufficient service vehicles for use by his own staff and employees in the management, supervision and performance of the Work.

1.3.7 Commercial Establishments

- I). Market and shopping complexes are available at nearby towns of the project site, which caters to the local population of the area. The Contractor may establish, with the prior permission of the authorities of Government commercial place(s) in his camps for use by his employees.

1.3.8 Medical Facilities

- I). Indoor medical facilities are available near Kalimpong.
- II). In addition to above, the Contractor shall construct, equip and maintain on the Site, the following medical facilities:
 - a). One clinic with ambulance and driver at his main camp.
 - b). One first aid station at each work site.
- III). The contractor shall comply with laws and health standards in force in the project area. In the event of an epidemic breaking out, the Contractor shall carry out and comply with all or arrangements or regulations, which may be issued by Government or local authorities.
- IV). These facilities shall be fully equipped and staffed to meet requirements of the maximum anticipated workload and labour force, taking into consideration the nature of the Works, its occupational hazards, location and accessibility. These establishments shall be available and fully operational within 45 days after the date of issue the Letter of Acceptance.
- V). Medical services in the clinics shall be under the direction of qualified doctor on a 24 hours basis throughout duration of the construction and shall be available free of charge persons engaged in the Works and their families or dependents on the Site. ↯
- VI). Treatment facilities and care of seriously ill or injured persons shall be on an emergency basis until their transfer to an established hospital.

VII). All the labors to be engaged for construction work shall be thoroughly examined by health personnel and adequately treated before issuing them work permit by contractor.

1.3.9 Power Supply and Illumination

I). General.

- a). Contractor has to make his arrangements at his own cost for entire construction power including any standby power requirements. Equipments/ transmission lines required for distribution and utilization of energy at Construction site for Power, light etc. shall be installed by the contractor on their own.
- b). Power to be used by Contractor for their Labour and Staff Colony shall be arranged by contractor on their own and at their own cost.
- c). Contractor shall arrange DG sets of adequate capacity at his cost to meet back up and emergency power supply requirement including lighting.
- d). Contractor shall indicate in his proposal of the phase wise requirement of Construction power (HT) at above-mentioned locations.

II). Power supply and Illumination provided by the Contractor

- a). The Contractor shall install, operate and maintain electrical distribution system, which shall include transformers, circuit breakers, disconnection and safety switches, voltage regulators, lines, poles, pole hardware, conductors, meters and other equipment necessary for power distribution throughout the Site and temporary facilities.
- b). The Contractor shall ensure adequate illumination for all his operations on the Site and at the Camps, including illumination of the streets for round the clock working. The contractor shall maintain equipment and arrange device to measure light intensities for illumination as follows:

	Area of Operation.	Luminous Intensity
a	Excavation and dumping areas and outdoor access ways	100 Lux
b	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refuelling, and field maintenance areas.	150 Lux
c	Indoors: warehouses, corridors, hallways, and exit ways.	100 Lux
d	General construction plant and shops, e.g. batching plants, mechanical and carpentry shops, active storerooms, barracks or living quarters, mess halls and indoor toilets	150 Lux
e	First aid stations, infirmaries and offices	350 Lux

III). Earthing of Wet work Areas, Control of Electric Discharges

- a). All equipment and appliances, which are exposed to lightning, shall be earthed electrically, and the Contractor's specialized personnel shall periodically check the effectiveness or such earthing.

- b). Personnel standing in water shall operate no equipment electrically powered by more than 24 Volts.
- c). Only air, battery-powered or hydraulic tools shall be permitted in the wet areas.

1.3.10 Maintenance of Traffic

- I). The Contractor shall be responsible for the safety along the roads related to the Site. Where the work is carried out on the Site of, or close to an existing road, the Contractor shall maintain the vehicular and pedestrian traffic safe at all times. If his operations can cause traffic hazards, he shall repair or fence or take such other measures for ensuring safety that are satisfactory to the Client.
- II). The Contractor shall submit his activity, schedule and the locations of his work along the existing public roads to the authorities concerned and obtain all necessary approval prior to the commencement of the respective work.
- III). At the road crossings or in heavy traffic locations, the Contractor shall carry out the Work within the working hours as directed by the Client, and after the completion of the work he shall immediately make the necessary backfill and pavement at the crossings.
- IV). The Contractor shall provide temporary passes and badges to give an access to the existing village houses, etc., to the satisfaction of the Client and the authorities concerned whenever he disturbs such existing way during the execution of works.

1.3.11 Water Supply

- I). The Contractor shall design, Install, operate and maintain two separate water supply systems on the Sites
 - a). Industrial Water: For general construction use, treated to the extent necessary to meet specified requirements of Works.
 - b). Potable water: For supply to all buildings and plants requiring high quality water meeting requirements for drinking water supply.
- II). Water shall be, supplied by the Contractor from any suitable sources. The water being supplied shall be free of contamination and unaffected by the Site construction Work.
- III). The Contractor shall furnish, install, operate and maintain all pumps, pipelines, fittings, valves, storage tanks purification plant and chlorination for the Water supply and distribution systems, adequate in quantity and pressure. Industrial water shall be used for construction purposes only. There shall be no cross connections of any kind between the industrial and potable water supply systems. Only potable water shall be piped into buildings.
- IV). The Contractor shall provide adequate water treatment facilities so as to ensure that the treated water is supplied for drinking purposes to all the camps and construction places.
- V). Ample number of drinking points of potable water shall be provided by the Contractor for the use of personnel in all working areas.

1.3.12 Sanitation and Sewerage

- I). Toilets shall be provided and maintained by the Contractor for the use of all personnel at all work locations, which are remote from the fixed sanitary facilities. The Contractor shall arrange for all chemical toilets to be attended to daily for proper sanitary disposal.
- II). All offices, workshops, laboratory and other occupied work buildings shall be provided with toilets connected to property constructed and regularly maintained septic tanks approved by the Client.
- III). The camp sites shall be provided with a complete, properly maintained and operated sewerage system, including septic tanks, sewage treatment and disposal facilities. Facilities for washing clothes shall also be provided and linked to the sewerage system.
- IV). Testing of water shall be done to meet the standards for sanitation purpose.

1.3.13 Dumping Areas, with Development Plans

- I). The contractor shall make necessary arrangements for the management of muck disposal so that it meets all the environment guidelines / conditions imposed for the construction of project by MOEF / Govt. bodies / State Pollution control board and/or other statutory bodies.

1.3.14 Waste and Garbage Disposal

- I). The Contractor shall daily collect waste material and garbage from camps, offices and workshops and transport it to an area approved by the Client, where it shall be incinerated and buried or disposed off as standard guidelines.
- II). The site shall be kept clean and free of refuse at all times. No waste shall be dumped in areas other than those approved by the Client for waste disposal. No waste of any kind shall be deposited in any watercourses.
- III). Waste and Garbage disposal system shall meet all environment guidelines and conditions imposed for construction of project by MOEF/ Govt. bodies at no extra cost to The Employer.
- IV). The contractor has to make appropriate provision for Oil / Grease interceptor at refuelling stations and at fuel storage locations.

1.3.15 Setting Up of Field Laboratory

- I). The Contractor shall establish a field laboratory for ensuring quality control measures for the Works, as detailed under Quality Assurance Programme described elsewhere in the tender documents.
- II). Prior to setting up of laboratory, Contractor shall submit detailed building plan with exhaustive equipment-list clearly showing the different area for equipment with sizes of the equipment and circulating area, and CV's of qualified personnel identified for laboratory work to the Client for approval. The laboratory shall be headed by an experienced graduate civil engineer. All the equipment shall be confirming to either the relevant IS or international standards.
- III). Upon receipt of Client's approval, the Contractor shall construct, maintain and operate an integrated laboratory which provides sufficient rooms and equipment to test aggregates, concrete samples, plain shotcrete, soil and rock samples, geogrids adherence test, soil

nails/rock bolts capacity tests, nuclear gauge tests to control the density of the compacted layers for earthworks, etc. The laboratory shall be established as early as possible as but not later than two months (60 days) from the date of issue of Letter of Acceptance.

- IV). The Contractor shall collect the samples, carry out the relevant tests, prepare the complete reports and submit them to the Client.
- V). All tests will be made according to approved standards, and the testing equipment shall comply with the same standards. All relevant standards shall be made available in the laboratory by the Contractor.
- VI). The laboratory shall be provided with light, ventilation, water supply, tank for curing, toilet, office for operators and responsible for laboratory, archive etc. and be spacious enough in order to store indoor the test samples

1.3.16 Land Requirement

- I). Employer has acquired the required land for permanent components of the project work, approach roads to various project components and muck dumping sites, which shall be handed over to the contractor on as is where is basis. The contractor shall organize the installation site in a way that his temporary buildings, plants, equipment etc will not hinder the final/permanent works. The land shall be used primarily for execution of work of the project and muck disposal. If contractor requires to use land required for development of station areas/ muck dumping, the contractor will sequence his activities to avoid re-shifting of plants and machinery once installed. The contractor will seek approval of the Client for setting up of site facilities on land acquired for the project. Nothing additional will be paid for re-shifting of any plants and machinery to the contractor. Extra land if needed by the contractor for setting up of any of his facilities, such cost of land will be borne by the contractor.
- II). Contractor shall submit his scheme of land utilization including muck disposal and subsequently construct the same after obtaining due approval of the Client.
- III). Muck generated in the works may be used by contractor for constructing his facilities / filling works etc. free of cost. The royalty payment and/or any cess leviable by the statutory authority shall however be payable by the contractor by such usage. Unusable muck shall be placed in muck disposal area.
- IV). Any Government duties, cess etc. levied by the statutory authority for land use outside railway land shall be borne by the contractor at no extra cost to the Employer.
- V). Before demobilization, the contractor shall remove all his temporary facilities which were installed for execution of the work and restore the land to its original state for all such land used as in (i) above.
- VI). Unless it is unfeasible, the contractor shall segregate the topsoil and store it separately, so as to dump it back in the permanent works at the appropriate locations.

1.3.17 Fencing and Site Security

- I). The Contractor's offices, workshops and storage compounds, campsites and all construction areas, where exclusion of unauthorized personnel is necessary for safety and security, shall be adequately fenced, gated and guarded. A central guardhouse shall be established at each main entrance to the Site.
- II). The Contractor shall employ adequate force of properly trained security guards at the worksite and at the construction camps on 24 hours duty including Sundays and holidays. Storage areas shall be fenced, lighted and regularly patrolled by security guards. Warehouse buildings and explosive magazines shall be kept locked and keys accounted for at all times.
- III). All employees engaged in the execution and maintenance of the Works shall wear identification badges when at the worksite.
- IV). The Contractor shall be entirely responsible for the losses occurring in his installations and those of the Client, resulting from carelessness on the Contractor's part.
- V). The contractor has to make appropriate provision for LED Lights on top of the barricading.

1.3.18 Site Signage

- I). Prior to the commencement of work at the Site, the Contractor, at the direction of the Client, shall supply and erect reflector site sign at all work sites for the information of the public at all entrances to the Site, containing the following information, clearly visible and legible (In English and Hindi language) to passers-by intended for the information of those affected by the Contract Works, for the guidance of those making deliveries and for general public safety:
 - a). Name of Project;
 - b). Name of Employer;
 - c). Name of Contractor;
 - d). Restrictions on access and appropriate safety warnings.
- II). The Contractor shall also maintain such signs throughout the contract period with up to date information and free from disfigurement.
- III). The Contractor shall also supply, erect and maintain appropriate reflector site signage and safety warning signs as are appropriate for the nature of the work being undertaken. No other signage or advertising materials shall be permitted on the Site, except with the specific consent of the Client.

1.3.19 Mobilization

- I). Contractor shall furnish all the labour, materials, equipment and shall perform all work required for mobilization to the Project Site.
- II). Mobilization shall include, but not be limited to moving personnel, plant, and equipment to the Site; arranging for necessary Site utilities; establishing camps, shops, offices and administrative facilities; and obtaining all required permits, licenses, and other regulatory authorizations required for the construction of the Project.

1.3.20 Demobilization / Final Clean Up

- I). Upon the Completion of Works, or when any plant has completed its functions, the Contractor shall dismantle and demobilize all temporary facilities and remove all refuse, debris objectionable material to areas approved by Client, and fill, grade and dress all excavated areas in a clean and proper condition acceptable to the Client. All such areas as far as possible shall conform to the natural appearance of the landscape. No extra payment shall be made on this account.
- II). Contractor shall furnish all the labour, materials, equipment and shall perform all work required for demobilization from the Project Site.
- III). Demobilization shall include, but shall not be limited to: removing all plant, equipment, and temporary facilities from the Site; disconnecting temporary utilities; relocating personnel from the Site; cleaning-up and restoring all areas occupied by the Contractor; closing out permits, licenses, and other regulatory authorizations; and disposal of all waste materials and excess construction materials which are not the property of the Employer.
- IV). No demobilization or removal of temporary facilities and equipment shall be made without the prior approval of the Client.

1.3.21 Inspection by Client

- I). The Client shall have the right at any time, to inspect any part of the Contractor's temporary facilities without advance notification and to require immediate rectification of any contravention of the specified requirements.

1.4 PAYMENT FOR SITE INSTALLATION AND PAYMENT

- I, The Contractor's initial mobilization costs such as purchase and transport of Constructional Plant and materials to the Site, planning, designing, installing, operating, maintaining and removal of all Temporary Works, Site installations, Services and facilities, making submittals to the Client, recruiting and transferring staff, obtaining rights of way, providing and maintaining temporary site roads, providing power at working area, offices, worker's colony, generating standby power for construction purposes, clearing and grading areas for temporary facilities, and any other costs involved in preparation to carry out the Permanent Works or items mentioned under this sub-chapter, shall not be paid separately (Except where mentioned specifically), but shall be deemed to be included in the rates quoted by the contractor for all the items of works. Charges if leviable for use of water or any other charges imposed by state/local authority for any of the site installation and services to be developed by contractor, the same shall be borne by contractor.
- II. Payment for monitoring of following environmental attributes during construction shall be paid separately as per relevant items of the BOQ:
 - a. Water Quality (Water Quality (As per IS 10500 and IS 2296) for parameters such as pH, BOD, COD, TDS, Pb, Oil & Grease and detergents for surface water, Water pH, TDS, Total hardness, Sulphate, Chloride, Fe and Pb).

2. SURVEYING

2.1 SCOPE OF WORK

- I). The employer has already established certain benchmarks and alignment references. These benchmarks and alignment markers are required to be validated by the contractor. Any error found in these benchmarks and alignment markers shall be rectified by the contractor with the approval of the Client. The contractor is also required to maintain these benchmarks provided by the employer throughout the period of construction. The survey to be done by the contractor shall be done by establishing the control points along the proposed railway alignment through the use of DGPS. All these control points will then be connected to the nearest GTS Benchmark using the Total Station.
- II). These services cover in general transfer of control points to working area, the establishment of axis, centerlines, alignments of project structures and features, the setting out for construction thereof; the accompanying control surveys for correct locations, dimensions and elevations as well as the necessary surveys for measurement to permit quantity calculations for billing.
- III). Such surveys shall be based on and/or referred to existing basic grid of datum points, triangulation points and benchmarks extended adjacent to the Work in the project area. This grid shall be the sole basis of reference for all survey work and measurement.
- IV). High precision direction measurement of the alignment shall be done at every approx. one km of excavation or as decided by the Client by use of surveying gyroscopes i.e Gyromat or similar, at the cost of the contractor.
- V). Responsibility of carrying out the work to correct line and level shall, however, continue to devolve on the contractor notwithstanding the fact that approval for any benchmark and/or alignment marker may inadvertently have been accorded by the Client. Consequently, any expenditure incurred by the contractor for rectification of the permanent and/or temporary works constructed to wrong line/level shall not be payable by the Employer.

2.2 SUBMITTAL

- I). Within 28 days from the commencement date, the Contractor shall submit to the Client for his approval a proposal of the sequence of the survey works to be performed, the biodata of the key personnel & in-charge of survey works, the list of survey equipment and instruments the Contractor will have available at the site, and a brief outline on methodologies of survey works to be applied for the various types of survey.
- II). At least 7 days prior to the commencement of any survey work, the Contractor shall inform the Client of his intention to perform the survey work. The Contractor shall indicate the purpose of the survey, the area to be surveyed, the structure or facilities involved, the methods to be applied and the survey period.

2.3 MATERIAL AND INSTRUMENTS

- I). The Contractor shall provide, maintain and operate suitable and appropriate equipment, instruments, materials and auxiliary equipment, commensurate with various tasks and precision requirements of the survey works.
- II). Type and accuracy of the survey equipment to be used by the Contractor shall correspond to the nature of the construction, erection works and the construction technique.
- III). All equipment, instruments, materials and auxiliary equipment shall be in perfect operating condition. Prior to the start of survey activities, equipment, instruments, etc., shall be checked as to their proper functioning and accuracy.
- IV). During the construction period, the survey instruments shall be checked and adjusted / calibrated at regular time intervals.
- V). Instruments and equipment which have suffered from use, damage or accidents to the extent that they are unfit for further use at the site, shall be removed from the site and replaced immediately.
- VI). The contractor should ensure availability of sufficient quantity and quality of survey instruments including provision of professional staff, to avoid any delay in the construction.

2.4 EXECUTION

2.4.1 General

- I). For the execution of the survey work the Contractor shall employ and provide experienced professionals and auxiliary staff. All survey and measurement work shall be recorded and filed thoroughly.
- II). The Contractor shall provide, maintain, adjust when necessary and operate the required survey and auxiliary equipment for the performance of the Work.
- III). All survey and measurement activities shall be recorded in maps and field books as directed/approved by the Client. Where required, the production of drawings and maps shall be deemed to be part of the work.
- IV). The Client shall have the right to check work performance, accuracy stations, etc., and all survey results, measurements and calculations as well as conformity with plans and drawings.
- V). The Contractor shall keep and maintain professional records of all field surveys and measurements, the related computations and calculations, manuscripts, plans, drawings and maps, and shall make them available to the Client whenever requested.
- VI). If in the opinion of the Client, deficiencies and/or inaccuracies in field and office work have been found, such work shall be repeated and made good to the satisfaction of the Client at the Contractor's expense. The Contractor shall be solely responsible for accuracy of Survey maps and drawings prepared out of the surveys.

2.4.2 Preparatory Works

- I). Prior to starting survey works, the Contractor shall inform his surveyors of the general construction procedure, survey requirements and time limits. The surveyors shall make adequate terrain investigations with respect to sightings, vegetation to be removed, placement

of datum points, reference monuments and benchmarks, taking into consideration future construction work which may affect the survey. Based on these investigations, a survey plan shall be developed comprising existing basic data, the survey grid to be developed, the equipments required for the particular survey task. Staff and time requirements arrangement in a way to warrant smooth progress of construction works. The plan shall be submitted to the Client for approval.

- II). All survey work shall be done within greatest care and precision.

2.4.3 *Verification of Survey Grid*

- I). The contractor shall verify the basic survey grid.
- II). All coordinates and elevations as shown on the Drawings are based on the basic survey grid. If after having executed the verification, the basic survey grid reveals inconsistencies, which may affect the location, alignment and elevation or structures of the works, the Client shall be forthwith informed of these inconsistencies by the Contractor.
- III). The Contractor shall record all calculations, control surveys, setting out and check surveying in a suitable permanent form for verification, which shall be available to the Client on request at all times.

2.4.4 *Augmentation of Basic Survey Grid*

- I). Existing datum points and benchmark located very near to the permanent structures may be endangered by construction activities. The Contractor shall therefore in due time establish additional datum points at safe locations and elevations to augment or extend the basic grid.
- II). The new datum points shall be of permanent nature and shall be constructed as, directed by the Client.
- III). The Contractor shall also establish reference monuments for center lines and line control of structures, which need frequent and extended control surveys.
- IV). New datum points, reference monuments and benchmarks shall be protected and maintained in the same way as the original grid points.

2.4.5 *Survey of Ground Profiles*

- I). Original Ground Profiles.

The Contractor shall inform the Client in writing, at least 14 days before commencing such work, of his intentions to perform any work which will result in a change to the topography of the existing site for the permanent works and or for temporary works. Thereupon, before commencing any work, the contractor shall survey the original topography with the approval of the Client over the entire area to be occupied or disturbed. Such survey may again be required after removal, of vegetation, topsoil or other overburden. The Contractor and the Client shall record the information so obtained. The contractor shall then provide the Client with a reproducible copy of each drawing to serve as a permanent record of the purpose of determining the quantities of excavation or earth works carried out in the construction of the permanent structures, Such records will also be required to ascertain the extent to which

Temporary works shall be removed or temporary excavations shall be refilled upon completion of the works.

- II). The Contractor shall also survey all excavated and final surfaces for the purpose of recording as constructed details, and for the measurement of quantities. Such survey shall be required at the following two stages:
 - a). On completions of excavation and prior to placing concrete or other work.
 - b). On completion of works.

2.4.6 *Setting Out Works*

- I). The contractor shall perform all setting out and check surveying of the Works in accordance with methods approved by the Client. The methods and programme of checking shall be such as to ensure the construction of every part of the Work to the correct line and level. The Client may at any time ask the contractor to submit proof that his own setting out has been satisfactorily checked.
- II). The number of points required for setting out as well as the spacing between these points shall be determined by the Contractor in accordance with the type of work. The Client may require that some or all of the given points and datum levels be clearly marked during construction in such a way that the marks can be retained after completion of construction.

2.4.7 *Setting Out Checks*

- I). The Contractor is expected to liaise with the Client to program the check survey to be carried out during non-production periods or in parallel to construction activities such that the minimum delay or inconvenience is caused to production works, wherever and whenever possible. The Contractor shall afford the Client, every cooperation and assistance in this regard including but not being limited to the provision of survey equipment, drainage, lighting and the removal of Contractor's equipment and other obstructions such that they do not interfere with the setting out checks.

2.4.8 *Accuracies and tolerances*

- I). Accuracies

Accuracy of survey works shall be within the following tolerances:

Triangulation	
Average Allowable error of closure shall not exceed	5 Seconds
Maximum Allowable error of closure shall not exceed	10 Seconds
Traversing	
Allowable error of closure	10 mm per Kilometer
Allowable error of distance	
Levelling	
Allowable error for each 1 km measured forward and	10 mm

backward	
Allowable error of closure	$10 \sqrt{S}$ mm

(Where S is the total distance of levelling expressed in km)

II). Tolerances

- a). The tolerance given above shall be the maximum permissible deviations from the specified dimensions, levels, alignments, positions etc. as shown on the Drawings of the structures of structural elements.
- b). In addition, at the interfaces with mechanical components, concrete surface be finished flush and shall also meet any additional tolerances required by the mechanical designs or works respectively.
- c). Where the tolerances overlap, the severer tolerance shall apply.

2.4.9 *Subsidiary Monuments and Benchmarks*

- I). The Contractor shall erect and establish all necessary additional survey monuments, fix points, benchmarks etc. required for setting out of the work and construction control including determination of coordinates and elevations.

2.4.10 *Handing over of Basic Survey Data*

I). General Requirements

- a). Prior to the commencement of the survey works, the Client shall hand over to the contractor all information and data of the verified basic survey grid and benchmarks to which the contractor's survey work shall refer. Upon handing over, the Contractor shall review this information and data and shall verify the existence of the datum points and benchmarks by field checks. Furthermore, the contractor shall take responsibility for maintenance and protection of these basic datum points and benchmarks.
- b). Should field checks reveal that points and benchmarks have been damaged, displaced or destroyed, the contractor shall inform the Client of this facts, and the Client shall give instructions regarding the re-establishment of such datum points and benchmarks.
- c). Should it become necessary that basic datum point and benchmarks be removed because of foreseeable construction works, the contractor shall inform the Client of the need thereof and obtain approval and instruction for the establishment of new basic datum points and benchmarks and/or auxiliary points.
- d). If, within 2 months upon handing over, inconsistencies within the basic grid or related datum points and benchmarks are detected by the contractor, he shall inform the Client immediately thereof and produce the evidence. The Client shall subsequently inform and instruct the contractor on remedial measures to be taken. Any survey work, setting out or measurement already taken or performed prior to the detection of such inconsistency shall be rechecked and corrected by the contractor.

- e). Additional basic datum points and benchmarks established by the contractor for the convenience of this work shall have at least the same quality and durability as those of the existing points and meets the accuracy requirements.

II). Data and Documentation Available

- a). Existing topographical maps based on the surveys, covering the area of the works can be made available to the Contractor upon request to the Client.
- b). Topo mapping of areas for temporary facilities like the Contractor's camp, constructional buildings, construction plant, etc., shall be prepared by the Contractor prior to the construction of such facilities. The Contractor shall also perform surveys works for construction roads and Minor Bridges including preparation of maps.

III). Survey Records and Documentation

- a). The Contractor shall keep records of all survey activities such as sketches, field books, calculations, etc., for the duration of the entire construction period. The Contractor shall upon request of the Client put at his disposal all records and documentation or provide copies thereof in format agreed by Client. On a monthly basis, the Contractor should submit along with the monthly progress report, a detailed report focused on the performed survey work and relevant results.

2.5 MEASUREMENT AND PAYMENT

- I). No item of survey work shall be measured for the purpose of payment. No separate payment shall be made for survey work and related auxiliary services, as the cost thereof is deemed to have been included in the rates quoted for various items of works.
- II). The survey work shall include, but not be limited to, the following activities:
 - a). All survey work, in particular fieldwork, office work, including preparation of survey maps/drawings/sketches, investigations, provision of skilled personnel, provision and maintenance of survey instruments and accessories, supply of all materials required for survey and associated purposes, provision of suitable labour, protection of survey points etc.
 - b). Shifting machinery and temporary plant out of the required sightlines.
 - c). Stopping all machinery, drilling, blasting, driving and other work causing vibrations, dust, gas, etc.
 - d). Restricting or stopping traffic of persons and vehicles near instruments or in sightlines during instrument observations.
 - e). Removing all obstructive accumulation of water.
 - f). Taking all necessary safety precautions.
 - g). Clearing sightlines by removal of bushes and scrub with the prior approval of the Client.

3 MATERIALS FOR CONSTRUCTION

3.1 SCOPE OF WORK

- I). The specification described herein under relate to the Work, which includes all labour, materials, equipment and service required to arrange materials for construction of various works under this Contract.
- II). Test reports of materials for the concrete shall be, submitted by the Contractor to the Client at the Trial Mix Stage as set out in Section "Cement Concrete".
- III). The specifications of some of the major construction materials are given hereinafter for planning purpose, however the contractor shall abide by all codes/regulations/ specifications as are deemed necessary for the satisfactory completion of work. The use of excavation material for construction purpose (concrete /shotcrete, aggregates, fill etc.) shall be investigated and proposed to the Client for approval.
- IV). Minimum buffer stock for one-month quantity as per agreed work's programme of following items shall be maintained at site for Cement, Reinforcement bars, Aggregates for Shotcrete/Concrete, Rockbolts, drainage material and pipes, Geogrids/geotextiles/geostrips as per requirements.
- V). However, towards work closure, the contractor may use these quantities with prior approval of Client. Materials which have a defined shelf life will be regularly consumed and recouped with fresh stock at suitable time intervals.

3.2 SUBMITTAL

- I). The Contractor shall, specify in his bid and subsequently also, the source (s) from which all construction materials will be obtained. In case the specified sources(s) is not acceptable to the Client, the contractor shall be required to substitute the source by an acceptable source. Additional suppliers and change of suppliers shall be subject to the approval of the Client.
- II). At least 28 days prior to procuring, or dispatch of the materials to site, the Contractor shall submit, to the Client, the following:
 - a). Certified quality test reports from manufacturers in respect of cement, steel, and other materials. This will also be necessary whenever the source is changed or when the sub-standard materials are received on the Site.
 - b). If the materials are to be arranged from several sources, the estimated quantity to be procured from each source and the proposed Schedule of supply.
- III). The layout of the stockpiles and the method of drawing aggregates from them shall be this is to inform that the part of relative documents shall be timely submitted to the Client, at least 28 days prior to the commencement of stockpiling of aggregates.
- IV). The details relating to the source, method of delivery and storage of water to be used during construction shall be submitted by the Contractor to the Client for approval, at least 56 days prior to the commencement of the Work.
- V). The Client reserves the right to require any additional information deemed necessary to be included in the submitted documents.

3.3 STANDARDS

The specifications, production, sampling, testing and storage of construction materials shall conform to the following latest Indian Standards or where not covered by these Standards, to the equivalent International Standards. The list is for guidance purpose only. The contractor shall abide by all codes/regulations/ specifications as are deemed necessary for the satisfactory completion of work.

I). Aggregates and water

IS 456 Code of practice for Plain & Reinforced concrete.

IS 383 Specification for Coarse & Fine Aggregates from natural source for concrete.

IS 2386 (All parts) Method of test for Aggregate of concrete

IS 516 Method of test for Strength of concrete.

IS 460 Code of Test Sieves

IS 1607 Methods of Test sieving

II) Cement

IS 269 Specification for Portland cement.

IS 1489 Specification for Portland Pozzolana cement.

IS 12269 Specification for 53 grade ordinary Portland cement.

IS 12330 Specification for Sulphate Resisting Portland cement.

IS 455 Specification for Portland slag cement.

III). Steel for Reinforcement

IS 432 (Part-I) Specification for mild steel & Medium tensile Steel bars and hard drawn steel wire for concrete reinforcement.

IS 1566 Specification for Hard drawn steel wire fabric for concrete reinforcement.

IS 1786 Specification for High strength deformed steel bars & wire for concrete reinforcement.

IV). Structural Steel

IS 2062 Steel for General structural purpose.

IS 808 Dimensions for Rolled steel Beam, Channel & Angle Section.

IS 8500 Structural steel- Micro-alloyed (Medium and High Strength Qualities).

IS 800 Code of Practice for General construction in steel.

V). Steel for Pipes

IS 6286 Seamless and welded steel pipes for sub-zone temperature service.

IS 3589 Steel pipes for Water & Sewerage.

IS 1536 Centrifugally cast (spun) iron pressure pipes for water, gas & sewerage.

IS 6631 Specification for steel pipes for hydraulic purpose.

IS 1161 Steel Tubes for structural purpose.

VI). Welding Electrodes

IS 814 Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.

IS 816 Code of Practice for use of metal arc welding for general construction in mild steel.

For all the materials latest IS-Codes shall be followed.

In case of conflict between the above Standards (or specified by Client) and the Specifications given herein, the Specification shall take precedence.

I. STONE

- a. All stones used on the Works shall be of sound, hard, durable and tough quality approved by the Client.
- b. The stones shall be fine or medium grained; hard, bright in color, breaking with a clean fracture and such as make a ringing sound when struck with a hammer.
- c. It shall be free from decay, vesicles, holes, flaws, cracks and other defects and must have, as far as possible, uniform color and texture. Porous stone absorbing water more than 1 (one) % of its dry weight after 24 hours' immersion, shall be rejected. No stones shattered or cracked by blasting operations or having any skin or earthy cover shall be used.
- d. In case the stone is not considered to be free from dust, or dirt etc. by the Client. The Contractor shall get the stone screened washed and/or treated as directed by the Client.
- e. Samples of stone that the Contractor intends to use shall be submitted for approval of the Client not later than 45 days prior to the date of use.
- f. Relevant codes and specifications and tests shall be followed by the contractor.

II. AGGREGATES

- a. General
 1. All aggregates shall comply with provisions of IS:383 and shall be tested in accordance with IS:2386. Slag and crushed over burnt brick or tile shall not be approved for usage on the project in any form.
 2. Use of aggregates (coarse and fine) containing excessive amount of zeolites, secondary minerals and such other components, which cause alkali reactivity of the aggregates and

consequent reduction in durability of the concrete is prohibited. The Client may however, allow the use of such material either in part or in full, with suitable remedial measures, keeping in view the extent of reactivity, the location, the nature of exposure and the structure, if the Client considers necessary, he may ask the contractor to carry out mineralogical tests to ascertain the absence of harmful minerals in the stones.

3. The Contractor shall make his own arrangements of aggregate crushing plants etc. for crushing of aggregates from stones extracted from approved quarries or obtained after excavation works of the project. Railway land if available can be used for setting up of aggregate crushing plants etc.
4. The Contractor shall take all permissions, licenses etc in this regard from the concerned Authorities. Till the time permission is obtained, contractor is required to procure material from alternate sources without affecting schedule of works. No claims on account of delays in grant of permission by authorities or delay in installation of the crusher plants will be admissible. The contractor's aggregate crushing plants shall meet all Environment guidelines and conditions imposed by MoEF&CC, Central /State Pollution Control Board and other statutory bodies, at no extra cost to the Employer.
5. The quality of all aggregates used in the works, as also processing such as washing, classifying, screening, rescreening, crushing and blending necessary to meet the required Specifications, shall be subject to the approval of the Client.
6. The aggregates shall be supplied from supplier after obtaining approval of Client. The Contractor shall carry out the required tests and submit the reports to the Client for establishing the acceptability of the quality of material and also for ascertaining the quantity of material in the sources.
7. The aggregates shall be sampled and tested by the contractor in the presence of Client in accordance with the Indian Standards. Gradation, abrasion and water absorption tests on all different types of aggregates procured from approved sources shall be performed at a frequency of 1 test per 200 cum of supply or part thereof.
8. The tests shall be made on samples that are representative of the grading that will be used in concrete and the aggregates shall be processed by the equipment proposed for the works.
9. The Client shall at all times, have access to and association with sampling and testing of aggregates and shall be entitled to discuss with the contractor, the results and proposals for grading of aggregates.
10. Coarse and fine aggregates shall be stocked and batched separately.
11. All in Aggregates is not to be used without prior approval of Client.

b. Coarse Aggregates

1. The term coarse aggregates apply to pieces of natural or crushed rock ranging in sizes from 4.75 mm to 150 mm.
2. The aggregates shall be composed of clean, hard, strong, durable pieces of stone, angular or rounded in shape obtained naturally or by crushing from suitable stones approved by the Client. Coarse aggregates shall not contain more than 15 % elongated or flat particles. An

elongated particle is defined as a particle having a maximum length of more than 5 times its maximum width. A flat particle is defined as particle in which its maximum width or length is more than 5 times its maximum thickness.

3. Coarse aggregates delivered to the batching plant shall have uniform and stable moisture content.
4. The coarse aggregates shall be free from objectionable materials such as wood or other deleterious substances, the percentage of which in any size of coarse aggregates shall conform to the relevant Standards except that the coarse aggregates shall contain no more than 0.30 % by weight of deleterious (reactive) iron sulphides. The sum of the percentage of all deleterious substances in any size shall not exceed 3 % by weight. Coarse aggregates having a specific gravity (saturated surface dry basis) less than 2.60 shall be rejected.
5. The aggregates shall be resistant to deleterious substance, chemical or physical change such as cracking, swelling softening, leaching or chemical alterations after its incorporation in concrete.
6. When subject to sodium sulphate soundness test, coarse aggregates shall not suffer more than 12 % loss of weight after five cycles.
7. The aggregates shall be crushed in approved type of stone crushers and different sizes of the coarse aggregate shall be separated into nominal sizes by screening over vibrating screens as under:

i Designation of size Nominal size range

ii 20 mm aggregate 4.75 mm to 20mm

iii 40 mm aggregate 20 mm to 40mm

iv. 80 mm aggregate 40mm to 80mm

v. 150 mm aggregate 80 mm to 150 mm

8. The grain size distribution of the coarse aggregate for the various maximum sizes of aggregates shall be as set out in the relevant Standards. These may be altered with the approval of the Client from time to time if necessary, on the basis of actual tests carried out regularly in the laboratory so as to get the best possible coarse aggregate grading.
9. Aggregate Impact and abrasion value shall not exceed 30%.
10. The percentage of weight of all the significant under-sizes shall be less than 5 % when tested on the designated test screens having opening 0.5 times the normal minimum size of the material. No oversize (i.e. material that would retain on the designated test screens having opening 1.5 times the normal sizes of the material) shall be permitted.

c. Fine Aggregates (Sand)

1. Sand or fine aggregates shall be used for mortar in stone masonry, in grouting and as fine aggregates in concrete work. It shall be either natural river sand or manufactured sand crushed from rock/stones or mixture of both in specified proportions. The sand shall be

composed of hard, clean and gritty pieces of stone and of a quality approved by the Client. It shall be free from injurious amount of clay, soft and flaky particles, vegetable or organic matter, loam, mica and other deleterious substances and shall not contain any salts.

2. Varying amount of moisture in fine aggregates contributes to lack of uniformity in concrete consistency. The fine aggregates shall therefore have uniform and stable moisture contents. Dry sand shall be preferred. Hence sand stockpiles shall be protected from rainfall.
3. The percentage of deleterious substances in the fine aggregates shall conform to relevant Standards except that the fine aggregates shall contain no more than 0.10 % by weight of deleterious (reactive) ferrous sulphides. The total percentage of deleterious substances must not exceed 5 % of the weight in natural uncrushed fine aggregates and must not exceed 2% of the weight in case of crushed fine aggregate.
4. Fine aggregates having a specified gravity of less than 2.60 are liable to be rejected. Fine aggregates when subjected to a soundness test with a solution of sodium sulphate, after 5 cycles of tests, shall not suffer a loss of weight in excess of 10 %.
5. The sand shall be well graded and, when tested by standard sieves, shall conform to the prescribed limits of gradation. The best gradation shall be determined by the Contractor after experiments and tests and shall be followed after approval of the Client.
6. The sand, as delivered to the batching plant shall have a fineness modulus of 2.6 to 3. The grading of fine aggregates shall be so controlled that the fineness modulus of at least 9 out of 10 samples of fine aggregates delivered to the batching plant shall not vary more than 0.20 from the average of 10 samples tested. All classifying, batching or other operations on the fine aggregates shall be done by the Contractor and the cost thereof shall be included in unit rate for the concrete, shotcrete or masonry item as the case may be.
7. The contractor shall provide complete facility at site for determining grading of aggregates by sieve as per IS: 383, IS:460, IS:1607 and IS:2386. The grading of fine aggregates when determined as described in IS:2386 Part-1, shall be within the grading zone I, II, III.

d. Natural Sand

1. Contractor shall seek approval of source from client before using natural sand. No sand affected by salty water shall be used. The sand shall be screened and thoroughly washed, preferably in flowing water so as to remove all earthy impurities and very small fine unless otherwise permitted by the Client.
2. Natural sand shall be free from laterite and other softer grains and all sources of sand showing appreciable percentage of these impurities shall be rejected.
3. The presence of mica in the fine aggregate has been found to reduce considerably the compressive strength of concrete. It is advisable, therefore, to investigate the mica content of the fine aggregates and make suitable allowances for possible reduction in strength of concrete or mortar. The decision of the Client whether to use such sand and if so, what allowances to be made, shall be final and binding on the Contractor.
4. The contents of the organic matter shall conform to relevant Standards.

e. Manufactured Sand

1. Whenever natural sand conforming to the required Specifications is not available recourse shall be taken to manufacture sand of desired quality by crushing of stones. The contractor shall comply with the directions of the Client in this behalf. The stone that will be used in crushing for getting fine aggregates shall conform in all respects to the stone / coarse aggregates specified under relevant Paras hereof.
2. In case the natural sand or the manufactured/crushed sand is not considered to be as per Specifications, the same may be rejected outright by the Client or the sand may be allowed after processing, provided the sand conforms to the requirements after such treatment.
3. For improving workability of pump able concrete mixes, the Contractor may consider a combination of natural and manufactured sands. Proposed proportions shall be submitted for approval of the Client.
4. No additional payment shall be made for producing manufactured sand.

III. Storage of Aggregates

- a. Storage areas for aggregates have to be covered, protected against any kind of contamination, avoid the possibility of mix among aggregates and protected also against any water inflow. The floor of the storage for aggregates has to be in concrete and has to be drained. Storage areas for different size of aggregates have to be independent to avoid any possibility of mix.
- b. During rainy and cold weather periods, the aggregates shall be stored undercover for at least 48 hours before being used and kept sufficiently dry.
- c. The stockpiling of the processed aggregate and drawl there from shall be such as to ensure that the variation in the free moisture in the aggregate during anyone shift of working, does not exceed 1 percent.
- d. The coarse aggregates shall, be stored as per the procedure of relevant IS: codes.
- e. Care shall be taken in screening and stocking of the coarse aggregates so as to avoid intermixture of different gauge materials and inclusion of any foreign materials.
- f. The stockpiles shall be built up in horizontal or gently sloping layers.
- g. Trucks and bulldozers shall be kept off the stockpiles to prevent breakage and impairing the cleanliness of aggregate.
- h. A hard base shall be provided to prevent contamination from underlying materials in storage areas in continuous use.
- i. Overlap of different sizes of materials shall be prevented with suitable walls or by ample distance between storage piles.
- j. Arrangement shall be made to store natural and manufactured sand in a way that shall protect it from being contaminated with dust, organic matter or other deleterious substances.

IV. WATER

- a. It may not be practical to arrange water from river at all locations. Contractor shall be responsible to arrange water from river, natural streams, etc. as convenient to him. Necessary permissions from the local authorities if required shall be obtained by the contractor at no extra cost to the employer.
- b. Adequate water storage facilities shall be provided by the Contractor at the batching and mixing plant and other Work Sites so that various operations of works do not suffer due to temporary breakdown in the main supply system.
- c. The Contractor shall supply test reports of water samples from the intended sources to the Client for approval.
- d. The Contractor shall establish the suitability of water to be used for construction purposes and submit for approval of Client
- e. Water for washing of aggregates, mixing mortar, concrete or grout shall be clean and free from earth, vegetable or organic matter, injurious amount of oils, acids, sugar, salt and alkaline substances in solution or in suspension and shall conform to relevant Standards. The maximum allowable contents of sulphates (SO₄) shall be 250 parts per million (ppm) and those of chlorides (Cl) shall be 200 mg per litre for plain concrete works and 100 mg per litre for reinforced concrete works. Turbidity shall be within 2000 ppm (or 0.2 % by weight) and preferably as low as possible.
- f. Water used for curing shall be clean and free from contamination and from excess amounts of acids or alkalis or other matter combining chemically with and thus, disfiguring the concrete surface. Water shall not contain organic matter causing stink.
- g. Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90 % of the average of strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements set out in section of "Cement Concrete".

V. CEMENT

- a. General
 1. The Contractor shall procure the cement of the specified quality from **Ultratech, Ambuja, ACC, Birla Gold**. Other brand cements will not be used without approval of the Client. For this purpose, Client shall approve at least two sources/plants out to those intimated by the Contractor so that there is a standby for taking care of any eventualities.
 2. Cement to be used for various works shall be of different types such as Ordinary Portland Cement or Portland Pozzolana (fly ash based) Cement as approved by the Client and shall conform to the relevant Standards at the time of its use.
 3. OPC 53/ 53S grade shall be used for shotcrete/grouting/underground concrete works and Portland Pozzolana Cement for other concreting and masonry works or as per direction of Client.

4. The Contractor shall deliver with each lot of supply of cement a certificate from the manufactures/suppliers by which the cement is guaranteed to comply with the requirement of the specifications. Client shall have the right to check or get the cement tested at any stage of its manufacture or delivery and these test reports shall supersede the test report given in the manufacturer's certificate.
 5. The contractor shall perform alkali aggregate reactivity test including accelerated mortar bed test to verify and negate the possibility of alkali silica and alkali carbonate reactive tendency and the cement to be used shall not have alkali contents exceeding 0.6% by weight of cement.
 6. The cement shall be sampled and tested by the Contractor in the presence of Client for strength and physical properties and chemical analysis will be carried out as set out in relevant Standards.
 7. The Cement samples for testing at the source/plant shall be obtained by the Contractor as the bins are being filled. Tests for false set shall be made on samples taken at the latest time prior to shipment.
- b. Transportation
1. Cement shall be transported to site in bulk/bags in bulk containers / trucks approved by the Client.
 2. All bulk containers / carriers shall be clean and dry prior to filling / loading with cement and equipped with weatherproof closures on all openings.
- c. Storage
1. Sufficient storage facilities shall be provided at the batching plant to enable each new shipment of cement to be stored separately from the cement stored from earlier shipments. ▭
 2. Cement shall be stored above ground adequately protected against rain sun and moisture. Bulk storage bins and silos shall be emptied complete and cleaned of all cement accumulation after every 3 months.
 3. Arrangement shall be made such that stock of approved cement are adequate to meet the programme of work at all times. The programme shall allow time for testing and approval of each shipment before such cement is incorporated in the works.
 4. Cement shall be used in the order in which it is received at Site. Cement of different brands, if received on Site, shall not be combined in the same mix and structure. Such cement shall be used in different structures as approved by the Client.
 5. Handling and storage facilities shall be such that no cement is stored before use for more than 90 days. Should any cement be unavoidably kept in storage longer than 90 days, it shall be tested and if found failing the specifications required to be met, shall be rejected for use on the Project.

VI. STEEL FOR REINFORCEMENT

a. General

1. High strength deformed steel bars and wires for reinforcing bar used in the works shall be deformed TMT Fe-500D conforming to IS:1786 manufactured by primary steel producers such as SAIL/TISCO/JINDAL/RINL/IISCO only.
2. Manufactures test certificate shall be supplied for each lot.
3. Steel shall be free from loose mill scale, rust, oil, grease, dirt, paint or other deleterious matter, when examined immediately before concrete is being placed.
4. Upto 10mm dia, one sample per 30 MT and beyond 10mm dia one sample per 70 MT or part thereof shall be tested for various physical and mechanical tests as per IS:226, IS:1608, IS:1559 and IS:1387.
5. Wire for tying reinforcement steel shall be black annealed iron wire or acceptable equivalent, with a suitable diameter and shall have an ultimate strength of 5.68 tonne/cm² and yield strength of not less than 8.8 tonne/cm².
6. After material passing done by engineer, the reinforcement rods shall then be treated in accordance with IS: 9077.
7. No extra payment for re-bar treatment shall be made and is deemed to be included in the quoted rates.

b. Transportation and Storage

1. Transportation shall be undertaken in such a manner that no damage is done to the steel.
2. Reinforcement steel shall be stored off the ground in separate groups according to size and length. Reinforcement steel, which has been cut and bent according to the schedules provided by the contractor, shall be marked with bar number, as shown in the schedule, by using weather proof tag or by placing in marked bins and shall be stored in such a manner as to be readily accessible when required and to facilitate inspection.

VII. STRUCTURAL STEEL

a. General

1. Structural steel used in the works shall conform to IS:2062 manufactured by primary steel producers such as SAIL/TISCO/JINDAL/RINL/IISCO only. Other brand steel shall not be used without prior approval of the Client.
2. All structural steel shall be of new/unused stock, clean and straight, free from excessive rust or scale and without any sharp kinks, bends or other objectionable defects.
3. All structural steel including steel plates and steel to be used for Supports as also for bolts, nuts and washers etc. shall conform to relevant Standards. Manufactures test certificate shall be supplied for each lot.
4. The material used in splices shall conform to the Specifications of the material being spliced.

b. Transportation and Storage

1. Structural steel shall be transported, handled and stored in such a manner that no damage is done to the materials or the structure.
2. All timber to be used for support accessories shall be stored in separate secure locations.

3.4 SAMPLING, TESTING & QUALITY ASSURANCE

- I. For sampling, testing and Quality Assurance, Programme will be submitted by the contractor for approval of Client.

3.5 MEASUREMENT AND PAYMENT

- I. No separate Measurement & Payment shall be made for supplying, including transportation and storage of material until and unless specifically included in the technical specification/BOQ. The cost of the materials and testing (including the royalties, if any) used in works shall be deemed to be included in the quoted rate for the relevant items of works.

4. DEWATERING OF SURFACE CONSTRUCTION SITES

4.1 GENERAL

- I. The Contractor shall perform all works necessary to drain the surface construction sites of rain, flood water, ground water and service water. The Work shall include, but not be limited to the following:
 - a. Design and construction of drainage, ditches, pits, dikes/bunds and pump sumps.
 - b. Design, furnishing, operation and maintenance of dewatering equipment.
 - c. Relocation of dewatering facilities required for the performance of other Works.
 - d. All auxiliary Works required for safe and continuous dewatering of the construction sites.
- II. Dewatering of surface construction Sites located near and above a river/stream shall be done up to the existing water level in the river / stream by gravity as directed by the Client. Suitable drainage shall be made joining the course downstream of the construction Site to provide required gradient to facilitate proper and efficient dewatering. Below the water level of the stream, dewatering shall be done by pumping water collected in the sumps and discharging the same into course of the river/stream downstream of the construction Site.

4.2 REQUIREMENTS AND DESIGN

- I. The Contractor shall design and install complete facilities at the surface construction Sites.
- II. The surface water dewatering systems shall be designed to accommodate, without undue disruption to the work, any rainfall event and considering the extent of the Sites to be dewatered and the dewatering arrangements proposed.
- III. Claims for extension of time due to delays caused by unfavourable weather conditions will not be considered.

- IV. The contractor shall provide adequate pumping capacity, including standby units, to handle all water entering any of surface construction Sites. In addition, he shall provide sumps and pumps and or well points in the immediate vicinity of the structure foundations using such water conductors as are necessary to conduct the water away from the excavation and concrete placement operations in an approved manner, so that such operation shall be kept free from standing or running water.
- V. Power for operating the dewatering system shall be arranged by the contractor from existing poling points. The contractor shall also make his own arrangement for enough standby power at his own cost to carry out the works during any interruption of power.
- VI. The Contractor shall ensure that all drainage water is disposed off without causing interference to his own or other Contractors' operations elsewhere on the Site and that no drainage water runs into adjacent Works.
- VII. The dewatering systems shall be designed and installed in such a way that modifications and extensions to the systems are possible while they are in full operation.
- VIII. All the components of the dewatering systems shall be installed and operated in accordance with the approved method and the construction time schedule, or approved modification thereof.
- IX. The approval by the Client of the dewatering system shall not relieve the Contractor from being fully responsible for the design, construction, operation, maintenance, safety and removal of the facilities provided for the dewatering system and he shall be liable for any damage or delays caused by its failure. The Contractor shall indemnify the Client against claims arising out of any such, failure made by a third party.

4.3 MATERIALS AND EXECUTION

- I. Drainage ditches shall be excavated along the top of excavated slopes and on the berms. Such ditches shall be kept well back from the excavation edges in order to prevent saturating the upper part of the slopes. The ditches shall be regularly cleaned out of all accumulated silt and other matter so that water may always flow freely.
- II. Where excavation is to be made below the ground water table, the Contractor shall lower the water table sufficiently below any working surface by means of properly screened wells and/or ditches to ensure that the foundation surfaces remain free of standing water and undamaged by the passage of construction traffic. All ditches shall be outside the foundation areas. The water shall be collected and removed by pumping, if no outflow by gravity is possible.
- III. Where concrete is to be placed, the water table shall be maintained below the lowest part of the finished excavation for minimum one day following the raising of structure above the natural ground water table, and for such additional time as may be necessary to preclude damages to structure foundation.

- IV. In trenches and foundations, the dewatering shall always enable to carry out the excavation Work in dry, and in a manner that will prevent loss of fines from the foundation.
- V. Upon completion of dewatering, temporary pipes and pump sumps beneath permanent structures shall be closed off and filled with grout, mortar or concrete as required by the Client.

4.4 MEASUREMENT AND PAYMENT

- I. Payment for all dewatering activities for surface construction sites shall be included in the rate of excavation itself. No additional payment shall be payable on this account including pumping required from sump, pits, wells etc. as the case may be.

5. EXPLOSIVE AND BLASTING

5.1 SCOPE OF WORK

The Specifications described herein under relate to supply transportation, handling, storage and use of explosives. All operations shall be carried out by the Contractor as per Indian Explosive Act, statutory requirements and regulations as applicable in India.

Contractor may obtain license from statutory authority for procuring, transporting, storing and using explosives. The same may also be arranged through existing approved suppliers/license holders in the project area. The Contractor may also have his own magazine for the storage of explosive etc. In either case, no claim of Contractor will be admissible on account of any delay in obtaining any mandatory permissions or in arranging the same for progress of the work.

The contractor will be required to draw the explosives, transport to the site and keep it safely as per safety guidelines of Indian Explosive Act. He shall acquaint himself with all applicable latest laws and regulations concerning storing handling, safety and use of explosives. The Client may issue modifications, if required and the Contractor shall comply with the same without these being made a cause for claim whatsoever, against the Client.

Explosives may be required for the Project if the contractor chooses to proceed with blasting and not by excavation with mechanical means. The rock mass excavation is considered limited on site and if blasting is required will be mainly to remove big boulders or the rock slope excavation at the south side of the upper slope. In any case and wherever used, blasting should be performed in a controlled way with limited vibrations so as not to cause instabilities to the permanent and temporary slopes on site.

Word "Explosives" would also mean the accessories related I similar substances for the purpose of safety unless otherwise specified.

5.2 SUBMITTALS

- I. At least 30 days after the receipt of the LoA, the Contractor shall submit to the Client for approval, the details relating to transportation, storage and use of materials such as explosives, detonators, Detonating I safety fuse coils, Blasting Cables, Exploders, Loading Poles and tamping materials etc.

- II. The Client reserves the right to require any additional information deemed necessary to be included in the submitted documents.

5.3 STANDARDS

- I. Transportation, handling, storage and use of explosives shall be carried out under Indian explosive regulation, 1984 in a safe and efficient manner and shall also conform to the following Indian Standards or where not covered by these Standards, to equivalent International Standards.

Indian Explosive Act 1883 and Explosives regulations 1984 (Amended 2005)

IS 6609 Methods of test for commercial blasting explosives and accessories.

IS 10081 Terms relating to commercial explosives, Pyrotechnics and blasting practices.

IS 15447(Part-I) Commercial blasting explosives specification- Nitroglycerin based.

IS 4863 Glossary of mining terms (drilling and blasting)

IS 7526 Detonating fumes.

IS 7632 Detonators.

- II. In case of conflict between the above standards and the Specifications given herein the specifications shall take precedence.

5.4 SUPERVISION

- I. Before taking up blasting operation, contractor/Explosive manufacturer shall submit blasting pattern, minimum safe charge, vibration control / monitoring etc. Such study report shall have to be got updated improved periodically during the excavation period.
- II. Design and excavation by blasting shall be permitted only under the supervision of competent and trained workmen who are fully experienced in the work and who have received adequate instructions. The Contractor shall make sure that his blasting crew is fully conversant with the rules and regulations concerning storing handling and use of explosives.
- III. Blasting specifications should include detailed description of state-of-the-art detonators, explosives and blasting patterns as well as blasting expert services including training of actual site personnel to be provided on site at the start of the project.

5.5 TRANSPORTATION AND HANDLING

- I. Explosive shall not be transported to the Site of operation except in suitable cases or containers, which are so made as to prevent any spillage of explosives during conveyance. No explosive shall be removed from such cases or containers except when it is to be used forthwith for the purpose of the work.
- II. Suitable Explosive Vans, duly approved by the Client, shall be used for transportation of explosives and detonators. The following rules shall be observed for use of Explosive Van:

- a. Vehicles shall have springs under the body. Tyre pressures shall be as per Indian Explosives Regulations.
- b. Detonators and igniters shall not be carried in the same vehicle with explosives.
- c. Beside the driver, only one helper shall be accommodated in the Explosive Van. The vehicle carrying the explosives shall not be used to transport workmen or other materials to workshops although there may be enough space for men or materials.
- d. Driver shall not leave the vehicle unattended while transporting explosives.
- e. All vehicles transporting explosives shall be marked or placarded on both sides and with the word "EXPLOSIVES" in bold letters.
- f. All explosive boxes shall bear explosive's Batch details, Mfg. Date and specifications etc. clearly on them
- g. A motor vehicle carrying explosive shall not be refueled except in emergencies and that too only when motor is stopped, and other precautions taken to prevent accidents. Such vehicles shall invariably have at least two fire extinguishers placed at convenient points.
- h. Use of Mobile phones shall be restricted while carrying detonators or while refueling takes place.
- i. Explosives Vehicle should have the seat belt for driver and the use shall be mandatory for the driver.
- j. Vehicles transporting explosives shall never be taken into a garage, repair shop parked in congested areas, or in a public garage or similar building.
- k. Explosives shall not be transported on a public highway during hours of darkness except in extreme emergency and that too only with the written approval of the Client.
- l. Explosives shall not be transported in any form of trailer, nor shall any trailer be attached to a motor truck or vehicle hauling explosives.
- m. No transfer of explosives from one vehicle to another shall be made on any highway except in case of emergency.
- n. Persons employed in the transport or handling of explosives shall not carry with them or in the vehicles, matches, loaded firearms, petrol or any flame-producing devices.
- o. All explosives shall be adequately protected against theft.
- p. Smoking shall be prohibited during handling, transportation and use of explosives. The places of Explosives storage shall be clearly marked as "No Smoking".
- q. The speed of the vehicle shall not exceed 25 km per hour on rough roads and 40 km per hour elsewhere.

- r. The interior of the body of the vehicle shall not have any exposed metal parts except those of copper, brass and other non-sparking metals and shall be preferably lined with wood.
- III. Motor vehicles used for transporting shall be carefully inspected daily to ensure that:
- a. No petrol driven vehicle shall be used.
 - b. Filled and serviceable extinguished are in position.
 - c. The electric wiring is well insulated and firmly secured.
 - d. Chassis, engine and body are clean and free from surplus oil and grease.
 - e. Fuel tank and feed lines are not leaking.
 - f. Lights, brakes and steering mechanism are in good working order
 - g. Vehicle is in proper condition in all respects for the safe transportation of explosives.
 - h. Two nos of red flags shall be present at the left and right top front ends of the vehicle
 - i. Condition of Van doors and locking arrangement shall be checked to ensure that rainwater or moisture doesn't damage the explosives case
- IV. Boxes or explosives shall not be handled roughly or allowed to fall.
- V. Containers of explosives shall be opened only by means of non-sparking tools or instruments.
- VI. After the loading of a blast is completed, all excess explosives and detonators shall be removed to a safe location or returned at once to the storage magazine, observing the same rules as when being conveyed to the blasting areas.
- VII. Containers for detonators shall always be used for storing detonators only.
- VIII. Explosives and detonators shall be carried in separate containers and by separate persons to the loading face. Only non-electric detonators shall be used.
- IX. The drivers of the vehicle carrying explosives shall be trained in use of fire extinguishers on his vehicle.
- X. If any fire occurs on a vehicle carrying explosives the driver shall take all practicable steps to ensure that all other traffic is stopped at least 300 m from the vehicle and that all persons in the vicinity are warned of the danger.
- XI. Loadings, unloading and handling of explosives shall, be supervised by qualified personnel. At the time of loading or unloading of explosives no electric switch shall be operated.
- XII. Explosives shall not be placed where these may be exposed to flame, excessive heat sparks or impact or hazards of similar nature.
- XIII. The covers of the explosives cases or packages shall be replaced every time after taking out part of the contents as long as any explosives are left in them.

- XIV. Explosives shall not be carried in any way other than as specified in The Explosives Act & The Explosives Rules.
- XV. Contractor shall ensure no misuse or mishandling of explosives such as carrying the explosives material in the pockets or folds of clothing etc. by any person.
- XVI. Primers shall not be made up in advance. Priming shall be carried out only when charging of the face starts except emergency for which written approval from client shall be required.
- XVII. Nothing shall be inserted in the open end of a blasting cap except fuses.
- XVIII. No person shall strike, tamper with, or attempt to remove or investigate the contents of a blasting cap or an electric blasting cap or attempt to pullout the crimped safety fuse out of a blasting cap.
- XIX. No attempt shall be made to soften I harden explosives by any specific treatment such as heating over a fire or by rolling the explosive on the ground.
- XX. The blasting powder, explosives, detonators, fuses, etc. shall be in good condition and not damaged due to damp moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed immediately.
- XXI. No attempt shall be made to reclaim or use fuses, blasting caps, electric blasting caps or any other explosives, which have been water, soaked, even if these have been dried out. The manufacturers shall be consulted for this.
- XXII. The Contractor shall make all necessary arrangements for the security of the explosives during transportation. However, the client, upon a request by the Contractor, may arrange protection by the Govt. security forces for large quantities of explosives, and the corresponding cost shall be borne by the Contractor.

5.6 STORAGE

- I. The Contractor may either obtain necessary licenses and consents and provide secure storage facilities for all explosives and equipment in accordance with Indian explosive act and requirements of local administration and client or may arrange explosives from nay existing explosive supplier in the region. In either case, the contractor shall take approval of Client and keep him initiated of the source of explosives. No claims on account of any delays will be admissible in this regard.
- II. If the Contractor has arranged the required licenses and decided to establish his own magazine for the storage of explosive etc. then: -
 - a. The contractor will be required to draw the explosives, transport to the site and keep it safety as per safety guidelines of Indian Explosive Act and the Explosive Rules. The magazine shall always , be kept scrupulously clean.

- b. All the explosives like dynamite shall be stored in a dry clean, well ventilated and fireproof building' constructed in accordance with Indian Explosives Act, on an isolated Site. The area around the magazine for 8 m shall be kept clear of all vegetation and combustible matter.
- c. There shall be a barbed wire fencing and security lights around the magazine and security guards shall be posted around for 24 hours to prevent loss or theft of explosives.
- d. Explosives, detonators and fuse coils shall be stored separately.
- e. The Contractor shall maintain a record of storage and withdrawal of all explosives. This record shall be made available to the client on request. The client shall be promptly notified of any loss or theft of explosives.
- f. Explosives shall be stored and used chronologically to ensure that the ones received earlier are used first. There shall be enough space between the stacks.
- g. A "preparation area" shall be identified close to the charging face prior to every blast for preparatory work by experienced men as required for the work. All safety measures shall be ensured in the "preparation area".
- h. Unauthorized persons shall not be allowed at any time to enter the magazine.
- i. The person-in-Charge of the magazine shall, always, ensure that the magazine is securely locked.
- j. Explosives shall be handled and used only by the Contractor's duly authorized personnel. The names and qualifications of such personnel shall be submitted to the client in writing in advance of any possible use of explosives.
- k. The magazine on no account is to be opened during or on the approach of a thunderstorm and no person shall remain in the vicinity of the magazine during such storm. Enough lightning conductors shall be provided on top of the magazine.
- l. Magazine shoes, without nails, shall always be kept in the magazine, and a wood tub or cement trough, about 30 cms high and 45 cms in diameter filled with water shall be fixed near the doors of the magazine.
- m. Persons entering the magazine shall put on the magazine shoes provided for the purpose and be careful not to allow the magazine shoes to touch the ground outside the clean floor.
- n. Persons with bare feet shall before entering the magazine, dip their feet in water, and then step direct from the tub over the barrier (if there is one) on to the clean floor.
- o. A brush or broom shall be kept in the lobby of the magazine for cleaning the magazine on each occasion it is opened for the receipt, delivery or inspection of explosives.
- p. No matches shall be allowed in a magazine.
- q. No person having articles of steel or iron on him shall be allowed to enter a magazine.

- r. Oily cotton rags, cotton waste and articles liable to spontaneous ignition, shall not be taken into a magazine.
- s. No tools or implements other than those of copper, brass, gun metal or wood shall be allowed inside the magazine. Tools shall only be used with great gentleness and care.
- t. Boxes of explosives shall not be thrown down or dragged along the floor and shall be stacked on wooden trestles. Where there are white ants, the legs of the trestles shall rest in shallow, copper, lead or brass bowls, containing water.
- u. Package containing explosives shall not be allowed to remain in the sun.
- v. Empty boxes shall not be stored in the magazine nor let any packing material lie loose.
- w. Blasting caps and electric blasting caps shall never be stored in the same box, magazine or building with other explosives.
- x. The following shall be hung in the lobby of the magazine:
 - I. A copy of these rules;
 - II. Display of Magazine License No and the capacity
 - III. A statement showing the stock in the magazine and
 - IV. Certificate showing the last date of testing of the conductor
- y. Adequate firefighting equipment shall be provided in the magazine.
- z. Signboards reading “DANGER HIGH EXPLOSIVES” “PROTECTED AREA” “NO SMOKING etc. shall be conspicuously displayed in front of the magazine.

5.7 DISPOSAL OF DETERIORATED EXPLOSIVES

- I. All deteriorated explosives shall be disposed off in an approved manner as per Explosive Regulation- 1984, The quantity of deteriorated explosives to be disposed off, shall be intimated to the client prior to its disposal.

5.8 DRILLING

- I. Preferably parallel cut drilling pattern shall be adopted.
- II All holes shall be of greater diameter than the diameter of the cartridges of explosives used.
- III. Under no circumstances shall any holes be charged until completion of all drilling operations at the face.
- IV. A drill or pole shall not be inserted in sockets of old holes even its examination fails to disclose explosives.
- V. Drilling shall not be resumed after-blasts had been fired until a thorough examination has been made to make sure that there are no misfires and sockets with explosives which the drills may strike.

- VI. Drilling shall not be started until all remaining sockets of old holes are examined for unexploded charges.
- VII. Drilling crew shall be provided with approved respirators in siliceous dusty atmosphere arising out of drilling operations.
- VIII. Blast design should cater to the changes in geology and/or geotechnical parameters and shall be decided face wise on ground

5.9 LOADING AND CHARGING

- I. The holes shall be cleared of all debris before a cartridge is inserted.
- II. In loading the holes, tamping, if required shall be done with a wooden mallet having no exposed metal parts.
- III. Primed cartridges shall be first inserted and shall be seated by even steady pressure only.
- IV. All loaded holes or charges shall be checked and located before firing.
- V. When holes are sprung ample time shall be left between spring shots for the hole to cool, and between the last springing shot and the loading of the main charge.
- VI. When practicable, no more cartridges shall be primed those are required for a round of blasting.
- VII. Detonators shall be inserted at the end of the primary cartridge facing the end of the drill hole, which is prepared specially for the purpose.
- VIII. Holes in cartridges for inserting the detonator shall be made with a sharpened wooden stick.
- IX. When blasting on the surface the entire area to be blasted must be covered with blasting mats, in locations where surface structures are to be protected, from damage by flying rock fragments.
- X. Detonating cord shall be cut from supply reel before attaching to explosive or tamping in hole. Use of the short pieces of fuse shall be prohibited for detonation purposes.
- XI. Naked flames and lamps shall be kept away at the time of the loading of holes.
- XII. Before starting the charging/loading of holes all electrical lines must be disconnected.
- XIII. Contractor shall arrange visits of Explosive manufacturer's technical team to design and execute the blast, train the blasting crew and supervise the blasting crew as per the direction of the client.

5.10 TYPE OF EXPLOSIVES & ACCESSORIES

- I. Explosives
 - a. For enhancing safety of operations, saving in time and better control of blast quality, bulk type explosives shall be preferable. However, packaged explosives may also be used.

- b. Explosives shall meet following criterion: -

SN	Parameter	Packages Explosive	Bulk Explosive
1.	Density of explosive	1.15±0.05 g/cc	0.6-1.1 g/cc
2.	Relative weight strength	110 -120 %	90 -110 %
3.	Relative bulk strength	155 -165 %	110 -160 %
4.	Velocity of Detonation	4000±500 m/s	3000 – 6000 m/s

These parameters shall be met before seeking client's approval. Additionally, client may collect random samples during any charging cycle, in case of any suspicion.

- c. Explosive as approved by competent statutory authorities shall only be used. These explosives shall be of safe to handle and use, exhibit excellent water resistance and liberate low volumes of noxious gases.
- d. Manual Mixing of chemicals to form any explosives shall not take place and such explosives shall not be used.
- e. Any Explosives having shelf life less than 6 months shall not be used.
- f. Explosives being used shall be capable of performing in low temperatures.

II. Detonators

- a. Priming of the explosives shall be done only with Non - Electric detonators with shock tube containing fine spray of around 13-16 mg/m HMX/AL powder
- b. The detonators shall be truly Non-electric in nature.
- c. The shock tube shall be of the nature that the color of the tube gets changed post blast and can be located easily for misfires etc.
- d. Identification tag and J - hook shall be placed at the end of the tube for identification and easy connectivity respectively.
- e. Ultrasonic seal shall be provided at the end of the tube to make it waterproof.
- f. Shelf life of the detonators shall be one year.
- g. Non - Electric detonators shall be safe against stray currents, static Electricity, Radio-frequency Energies and accidental initiation by impact, shock, friction and time as per the standards fixed by the appropriate authority.
- h. The delay range of detonators should comprise of a minimum 0 - 15 delays firing completely in not less than 8000 ms for long period detonators.
- i. Short delay series shall contain a nominal delay interval of 25 milli second (ms).
- j. Electric detonators shall not be used except for the initiation of Detonating Fuse.

III. Detonating Fuse / Safety Fuse

- a. Detonating Fuse shall be used for connecting Non-Electric detonators.
- b. Nominal Weight of PETN shall be 10 gm/m in detonating fuses (DF).
- c. Detonating Fuses shall be able to get initiated by No.6 electric detonators.
- d. Water resistance shall be excellent.
- e. Detonating fuse shall be used only to initiate the plain detonators.

5.11 WIRING

- I. All detonators in a single blast shall be of the manufacture.
- II. Each electric blasting cap used for initiation of shot shall be tested with an approved galvanometer (circuit Tester) to determine whether it will carry the current. All testing shall be done away from the heading face. Testing of a single detonator at any time shall be avoided.
- III. After testing the leg wires of electric blasting caps, they shall be short circuited by twisting the bare ends together and shall remain so twisted until ready to be connected into the circuit prior to connection to the firing line.
- IV. Unless, the power supply is heavy it is recommended that all electric blasting caps shall be wired in series and the firing line shall not be smaller than No; 14B and S-gauge copper wire.
- V. The number of electric blasting caps used in a circuit shall not exceed, the tested capacity of the blasting machine.
- VI. The circuit including all caps shall be tested with a circuit tester or galvanometer, operating accurately before being connected to the firing line.
- VII. In surface blasting the cartridges shall not be primed nor a hole during the approach of a thunderstorm or while it is in progress. If a charge has been primed or holes loaded, every person shall be ordered to a safe distance until the storm is over.
- VIII. Blasting circuit wires and/or detonators leg wires shall never touch other wires carrying electric current.
- IX. Blasting operation control shall consist of two switches; a safety switch and a firing switch located at least 2 meters apart, the connection between the switches to be made by a “plug-in” jumper, which may be permanently attached to the safety switch. The plug-in jumper Is so made that it cannot be plugged into or connected to the firing switch until the firing switch is unlocked, and the jumper must be disconnected from the firing switch before the firing switch can be locked.
- X. Both the safety switch and the firing switch shall be of the locking, double pole, double throw type which, when opened and locked in downward position short circuit and ground the leading wires.

- XI. Both the safety switch shall be locked immediately after firing the shot and before any person can return to the area. Keys to the switches shall always remain in the possession of the starter.

5.12 FUSE BLASTING

- I. Fuse blasting is not allowed

5.13 FIRING

- I. Shots shall, so far as practicable is fired electrically and only apparatus especially designed for the purpose shall be used. Power lines shall not be tapped for the purpose. No shot shall, be fired except by a licentiate blaster authorized by the client.
- II. The charge shall be fired successively and not simultaneously.
- III. Prior to the firing of a shot all persons in the blasting area shall be warned of the blast through audible warning and ordered to a safe distance from the area.
- IV. Competent flagmen; equipped with red flags and whistles shall be posted to stop traffic at access points on each possible route of travel to the vicinity of the blasting area.
- V. Blasting shall be done at fixed hours approved by the client and the blasting times shall be displayed on a Notice Board.
- VI. Order to fire shall be given only by the Supervisor-in-Charge of the work after giving three warning signals to enable all the workmen to reach safe shelters.
- VII. Blast shall not be fired until it is certain that every person has retreated to a safe distance.
- VIII. The person-in-Charge of blasting shall be the first one to leave the area to be blasted.
- IX. A bugle or an electric buzzer with a distinctive note shall be used to give warning signals. This bugle shall not be used for any other purpose. All the labour shall be made acquainted with the sound of the bugle buzzer and shall be strictly warned to leave their Site of Work immediately for safe shelters at the first warning signal and not to leave the shelters till all clear signal has been given.
- X. An all-clear signal shall be given when the blasting is over.
- XI. Definite places of shelter, natural or artificially constructed, shall be assigned to the crew. Workers shall be made to go to these shelters rather than trust each other's judgment about a safe place.
- XII. In special cases suitable extra precautions shall be taken. The client may, however, permit blasting for underground excavation without restriction of fixed time provided he is satisfied those proper precautions are being taken and that the work of other agencies on the site is not unduly hampered.
- XIII. Only Supervisor-in-Charge shall be responsible for the safe custody of the firing apparatus.

- XIV. For blasts in series, only detonators of the same brand and same electrical resistance shall be used. All detonators shall be checked before use.
- XV. The firing cables shall be with a proper insulating cover to avoid short-circuiting due to encountering water, metallic parts or rock.
- XVI. Use of earth, as a return line shall not be permitted.
- XVII. The firing cable shall be connected to the source of current only when nobody is in the area of blasting.
- XVIII. Mats or rubber tyres tied together will rope shall be used as protection from flying debris to cover the charges where blasting may expose persons or Property to injury or damage.
- XIX. Blasting shall be permitted only after adequate provisions have been made for the protection of persons, the works, and public and private property. The client's approval of any of the Contractor's blasting operations shall not relieve the Contractor of his sale responsibility for the safety of persons and property. Any damage done to the works or property by blasting shall be repaired by the Contractor.

5.14 INSPECTION AFTER BLASTING (MISFIRE DRILL)

- I. Immediately after a blast has been fired, the firing line shall be disconnected from the blasting or other source of power.
- II. After a blast has been fired, a careful inspection shall be made by the blaster to determine if all charges have been exploded. The blaster shall count the number of the exploding shots in blasting. Misfires in fuse blasting shall not be examined for enough time after its failure to explode. Electric blasting misfires shall not be examined for at least 15 minutes after failure to explode. Other persons shall not be allowed to return to the area of blast until an "All Clear" signal is given.
- III. The shot-firer must keep a record of the number of shots fired, their time of firing, type and weights of explosives used per delay and total explosives used in the round and the type and number of detonators used, together with a record of the post-blast situation for each and every location. A copy of the record shall be available to the client at the end of every shift on which shots are fired.
- IV. All wires shall be carefully traced, and search made for any unexploded cartridges by the person-in-Charge of the blasting operation.
- V. Loose pieces of rock and other debris shall be scaled down from the sides of the face of excavation and the area made safe before proceeding with the work.

5.15 MISFIRES

- I. Misfired holes shall be placed in the charge of a competent person.
- II. If broken wires, faulty connections, or short circuits are determined as the cause of a misfire, proper repairs shall be made, the firing line reconnected; and the charge fired. This shall be

done, however only after a careful inspection "has been made of burdens remaining in such' holes and no hole shall be fired when the burden has been dangerously weakened by other shots.

- III. The charge of explosives from a misfired hole shall not be drilled, bored or picked out.
- IV. Misfired charges, tamped with solid material shall be detonated by the following method:
 - a. Float out the stemming by use of a water or air jet from hose until hole has been opened to within 60 cm of charge;
 - b. Water shall be siphoned off or pumped out;
 - c. New charge shall be placed and detonated.
 - d. Whenever this method is not practicable; then a new parallel hole, not nearer than 60 cms, shall be drilled, loaded and detonated. A careful search shall be made of unexploded material in the debris of the second stage.
- V. If misfire has been found to be due to defective detonators or dynamite, whole quantity or box from which the defective article was taken must be withdrawn from the works site for return to the manufacturer or destruction as decided by the client.
- VI. The Contractor shall report, in writing, to the client, all cases of misfire, causes of the same and steps taken in connection therewith.

5.16 MONITORING OF BLAST

- I. General
 - a. The Contractor shall supply and operate at least four approved Engineering Seismometer (Triaxial) or Seismograph to measure 3-components of ground vibration and air blast overpressure. The equipment shall have enough memory space to store at least 300 events and shall be equipped to measure wide range of ground vibration and air blast overpressure. It also shall be equipped with a microphone attachment, permanent paper trace output with built in strip chart printer, LCD display and PC retrieval attachment for data to be used as and where directed by Client to monitor blasting work.
 - b. Unless otherwise agreed in writing by the Client trial blasts, initial blasting in general, and initial blasts in new areas and blasts adjacent to complete concrete structures and sensitive areas shall be monitored. For structures in the proximity of blasting the peak particle velocity shall be' measured at the locations immediately adjacent to the structure nearest to the face being stated or another location where it is necessary to limit vibration as instructed by client.
 - c. The measured vibration results shall be transmitted to the Client together with all the useful information concerning the completed information (cut of the face / slope of the cutting face; particle size distribution of the excavated material etc.; drill marks; vibration wave form in three directions-radial, transverse & vertical; air overpressure waveform; print out of Peak Particle Velocity (PPV) and associated predominant frequency in each direction).

- d. Assistance shall be taken from blasting consultants / experts as specified in Quality Manual document.
- e. In case the defined thresholds be exceeded, blasting operations shall be stopped in order to finalize the new blasting pattern or the choice of other methods of proceeding with the excavations.
- f. In general, the methods, parameters to be measured and equipment for measurement of vibration shall be in accordance with IS 14881 unless otherwise specified.

II. Restriction of Blasting

- a. All blasting works shall be completed before pouring the first structural concrete, unless otherwise specifically agreed by the Client in writing. When excavation is carried out using explosives the Contractor shall arrange his excavation and concrete placing programmed so that as far as practicable it shall not be necessary to use explosives close to permanent construction. The Contractor shall be responsible for avoiding damage to adjacent structures from fly rock by erecting barricades and/or the use of blast mats or other means by installing shielding device acceptable to the Client. The maximum allowable limit of noise overpressure in blasting shall not exceed 110 dB (beyond 100m in any direction from blast) In surface blasts: It must be measured close to the structure to be protected from blasting. Ground vibration induced by blasting shall be measured in terms of the Maximum or Peak Particle Velocity (PPV) in mm/s and predominant frequency of the ground vibration.
- b. The measurement of peak particle velocity shall be obtained from instruments capable of measuring along three orthogonal axes, one of which shall be aligned parallel to the center line of the excavation and another shall be vertical. The Contractor is to provide supports for the measuring instrument if so, required by the manufacturer's instructions.
- c. The measurements of the particle velocities (PPV) shall be the responsibility of the Contractor. Copies of the readings in an agreed form shall be supplied to the client.
- d. The following limit on peak particle velocity are given as a guide and may be modified by the Client based on seismograph records and observations during the progress of works.
 - i. PPV shall not exceed 30mm/sec at 20m distance from the blast hole.
 - ii. For existing surface structures adjacent to excavation areas, including structures of following types.

Not forming part of the contract,

Belonging to Employer and

Not belonging to Employer,

The frequency and peak particle velocity dependent safety criteria as per Director General of Mines Safety (DGMS) criteria shall be followed for protection of nearby structures in surface blasts.

- e. Where circumstances dictate, such as when blasting adjacent to partially cured concrete, the peak particle velocity permitted may be reduced by the Client
- f. For specific structures and if requested by the Client the Contractor shall fulfill the following criteria:
 - i. At a 20 m radius of the blast, the interstitial velocity, for frequencies inferior to 100 Hertz, shall be limited to 4 cm per sec. (40 mm/sec.)
 - ii. After blasting and scaling of blasted surface, 60% of the half bore holes (barrels) must be visible,
 - iii. Smooth/control blasting is mandatory, in case of “Smooth blasting the spacing of perimeter holes should not exceed 40 cm c/c and the distance between perimeter row of holes and the buffer row of holes should not exceed 0.7 m.
 - iv. Bores holes space is 45 cm maximum.
- g. If necessary, the Client may require the Contractor to restore at his own expense any building, structure, masonry and equipment damaged by blasting, through direct or indirect effects.

III. Recording blasting operations

- a. The Contractor shall keep records of all blasting carried out showing the time and location of each blast, the type and amount of explosive used, together with any other relevant data in an agreed format approved by the Client.
- b. During the site works, as mentioned before each blasting pattern shall be submitted to the Client for approval at least 24 hours before the blasting operation is due to begin. This shall be in the form of a presentation sheet setting out all the information concerning:
 - i. The type(s) of explosives to be used.
 - ii. The x, y, z coordinates of each firing hole and the firing polygonal,
 - iii. The diameter, depth, charge and the packing of each hole,
 - iv. The method of ignition and the type of detonator for each charge,
 - v. If using a sequential exploder, the connection of the different lines and a plan showing the effective delays of the charges,
- c. The total quantity explosives for the firing of the round: always, “CLIENT” can interrupt the explosive operation or request the Contractor to modify to the blasting patterns and the cost on this account shall be borne by the Contractor.

5.17 MEASUREMENT AND PAYMENT

- I. No separate measurement & payment shall be made for furnishing safe blast reports & their time to time updating from reputed institution as approved by client, supply of blasting

material, its safe storage, drilling of holes, loading of blasting material, all blasting operations including monitoring etc. This is deemed to be included in the quoted rate of excavation, provision of support system etc., for different classes of rock mass in all open works.

6. GROUTING

6.1 STRATA GROUTING

6.1.1 General

- I. Ground treatment includes grouting or other ground improvement proposed by the Contractor to stabilize weak, permeable or potentially unstable ground, where to control the flow of water or for any other purpose.
- II. Ground improvement includes penetration grouting with cement, micro fine cement or chemicals. The Contractor may determine other means of ground improvement with the approval of the Client.
- III. The need for ground treatment shall be based on:
 - a. Geotechnical investigations
 - b. Monitoring results
 - c. Existence of cavities
 - d. Any other indications that the ground to be excavated is soft, shattered, fissured or heavily water bearing, making instability or excessive displacement probable

6.1.2 References

The concrete materials, production, methods, testing and admixtures shall conform to Indian Standard or where not covered by these Standards, to the equivalent International Standards.

6.1.3 Submission

- I. Mix designs for proposed grout mixtures to be utilized.
- II. Full product data for all chemical grout or other proposed grout materials.

6.1.4 Records to be retained

- I. Method Statements shall be prepared and the following particular matters shall be included.
 - a. Plans for grouting work shall include, but shall not be limited to: Work plan: A detailed work plan specifying:
 - i. Basic type, objectives and principles of ground improvement scheme.
 - ii. Analyses to support the grout application design.
 - iii. Location, size and depth of each grout hole.
 - iv. Target grout volumes at each location.

- v. Details of grout type and application method, and proposals to demonstrate suitability of the grout type.
 - vi. Grout pipe installation procedures.
 - vii. Injection procedures and sequences.
 - viii. Data recording and reporting methods.
 - ix. Field quality control procedures and quality assurance.
 - x. Schedule of the grouting work and relationship to anticipated excavation or filling work.
 - xi. Locations and types of instrumentation.
- b. Plant and Equipment Detail: Relevant data concerning the plant and equipment which shall include, but not be limited to the following:
- i. Layout plans of grout pipes showing the depths of injections, the angles, and other data prior to excavation/filling works.
 - ii. Complete details and sequence of operations relating to the grout plant, including the manufacturers' catalogues concerning each component of the plant.
 - iii. Detailed procedure of grouting.
 - iv. Estimate of the quantity of grout to be used.
- II. Grouting Records
- a. Keep accurate and up-to-date records of all grouting work. These records shall include grout ingredients and mix proportions, gel time (if applicable), injection date and time, injection rates, volumes, pressures, maps showing locations, details and other relevant data.
 - b. Display data in an acceptable chart-type graphical format that facilitates rapid visual evaluation of the results of the work.
 - c. Record and provide particular circumstances, such as geologic and groundwater conditions, groundwater flow, indications of success or failure of ground improvement work; include sketches and photos as required.
- III. Samples
- a. Samples of materials proposed to be used in ground treatment work.
- IV. Certificates
- a. Where grouting is used, records of each point of injection with the quantity and type of grout used, the pressure applied, and the depth of the hole.

6.1.5 *Quality Assurance*

- I. Planning for grouting and the actual placement of grout pipes, grout mixing and injection shall be performed by an experienced grouting crew who has completed at least five grouting projects of similar scope and purpose during four years preceding this Contract, and who is experienced in the use of the proposed grouts and grouting methods.
- II. Personnel Qualifications: On-the-job supervision of all grouting shall be under the direction of a grouting supervisor with at least three years of recent actual field supervision in the method of grouting proposed.

6.1.6 Material

- I. Cement Grout:
 - a. Cement used in grouting works shall be as specified in ASTM C150 or sulphate resistant cement if required based on the geotechnical investigation.
 - b. Chemical additives shall be as specified in ASTM C494.
- II. Compaction Grout:
 - a. The fine aggregate shall be uniform well graded natural sand satisfying the following grading criteria:
 - i. 100 % passing the No. 4 sieve;
 - ii. The fraction passing the No. 200 sieve shall be between 15-30 percent;
 - iii. The clay content shall be less than 1%.
 - iv. The natural fines may be supplemented with aggregate washings, of fly ash. Bentonite shall only be added in the case of the grout mix plugging under the specified pressures.
 - b. Water: Potable, free of impurities that will affect the grout and shall be as specified in IS 456: 2000.
 - c. The mix for compaction grouting shall be a mixture of the specified fine aggregate with sufficient water to produce a pumpable grout having a slump range between 15 and 40 mm as specified in ASTM C143. Any mix exceeding 50 mm slump shall not be injected but shall be wasted or recycled and remixed through the holding tank and pump until the specified slump is reached.
- III. Protection of Materials:
 - a. Deliver materials in undamaged, unopened containers bearing the manufacturer's original labels and store and handle in accordance with the recommendations of the manufacturer.
 - b. All materials shall be non-toxic and non-corrosive and shall be protected from contamination or pollution at all times.

6.1.7 Drilling

- I. Grout holes shall be drilled either with percussion type or rotary type drilling equipment.

- II. The diameter at the bottom of the grout holes shall not be less than 35 mm. For percussion drill holes the diameter of the drilling bit shall be at least 8 mm larger than the diameter of the couplings used for the drill rods.
- III. Only water shall be used for flushing during drilling unless directed otherwise by the Client. All holes shall be thoroughly cleaned immediately after drilling using water and/or air under pressure. After washing, downward holes shall be kept plugged until the commencement of grouting operation.

6.1.8 *Water Pressure Tests*

- I. The Contractor shall propose maximum pressures to be used for grout injection at each location. The pressures specified shall be got approved from the Client.
- II. As directed by the Client, water pressure tests shall be carried out in accordance with the above Clause of this Specification.

6.1.9 *Mixing of Grout*

- I. All grout mixes shall be prepared using high speed, high shearing action mixers to produce a grout of uniform consistency.
- II. When, prior to pumping, mixed grout is to be stored for short periods purpose made agitator tanks shall be used.
- III. When clay or bentonite additives are used, separate mixing tanks shall be provided for mixing and agitation.
- IV. Water meters shall be provided for accurate measurement of water used for mixing. Pressure gauges, safety valves, by-pass valves etc. shall be provided where required on mixers, agitators, pumps and injection hoses.

6.1.10 *Grouting Operation*

- I. Provisions shall be made to permit accurate control of grouting pressures and volumes as in Clause 6.1.9 (iv).
- II. All hoses and piping should be of a small diameter to ensure a high velocity flow without segregation.
- III. Grouting operation shall be performed without major interruptions.
- IV. In case of an interruption before completion of grouting (plant breakdown), the hole shall be washed with clean water.
- V. Until experience of the ground conditions is gained, grouting shall proceed with caution. Safety valves shall be tested before each application.
- VI. Strata grouting shall start with neat cement grout. Depending on the grout taken the water/cement ratio may be reduced subsequently. In case of large grout takes, injections shall

be continued with cement mortar grout. Final injections shall be done with neat cement grout again.

- VII. In case of no pressure building up when using a sand/cement mix, grouting shall be stopped and the hole washed. After a few hours, grouting shall recommence using a sand/cement grout until the desired pressure builds up.
- VIII. In case of any grout communicating between holes, grouting shall be done simultaneously or holes where grout issues shall be plugged.
- IX. Grouting is completed, when the required pressure can be kept constant over a period of 10 minutes.
- X. Records of all details of grouting works such as location, inclination, diameter of boreholes, drilling time, equipment used, water pressure tests, mix, quantity, pressure of grouting, development of and special events during grouting operation etc. shall be kept by the Contractor, counter signed on site by the Client's supervising personnel and submitted to the Client.

6.1.11 Plant and Equipment

- I. Design all plant and equipment used in ground treatment works for the procedure with which it is to be used. It shall be maintained in good operating condition at all times.

6.1.12 Execution

- I. Where ground treatment by grouting is to be carried out ahead of excavation, drill holes to a distance and to a pattern into the zone to be treated and grout injected under pressure. Where necessary perform secondary grouting by drilling out a previously drilled and grouted hole, flushing with water, and re-injecting with grout.
- II. Install gauges adjacent to the point of injection and use to measure the grout injection pressure.

6.1.13 Field Quality Control

- I. Take grout samples periodically during pumping times and check for grout quality, gel times and neat strength.
- II. Where grouting is carried out to reduce soil or rock permeability, make field permeability tests in boreholes before and after grout injection and calculate permeability changes.
- III. Measure grout intake at each hole and record together with average and maximum pressures employed. At the end of each day, compare quantities so recorded with quantities measured at the grout pump in order to identify any irregularities.
- IV. Where grouting is carried out to increase soil or rock strength, take core samples of grouted materials to examine for grout intake and for tests for unconfined compressive strength.

- V. Perform water acceptance tests of grout holes before grouting in a manner that shall permit the measurement of the volume of the flow of water at various pressures.

6.1.14 Measurement

- I. The quantities of strata grouting to be paid shall be the weight of the cement used. It shall be measured by the Client for payment as herein described and accepted with all its additional requirements.

6.1.15 Payment

The accepted quantity measured as provided above shall be paid for at the contract unit prices respectively for the pay items shown in the Bill of Quantities which price and payment shall be full compensation for drilling, washing of the consolidation grouting hole and the inspected holes, the supply, mixing, grouting of the grout, test and quality control inspection, the supply of all labour, supervisors, materials, the Contractor's equipment and materials and all work necessary for consolidation grouting.

7. INSTRUMENTATION

7.1 SCOPE OF WORK

- I. This section specifies the requirements for the geotechnical measurements in the reprofiled slopes for the purpose of observing and recording deformations, settlements.
- II. As part of safety concept 3-dimensional (3-D) deformations of the reprofiled front of the slopes and the natural slope shall be monitored by means of optical methods. The points to be observed are marked by targets or reflectors mounted on standard convergency bolts.
- III. Measurement shall be carried out with a free-station high precision Total Station. The flow of data shall be fully automatic. The software shall allow determination of displacements in an absolute coordinate system with an accuracy of ± 1 mm in minimum.
- IV. The work of geotechnical measurements includes the installation of geotechnical instrumentation and devices.
- V. Necessary conclusion shall be drawn from the geotechnical measurements, from their magnitude, alterations and tendencies about stability of the primary lining and surrounding rock, performance of the initial support applied and utilization of the support elements.
- VI. The location and spacing between geotechnical measurement sections depends geological conditions and as specified in the tender drawing. The location of measurement sections may be changed during excavation according to the local geological conditions and the experience gained during excavation and as required by the Client.
- VII. Reading of instruments, interpretation and evaluation of monitoring results as well as geological mapping during excavation will be carried out by the Client.
- VIII. The Contractor shall supply, install, calibrate, test, survey and maintain instrumentation on the reprofiled slopes and near-by natural slopes as specified in this Section or as directed by

the Client. Minimum instrument stock for 3 months shall be maintained at site as per approved instrumentation program. The Contractor shall supply and install all ancillary measuring equipment, read out units and construct terminal structures, protective surrounds for instruments, excavate pits and trenches, backfilling, drill holes, install pipes and fittings, and cast concrete where required. Contractor shall get approved instrumentation plan prior to installation of any instrument. All the instruments to be installed by the contractor in all the structures shall be procured from very reputed manufacturers who have supplied such instruments at other similar projects also and have good credentials of having satisfactory working of those instruments. The specifications and the source of instruments shall be got approved by the contractor from Client before procuring them.

- IX. The extent, type and location of the individual instruments as shown on the Tender Drawings, the number and location of the instruments may be altered by the Client during the construction period, according to the requirements.
- X. The Contract Documents give only the numbers, general type, and general arrangement of the instruments to be supplied and installed by the Contractor.
- XI. Instruments shall be preferably vibrating wire type. All instrumentation operating on electrical or hydraulic systems shall be accompanied by individual test certificates and shall be tested in the presence of the Client prior to installation, unless specifically stated otherwise.
- XII. All instruments shall be installed to the lines and elevations shown on the Construction Drawings or as established by the Client as the work progresses during construction.
- XIII. The installation of instruments may interfere with the overall construction progress. The Contractor shall make provision for any such interference in his construction planning. He will not be entitled to any compensation or extension of the Time for Completion by reason of any such delays, including repair and -replacement of damaged instruments.
- XIV. No instruments or any of their components shall be purchased prior to Client's approval. However, approval by the Client of the Contractor's proposals and drawings or data shall not relieve the Contractor from his sole responsibility to meet all the requirements under this Contract.
- XV. All instruments shall be guaranteed against defect in installation / manufacturing till completion of Defect Liability Period. The contractor at no cost to "Employer" shall replace all defective instruments during the period of guarantee. However, the buried defective instruments shall not be returned to the contractor.
- XVI. All the instruments shall be supplied with at least 3 copies of instruction manuals explaining installation procedures, guidelines, necessary protection measures and necessary maintenance requirements etc. complete in all respects.
- XVII. The measuring devices to be provided shall be manufactured by a reputed manufacturer with proven record and acceptable to the Client.

XVIII. The contractor shall take utmost care in the recording and analysis of the readings and prevent mixing of readings from different instruments.

XIX. During execution of the works, the contractor shall observe, record and submit readings of all the instruments in specified format along with analysis of observed data and at specified frequency / period to the Client.

7.2 SUBMITTALS

- I. Within 56 days from the commencement date, the contractor shall submit details of the instruments proposed for the installation. These shall be consistent with the general information on the instrumentation submitted by the contractor with his tender as well as with any modifications subsequently agreed to by the Client and the Contractor and shall include:
 - a. Detailed description of all instrumentation, cabling and accessories including any ancillary measuring equipment he proposes to install.
 - b. Evidence of successful performance of the instrumentation proposed for installation.
 - c. Manufacturer's instruction for the installation, testing and operation of the instruments.
 - d. Schedule of monitoring of instruments.
- II. The monitoring instruments must include
 - a. Piezometer,
 - b. Targets for measuring deformation using Total Station.
 - c. Inclinator
- III. During the execution of the works, the contractor shall submit any further details regarding the instrumentation required by the Client. The contractor shall prepare surveys and furnish "AS BUILT" drawings for all the installed instruments.

7.3 SKILLED PERSONNEL

- I. The whole of the instrumentation work shall be carried out under the direct supervision of a senior supervisor, approved by the Client, and employed by the contractor who is well experienced in all types of instrumentation and installation work and who understands the purpose and function of all instruments being installed.
- II. Installation and calibration of instruments shall be carried out by skilled technicians, well experienced in the installation of instruments and who have a thorough understanding of the purpose and function of the instruments being installed, acceptable to the Client.

7.4 INSTALLATION

- I. The Contractor shall install and calibrate all instrumentation conforming to the supplier's instructions and shall, where necessary, expose all partially installed instruments, cables and tubes to continue their installation, including carrying out all survey work required to locate

such instruments. A representative of instrument's manufacturer shall be present during the entire process of installation. The contractor shall submit a certificate issued by the manufacturer regarding the installation of instruments as per the instrument's manual, to the Client. The contractor shall tag all cables and tubes with identification tags approved by the Client at intervals of 15 m or at such closer intervals as necessary to provide continuous identification.

- II. Instrumentation shall be installed and calibrated in the presence of the Client, and when he considers it desirable, instruments shall be installed preferably during daylight hours. At all times, the contractor shall ensure that adequate lighting is available, whether by natural or artificial means, to ensure proper execution of the work.
- III. Cables and tubes shall be installed in the maximum lengths practicable. Splicing and coupling, if essential, shall be performed in accordance with the manufacturer's recommendations. Calibration readings shall be taken prior to and immediately after splicing. Open ends of all incomplete lines of tubing and casing shall be kept plugged or sealed and the contractor shall always during installation keep the insides of casings and tubes free from foreign matter. Cables and tubes shall be protected from mechanical damage.

7.5 CARE OF INSTRUMENTATION

- I. No traffic or equipment shall be allowed to pass over any part of any instruments or connections unless suitably protected as recommended by the instrument supplier and approved by the Client. The backfill material shall be carefully compacted in such a way that the density of backfills will become equivalent to the surrounding materials to the satisfaction of the Client.
- II. The Contractor shall protect all instruments and connections from damage and displacement during the progress of the work. If damage or displacement of the instruments or connections occurs during the progress of the work, they shall be repaired or replaced immediately by the contractor.
- III. The Contractor shall be fully responsible for the maintenance and repair of all instrumentation during the contract period.
- IV. The Contractor shall recalibrate instruments at the frequency / period as specified by manufacturer as approved by Client.

7.6 READING OF THE INSTRUMENTS

- I. Calibration of all the instruments shall be done by the contractor and all the facilities for the same shall be arranged by him. An initial set of readings on all instruments installed at any elevation will be taken immediately after their installation, and the contractor shall not place concrete over the instruments or tubes or cables at this location until these readings have been taken.
- II. The contractor, after consultation with Client, shall program his work and make all necessary arrangements to record the reading of instruments as soon as possible after their installation.

Such arrangements shall include, where necessary, the provision of temporary read out points.

8. INSTRUMENTATION AND MONITORING FOR STRUCTURES

- I. The contractor shall supply and install the measuring devices, carry out additional excavation, drilling, construct concrete or mortar pads, backfilling with concrete, perform the measurement, and record the readings at frequency / period specified by Client for the following instruments
 - a. Topographical markers / survey points
 - b. Seepage Measuring Devices (Measuring Weir)
 - c. Automatic Weather Station
 - d. Cables
 - e. Cable splicing kit.
 - f. Junction Boxes
 - g. Readout units.
 - h. Tiltmeter
- II. The instruments shall be supplied, installed and monitored by the contractor as directed by Client in order to assess the behaviour of the structure and other structures during the Construction of the work.
- III. Topographical Markers.
 - a. The contractor shall supply, install and survey studs, base plates, observation pillars and survey targets along with accessories, as shown on the drawings for precision surveying. Base plates and leveling studs shall be used to measure the vertical movements of the structure top or parapet wall & other concrete structures. Survey targets and observation pillars shall be used for measuring horizontal movement or deflection. Observation pillars shall be installed on the downstream side banks and targets mounted on the structure at various elevations as shown on the drawings.
 - b. Observation pillar shall be of size 600 mm X 600 mm X 900 mm (projecting 300 mm above ground), RCC of M30 Grade having 4 nos 10 mm longitudinal reinforcement bar with 4 nos 6 mm reinforcement bar stirrups. Observation pillar shall be of size 600 mm X 600 mm X 900 mm (projecting 300 mm above ground), RCC of M30 Grade having 4 nos 10 mm longitudinal reinforcement bar with 4 nos 6 mm reinforcement bar stirrups.
 - c. Survey studs shall be of stainless steel of 15 mm \emptyset and 250 mm long and of the shape and size as shown on the drawings.
 - d. Levelling studs/ base plates shall be installed as soon as possible after placement of concrete at the locations where required. The base plate shall be 100 X 100 X 3 mm stainless steel

plates or brass plate with 4 MS spikes (hold fasts) about 5 mm Ø X 70 mm long to hold the plate in concrete. The top surface of the plate shall be a perfect plane.

- e. Survey targets shall be made of solid brass or stainless steel of about 35 mm Ø on top and 75 mm long. Its top there will be an engraved cross mark 1 mm thick and 1 mm deep. The contractor may suggest some different type of targets also for approval of the Client.
- f. Immediately after installation of any studs / base plates, its position and level shall be precisely surveyed. The level and coordinates shall be computed and submitted in writing to the Client within 24 hours of installation.

IV. Seepage Measuring Devices (Measuring Weir)

- a. Measuring Weir shall be installed at appropriate locations as shown in the drawing or as directed by Client to measure the amount of seepage with the help of V-notch steel plate weir.
- b. Water level variations shall be accurately sensed by vibrating wire sensors. These gauges shall measure the buoyancy (Uplift Pressure) force acting on buoys within protecting cylinders at various depth of submergence. It shall consist of attached data logger to record time data of flow. It shall be capable of providing alarm signals also at predetermined excessive flow rate.
- c. Seepage measuring device shall consist of liquid level indicator (float), vibrating wire transmitter and an indicator. Liquid level indicator shall consist of a V-notch weir and a sensing element. The sensing element shall consist of a pair of cylinders, each having a vibrating wire type transducer as specified earlier. The scope of supply shall include liquid level float, vibrating wire transducer protection box, datalogger, and all other accessories. The measuring range of the weir shall be upto 30 litre / sec.

V. Automatic Weather Station

- a. Contractor shall supply and install weather station (automatic type) and take observations during construction period and hand over to the Employer at the end of the construction period.
- b. The Automatic Weather Station (AWS) must permit to record automatically and continuously the following meteorological data:
 - 1. Wind speed
 - 2. Air temperature
 - 3. Rainfall
 - 4. Relative humidity
- c. The Sensors of the AWS shall meet the following requirements:
 - 1. Wind speed Sensor

Range : 0.5 to 100 m/s

Resolution : 0.5 m/s

2. Air temperature Sensor

Range : -100 C to +600 C

Resolution : 0.10 C

3. Rainfall Sensor

Maximum Range : 10 mm/min

Resolution : 0.02 mm

4. Relative humidity Sensor

Range : 5% to 99%

Resolution : 0.1%

- d. The sampling interval shall be adjustable from 1 to 3 hours.
- e. All the sensors must be operated with solar cells with provision for power module.
- f. The data storing unit of the AWS shall have the facility to store all data for a period of at least 6 month and shall permit instant display/USB transfer of data.
- g. The Contractor shall supply and install a complete AWS including all instrument shelters within one month from the date of commencement.

VI. Cables

- a. Cables connected to instruments shall be laid as per the detailed cable routes submitted by the contractor and approved by the Client.
- b. Cables shall be generally be of following types.
 - 1. 12 core cable: it shall have 7 / 0.25 mm ATC PE insulated, with six twisted pair (12 core), color coded, screened with water blocking aluminum foil or jelly filled, polyester taped, inner polythene sheeted, 0.3 mm galvanized iron wire braid armored with 50 % coverage, overall polythene sheathed and overall diameter of around 14 mm.
- c. Special cables, where required, for various gauges shall be of standard market quality, as approved by the Client.

VII. Cable Splicing Kit

- a. It is required for joining two cable ends of four-core cable. It shall be suitable to make a water resistance sealed joint and shall have requisite amount of cable jointing compound like epoxy

and silicon grease. The splicer shall be made of stainless steel and shall be able to withstand a pressure of 30 kg / cm² and a tensile force of 12 KN.

VIII. Junction Box

- a. The junction box shall be mounted at appropriate locations as shown on the drawings or as directed by Client. The junction box shall be a device to provide connection between core cables leading from the different instruments and multi-core cables leading to the multiplexer unit. The junction box should have a connector socket for the fly leads from the portable read out unit and a rotary switch to select individual instruments.
- b. All switchable junction boxes shall be double ended. This is essential to remove the possibility of one rogue instrument interfering with the performance of the others. The junction box shall have an arrangement for connecting minimum 20 instruments. The wires and terminals within the junction box shall be fitted with entrance hubs to protect them against danger of water penetration.
- c. The junction box shall be of drip tight sheet steel and shall be provided with stuffing box for special measuring cables and connecting cables and shall have built in terminals and socket strips. The junction box shall be provided with an arrangement for protection against over voltage. The sheet steel metal construction of the distribution box shall be properly treated and coated with corrosion resistant paint. The junction box shall also be provided with an arrangement for earthing and shall be supplied along with its accessories. The specifications for the junction box given herein indicate broad requirements only.
- d. Tiltmeter:
- e. Tiltmeters shall be installed at appropriate locations on structures to measure small changes of the inclination.
- f. Position of the tilt meter should be determined immediately after installation and parallel to the zero measurement.

8.1 MEASUREMENT AND PAYMENT

- I. The payment for supplying and installing all the instrumentation shall be made as per the rates quoted for various items of works in the schedule of item rates. Unless otherwise specified, the scope of instrumentation shall include the following:
 - a. Supply, installation, calibration, testing, surveying, repairing and maintaining of all instruments, ancillary and read out equipment, including protective steel covers, tubes and tube protections, required to perform the specified measurements.
 - b. Forming all necessary recesses in concrete, all necessary trench and pit excavation, foundation preparation, temporary and permanent protection of instruments and ancillary equipment by surrounding with selected material or by other approved method and maintaining easy access to all readout points. No deduction will be made for the volume occupied by the instruments and instrument protection when measuring the embankment material for payment.

- c. Entire cost of supply and installation, testing, taking measurements and readings and submitting installation protocols and results to the Client.
- II. Payment for posting of Instrumentation & Monitoring Engineer (of a reputed instrument manufacturer whose instrument is being procured by the contractor or having suitable experience.) shall be made separately as per rates entered in the schedule. The Instrumentation & Monitoring Engineer shall possess minimum 5 years working experience of field installation, maintenance and taking readings of the instruments. The Instrumentation & Monitoring Engineer shall be mandatory for installation, Regular reading of the instruments / equipment, and interpretation and submission of reports on formats approved by the Client during construction and the handing over of all data up to the time of completion along with and the instruments and readout units, with all accessories, in proper working order as required by the Client. The Contractor shall deploy Instrumentation & Monitoring Engineers according to man month mentioned in BOQ in 2 shift per day.

9. OPEN EXCAVATION

9.1 SCOPE OF WORK

- I. The specifications described herein under relate to the work of open excavation for various structures and shall include all labour, tools, plants, Constructional Plant and services, necessary to carry out the excavation of different type of materials, geological mapping of excavated surfaces, dewatering, temporary slope stabilization measures required to facilitate excavation, transportation and stockpiling I disposal of all excavated materials into stockpiles I dumping areas as shown on the drawings or as approved by the Client.
- II. Excavation shall be made to the lines, grades and dimensions shown on the drawings or as otherwise directed by the Client, which shall be required to be backfilled with acceptable material and compacted by contractor in a manner acceptable to the Client.
- III. The Contractor shall maintain the excavated slopes, drainage and trenches and prepare foundations as shown on the drawings or as required by the Client. The Contractor must ensure slope protection measures for riverbank and non-dumping station areas ensuring environmental mitigation measures as per the approved environmental mitigation plan.
- IV. The area of open excavation shall, where, in the opinion of the Client, clearing is necessary, be cleared of all trees, bushes, rubbish and other objectionable matter and the materials so removed, shall be disposed off suitably or as directed by the Client.
- V. When additional excavation outside the lines and grades shown on the drawings is required by the Contractor for his own convenience, such additional excavation shall be required to be backfilled with acceptable material and compacted by the Contractor in a manner satisfactory to the Client. The contractor shall submit his plans for such proposed work in writing for Client's acceptance prior to the commencement of the work.
- VI. The removal of mud and slush resulting from heavy rains or flooding of the sites, when necessary to ensure the safe and effective performance of the work, shall be performed by the Contractor. For this purpose, Perimetric drains will also be required to be provided at a

suitable distance from the edge of the cutting around the slopes to ensure the safe drainage of superficial water, avoiding slope erosion.

- VII. At all times during construction, the Contractor shall adopt such excavation procedures that at no time the stability of any slope be impaired. For the excavation in intake area special care shall be exercised and the contractor shall adopt modern controlled blasting techniques.
- VIII. The approval given by the Client to the contractor's methods and equipment shall not relieve the Contractor of his full responsibility for a proper and safe execution of excavation, or of liability for injuries to, or death of person(s), or any obligations under this Contract.
- IX. The Contractor shall comply with all safety procedures and requirements as stipulated elsewhere in the tender documents.

9.2 SUBMITTALS

- I. At least 30 days prior to the commencement of excavation, the Contractor shall submit details of his excavation methods and sequences for all open excavation Works including the schedule of deploying equipment.
- II. The description of drilling and blasting procedures, if required, shall include the following:
 - a. Diameter, spacing, depth, pattern and orientation of blast holes
 - b. Type, strength, amount and distribution of explosives to be used, per hole.
 - c. Description and purpose of any special method to be adopted by the Contractor.
 - d. Sequence of various activities of the excavation work with an indication of corresponding time requirements.
- III. At least 30 days prior to dumping or stockpiling of any excavated material, the Contractor shall submit the layout of the spoil and stockpile area. All data pertinent to working methods and provisions for the security, stability and temporary and permanent drainage of the work areas shall be included along with details of volumes, material types, heights and grade provided. To prevent spillage of muck, R. R. masonry/ Gabion retaining walls with adequate arrangement shall be provided in disposal area.
- IV. To enable the Client to verify all necessary setting out and elevations carried out by the Contractor, the latter shall notify the Client in writing, giving at least 1 (one) week notice of his intention to start excavation.
- V. The Client reserves the right to require any additional information deemed necessary to be included in the submitted documents

9.3 CLASSIFICATION OF EXCAVATION

- I. Open excavation shall comprise of the following types of excavation:
- II. Soil excluding Rock (Seismic velocity $V_p < 1000$ m/s)

- a. Loose excavation shall include all types of soil and such other material, which can be excavated manually by ordinary pick and shovel or barring and wedging or by mechanical equipment such as dozer blade, ripper, power shovel and dragline but without resorting to blasting. It shall also include embedded boulder not bigger than 1-meter size in anyone direction.
- III. Rock not requiring blasting
- a. This shall include excavation of all rock, which can be excavated by mechanical equipment such as dozer blade, ripper, power shovel and dragline but without resorting to blasting to loosen the same.
 - b. This shall also include boulders and detached rock blocks of size larger than one meter in any direction. It shall also include the removal of softer materials, lying between layers of rock.
- IV. Hard Rock requiring blasting
- a. This shall include excavation of all rock, which cannot be excavated without prior blasting to loosen the same.
 - b. The term rock shall include boulders and detached rock blocks of size larger than one meter in any direction which requires blasting for removal. It shall also include the removal of softer materials, lying between layers of rock.
- V. Hard Rock requiring blasting but blasting not permitted
- a. This shall include excavation of all hard rock, which cannot be excavated without blasting but due to restriction imposed at site by employer, the same is required to be excavated by chiselling or rock breaker, vibratory rock rippers, rotary drum cutters. Alternatively, propellants (non-detonating silent explosives for ex. NONEX, ROYAX).
 - b. The term rock shall include boulders and detached rock blocks of size larger than one meter in any direction which requires blasting for removal. It shall also include the removal of softer materials, lying between layers of rock.
- VI. Removal of Slip
- a. Unavoidable slips, which may occur in the excavated slopes, shall be removed by loading, hauling, dumping of the material and the surface cleaned.

9.4 REMOVING BLUFFS AND LOOSE ROCK

- I. All loose boulders, semi-detached rocks (along with the earthy stuff which might move therewith) not directly in excavation but so close to the area to be excavated as to be liable in the opinion of the Client, to fall or otherwise endanger the workmen, equipment of the Work, shall be stripped and removed from the areas of excavation. The methods used shall be such as not to shatter or render unstable or unsafe any rock that was originally sound and safe. Any material not requiring removal as contemplated in the Work but which, in the opinion of the

Client is likely to become loosened or unstable later on shall also be promptly and satisfactorily removed as directed by the Client.

9.5 EXCAVATION IN OPEN CUTS

- I. The side slopes of the excavation shall be as shown on the drawings or as directed by the Client.
- II. Any changes in the slopes as shown on the drawings on account of site conditions shall be subject to the approval of the Client.
- III. Every precaution shall be taken to prevent slips. In case slips occur, the slipped material shall be removed to the designed / modified slope. Utmost care shall be exercised to cause no harm/structural damage to structures and/or utilities in the vicinity of the excavation area.
- IV. In case of loose excavation, where the surface is left as excavated, or is to be covered by pitching, formation of rain cuts and gullies shall be avoided by proper drainages. Any gullies formed shall be made good, by properly packing excavated rock spoil in them. All holes left by removing boulders shall also be filled in with rock spoil.
- V. Where plain surfaces are required, such faces of excavation shall be formed in such a manner that would least shatter the rock mass. Only light blasting, ream holes pre-splitting or similar methods shall be allowed in areas adjacent to such faces.
- VI. In special locations (only in rock) where specifically indicated or ordered by the Client, the use of explosives shall be discontinued and excavation completed by the drilling, wedging or barring or other suitable method approved by the Client.
- VII. Blasting within 30m of concrete or grout or shotcrete will be permitted only after concrete grout is 7 days old and only after the submission by the Contractor and approval by the Client of a plan showing the relative positions of structures or grouted area and the areas to be blasted, Contractor 's proposed drilling and blasting plan together with an outliner of precautions to be taken.
- VIII. All concrete/shotcrete works and other completed works within 30m of blasting shall be protected by limiting the charges / size of blasts so as to ensure that the maximum displacement velocity of particles at nearby structures is not more than 50mm per second. For concrete or grout or shotcrete less than seven days old, this velocity shall not be more than 10 mm. In such cases, trial blasts for assessing the displacement velocity shall be carried out without additional remuneration.
- IX. The Contractor shall carry out the excavation of open cut rock slopes utilizing the controlled perimeter blasting technique wherever blasting is required.
- X. Excavation shall be carried out in a descending way by benching. The bench height shall not exceed 2 m. A horizontal berm with a minimum width of 4 m shall be provided at least every 10 m of height or as shown on the drawings.

- XI. Immediately after excavation and sealing to the satisfaction of Client and prior to the excavation of next bench, the Contractor shall install drainage boreholes with pipes, shotcrete, wire mesh, rock bolts and weep holes if considered necessary, as shown on the drawings or as required by the Client. Water ingress behind the shotcrete lining shall not be allowed.
- XII. The wire mesh for shotcrete shall have proper overlap between two successive benches or elsewhere as required. The overlap shall not be less than 300 mm or as shown on drawing or as directed by the Client.
- XIII. At slope surfaces where shotcrete but no rock bolts are to be installed, the Contractor shall install soil nails to secure the shotcrete lining. The soil nails shall be at least 1 m long L-shaped steel rebars, diameter 16 mm. At least one soil nail shall be installed every 4 sqm.
- XIV. All blasted rock shall be removed from the bench toe before undertaking further work.
- XV. All other specifications pertaining to blasting and scaling etc. relevant to open excavation shall be as per stipulations of Section of Explosive and Blasting.

9.6 EXCAVATION FOR FOUNDATIONS OF STRUCTURE

- I. While carrying out excavation for the foundations of the structure, if it is considered necessary for a work and if approved by the Client, the sides of the loose excavation shall be shored and strutted to the satisfaction of the Client.
- II. After completion of the loose excavation, the rock excavation in foundations of the Structures shall be carried out to the depths as shown on the drawings. At all stages of excavation, precautions shall be taken to preserve the rock beyond the lines of required excavation. The quantity and strength of explosives used in the foundation excavation in rock in various locations shall be such as will neither damage nor crack the rock outside the limits of excavations.
- III. As the excavation approaches its final lines and is within 300 mm to 600 mm of the specified foundation levels, the depth of the holes and the strength and quantity of explosives shall be progressively and suitably reduced so as to ensure that the rock profile beyond the lines and levels specified on the drawings shall remain undisturbed. If so, directed by the Client, this excavation shall be carried out by the line drilling.
- IV. Final excavated surface shall have no abrupt changes in slope and sharp projection greater than 500 mm. Projections in excess of 500 mm shall be treated where necessary by supplementary excavation as determined by the Client to produce the desired surface of contact between concrete and rock/soil.
- V. All excavations done beyond the lines and the dimensions shown on the design drawings shall be back filled with concrete of the same grade and quality as that of the foundation or as directed by the Client.
- VI. Acceptance criteria for important foundations: Important structures shall be founded on sound and competent rock and suitable for taking up the load of the super structure without

undergoing deformation beyond the acceptable limits as per the directions of Client. After excavation up to fresh rock level, further excavation shall be done up to one meter by wedging and barring to remove all the loose and soft, weathered rock, sheared material etc. All sheared portion shall be excavated to a desired depth and filled with concrete with steel reinforcements as per approved design and drawings. Concreting shall be taken up only after getting written approval of the Client.

- VII. Stable slopes shall be provided in open excavations along with berms of specified width as per approved design & drawings.
- VIII. All permanent rock slopes shall be stabilized by suitable treatments such as shotcrete with chain link mesh, rock anchors, spot rock bolts, perforated drainage pipes, berms with drains etc., as per approved design and drawings.
- IX. Surface Preparation of Foundations
 - a. After completion of excavation of foundations, trimming for the final removal of all dummy rock or loosened mass, shall be done by chiseling, barring and wedging as directed by the Client.
 - b. Any weathered or decomposed rock remaining shall be removed. Open fissures joints; crevices and any other doubtful areas shall be cleaned to a suitable depth up to firm rock and backfill with the concrete/mortar of the same grade as that of the main structure and contact grouting as specified.
 - c. Consolidation grouting of the foundation rock shall be carried out upto the specified depth before the placement of concrete.
 - d. Contractor shall wash all rock surfaces of the excavations. This washing shall be carried out initially for inspections when required by the Client.
 - e. Final washing of any section of the work prior to concreting or application of shotcrete shall be carried out only when the blasting for the excavation and removal of projections inside the neat lines has been completed.
 - f. Final washing prior to concreting shall be done by directing a stream of water at a pressure of about 8 to 10 bars on the rock surfaces from a distance of 1.5 meter through a nozzle of 18 mm diameter so as to remove all loose rock, fragments, dust and debris from the surfaces.

9.7 DISPOSAL OF EXCAVATED MATERIALS

- I. The excavated materials suitable for construction shall be stockpiled at locations approved by the Client, if the immediate placement in the final location in Permanent Works is not possible.
- II. Excavated materials which are not suitable for construction and those in excess of the requirement for construction shall be disposed off in the waste disposal area. Surfaces of material so disposed off shall be trimmed to regular lines and grades satisfactory to the Client. Disposal of all material shall be such that it will not interfere with natural drainage

and is as per the regulations for environmental protection or with Client 's acceptance. The Contractor must ensure muck management as per the approved environmental mitigation plan with proper turfing and plantation at dumping sites. Nothing extra shall be paid for it and the contractor must include the same in his quoted price.

- III. The contractor shall ensure that no excavated materials are disposed off in the streams or at locations, where these are liable to be washed away by the floods or may block the water way of streams.
- IV. The plan of muck dump yard fill, berms and provision of retaining walls, slope of fill etc. will be as per site requirements and the same shall be got approved by contractor from Client before start of such works.

9.8 DRAINAGE

- I. Seepage water from springs or rainwater shall be suitably collected and drained away from work area by gravity, wherever it is possible to do so. Where, however, drainage by gravity is not feasible, pumping could be resorted to all stipulations laid down in Section of "Dewatering, Drainage and Pumping" shall be followed.
- II. The surface water dewatering systems shall be designed to accommodate, without undue disruption to the work, any rainfall event. The removal of mud and slush resulting from heavy rains or flooding of the sites, when necessary to ensure the safe and effective performance of the work, shall be performed by the Contractor. For this purpose, Perimetric drains will also be required to be provided at a suitable distance from the edge of the cutting around the slopes to ensure the safe drainage of superficial water, avoiding slope erosion.
- III. The reprofiled upper slope and the fill at lower slope shall be covered with protective felt during monsoon to prevent erosion and subsequent failure of the slope.
- IV. The long drainage pipes installed in the natural soil for ensuring drained conditions during the 120 years of design life shall be slotted PVC pipes wrapped with geotextiles. The length, diameter and the spacing of the drainage pipes shall be as given in the drawings. The drainage pipes in the reprofiled upper slope shall go up to 10 m in the bed rock.
- V. The drainage pipes laid in the fill soil on the lower slope shall be HDPE pipes of 200 mm diameter.
- VI. Thickness of the drainage pipes shall be as per Table 1 of IS 4985:2000
- VII. Geotextile Type III for wrapping around drainage pipes and as filter media shall be as per MoRTH (Fifth Revision) Clause 700. The nonwoven thermally bonded or needle punched, or any equivalent geotextile shall be used. The geotextile shall be made of polyethylene or Polypropylene or polyester or similar fibres manufactured through machine made process of heat bonding or needle punching techniques. The mean Values of Geotextile shall be referred from Table 700-1 and 700-3 in MoRTH Clause 702.
- VIII. Drainage layers in the fill on the lower slope at levels of sub surface drains shall be minimum 600 mm thick, protected from contamination of fines by layers of non-woven geotextiles. The

drainage layers shall be with well – graded crushed aggregate (materials of 19.5mm to 9.1mm size as per IS: 383). The desirable gradation of the aggregate used in the drainage layer is indicated in the table below. Besides meeting gradation requirements, it should be ensured that the aggregates are not friable, flaky, elongated and are sound in strength. Relevant tests as per MORTH 2013 specifications may be used to judge the suitability of the material used in the drainage layer.

Sieve Opening, mm Percentage Finer

37.50 90-100

20.00 80-100

12.50 0-20

Alternatively, geo composite conforming to IRC 34:2011 which ensure adequate drainage may be provided. Specifications for Geo-composite should be as recommended in MORTH Specifications- 2013 Tables 700-9 and 700-10.

9.9 BACKFILL

- I. The backfill of the lower slope in Melli yard is vital for the slope and platform stability and thus, Contractor's quality assurance shall be strictly monitored by the Client.
- II. The whole humus layer from the natural surface has to be removed and stored separately to be used afterwards for replantation.
- III. Backfill shall consist of materials as approved by the Client and shall be placed in locations as directed by the Client.
- IV. Only suitable materials obtained from excavation, if practicable, shall be used for backfilling.
- V. Material to be used in backfill shall be free drainage type.
- VI. The fill material is to be selected from the upper slope excavation and by quarrying it in the neighbouring areas. Muck material from the excavation of the adjacent tunnels of Melli area can also be used. The coarser size fraction is to be favoured and the quantity of the fines shall be carefully calibrated for assuring the final target characteristics ($\phi = 35^\circ$ and $c = 2$ kPa).
- VII. The coarser size fraction is to be laid as first layer over the natural scraped surface which will act as a draining high friction layer. And over this initial layer, the fill can proceed up to the target elevation and incline (23°). This operation shall proceed from the bottom of the valley upwards.
- VIII. The backfill shall be laid in 300 mm thick layers and compacted as per RDSO guidelines. The compaction of backfill material shall be 95% of maximum dry density obtained from modified Proctor compaction test performed as per IS 2720 (Part-8).

- IX. Each layer shall be thoroughly compacted with the help of suitable compaction equipment to reach minimum density of 17.5 kN/m³. Subsequent layers shall be placed only after the finished layer has been tested for required density and accepted by the Client.
- X. Compaction needs to be performed over material with optimal moisture content so as to achieve the required results. This implies that interruption of earthworks during rain events are to be expected.
- XI. When density measurements reveal any soft grounds, further compaction shall be carried out. In spite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means to the density requirements and satisfaction of the Client.
- XII. If required or requested the backfill shall be covered with protective felt during monsoon to prevent erosion and subsequent failure of the slope.
- XIII. Earthmoving equipment shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.
- XIV. The material used for fill shall be free of logs, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the reprofiled slope.
- XV. The fill should not have clay with liquid limit exceeding 50 and plasticity index exceeding 25. Expansive clay exhibiting “free swell index” exceeding 50 percent shall not be used as fill material.
- XVI. The backfill at the proximity of nalas and river banks or other water bodies, is to be protected against erosion of the toe structure foundation. These secondary works are to be ascertained in detail during the topographic positioning of the fill and the relevant foundation excavation.

9.10 MEASUREMENT AND PAYMENTS

9.10.1 General

- I. Payment for open excavation shall be made as per Bill of Quantities.
- II. The Contractor is assumed to have included the entire cost but not limited to the following:
 - a. Provision of all labour, equipment and materials required for open excavation in various locations including drilling holes for blasting, developing and Improving controlled blasting methods, performance of blasting, cleaning, washing protection and maintaining excavated surfaces in satisfactory conditions' and additional excavations if any, required by the Contractor for his construction methods.
 - b. Geological mapping of the excavated area and the temporary stabilization measures adopted for facilitating the open excavation work.
 - c. Provision for loading, handling and dumping the excavated material on stockpiles, dumping area or point of incorporation into permanent work up to a lead of 200m from exit point of

- various structures to entry point of disposal area, shaping and trimming of the excavated materials in the dumping area, cleaning of the stockpile area, formation and maintenance of stockpiles, rehandling of suitable materials including segregating; grading, draining and drying of materials suitable for use in embankment construction or as backfill.
- d. In case, the dumping of excavated material is required to be made in the areas beyond 200m of initial lead or incase due to any reason beyond contractor's control, then extra payment shall be made for additional lead as per relevant item of the Bill of Quantities and no other claim what-so-ever shall be admissible to the contractor.
 - e. Complying with all requirements of statutory laws and regulations relating to the works and any restrictions resulting there from obtaining all necessary permits and licenses for the purchase, use storage and transport of explosives and other materials.
 - f. Surveying, setting out, checking of excavated profile, layouts and any subsequent rectification works resulting from unable or incorrect surveys, provision of suitable equipment for and delays due to carrying out this work.
 - g. Furnishing, installation, operation, maintenance and removal of Communication and illumination systems and observing safety precautions.
 - h. Recording and preparation of reports related to excavation progress and procedures.
 - i. All work involved with and any partial or short interruptions or inconveniences caused by the check surveys, performance of the rock mechanics tests, installation and monitoring of instruments and geological mapping, for which no separate payment is provided elsewhere in these specifications.
 - j. Seepage water or rainwater suitably collected and drained away by gravity including provision of catch drains, diversion of nallah etc.
 - k. Dewatering by pumping in the open excavation area due to any reason whatsoever.
 - l. The compensation for removal of mud and slush resulting from heavy rains/flooding of the sites if necessary, to ensure the safe and effective performance of the work shall be deemed to be included in the quoted rate of excavation.
 - m. The payment towards the preparation of disposal area shall 'be deemed to be included in the quoted rates of excavation'.
 - n. Excavation for drainage trenches will neither be measured nor be paid for.
 - o. All taxes duties including royalties.
 - p. Clearing of all trees, bushes, rubbish and any other objectionable materials and their removal and disposal.
 - q. Over excavation beyond the excavation lines shown on the drawings, removal of material or backfilling with acceptable material where and when as required by the Client.

- r. Replacement of survey points fixed by the Client, which are damaged by Contractor's negligence, and fixing of additional survey points near working area.
- s. Methods adopted for specially controlled excavation at foundation level or near the faces where plain surfaces are required.
- t. Formation of berms or ramps sump pits for installation of dewatering pumps at places, which fall beyond the specified excavation lines.
- u. Replacement or repair of concrete or other works damaged by blasting.
- v. Over-excavation required for contractor's convenience. The concrete required to fill such excavation shall also be at the contractor's expense.
- w. Draining, shaping and trimming of the dumped materials in waste disposal area to the lines and grades as directed or approved by the Client.
- x. Provision of catch drain, nallah diversions etc. to avoid flow of water to working area.

9.10.2 *Open Excavation*

- I. Measurement for payment of excavation will be of the in-situ volume defined by the excavation lines as shown on the drawings, and shall be worked out on the basis of solid volume, worked out from the initial, intermediate, and final ground cross sections recorded or as per direction by the Client.
- II. Payment will be made at the appropriate Unit Rate per cubic meter as entered in the Schedule of Item Rate.
- III. Payment for removal of bluffs and loose rock close to the areas to be excavated shall be deemed to have been included in the quoted rate for item of open excavation for various structures.
- IV. Payment for removal of unavoidable slips, which may occur in the excavated slopes, will be deemed to have been included in the quoted rate for the item of open excavation for various structures.

9.10.3 *Shoring and Strutting*

- I. The rates for shoring and strutting shall be included in the rates of excavation itself.

9.10.4 *Royalties*

- I. Soil or rock spoils such as stones, boulder, pebbles, gravels etc. available from excavation, if are found suitable for use in works as per required specifications, can be used free of cost but the legally payable royalty and taxes are to be paid by Contractor to the concerned authorities.

10. ROCK BOLTS/SOIL NAILS AND WIREMESH

10.1 SCOPE OF WORK

- I. The specifications described herein under relate to the Work which includes all labour, material, equipment and services required for the supply, installation, testing and monitoring of rockbolts/soil nails. and also the supply and installation of wire mesh and mesh anchors as specified herein or as shown on the drawings.
- II. Rockbolts/soil nails etc. shall be furnished complete with all accessories and other materials necessary for their installation, stressing and grouting.
- III. If directed or approved by the Client, the Contractor shall supply and install flat steel plates or rolled steel sections to connect together two or more rockbolts/soil nails.
- IV. The contractor shall maintain on site or have immediately available at least one month buffer stock as per agreed work programme of any of the support elements i.e. Wiremesh, Self-Drilling bolts, SN bolts or any other specialised bolts required according to the geological conditions and as per drawings. However, towards work closure, the contractor may use these quantities with prior approval of Client.

V. **STANDARDS:**

The specifications, production, working etc. shall conform to the following latest Indian Standards or where not covered by these Standards, to the equivalent International Standards. The list is for guidance purpose only. The contractor shall abide by all codes/regulations/specifications as are deemed necessary for the satisfactory completion of work.

a. Indian Standards:

1. IS: 1786 – 1985 (Reaffirmed 2000), Specification for high strength deformed steel bars and wires for concrete reinforcement

b. American Society for Testing and Materials (ASTM):

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel
2. ASTM C150 - Standard Specification for Portland Cement
3. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete
4. ISRM - Doc.2, Part 1 "Suggested Method for Rock-bolt Testing".

10.2 SUBMITTALS

- I. At least 8 (eight) weeks prior to the commencement of excavation works, the contractor shall submit, to the Client, the details of equipment to be used for testing and installation of Rockbolts / Soil Nails / wiremesh etc.
- II. The Client reserves the right to require any additional information deemed necessary to be included in the submitted documents.
- III. Test reports of tensile strength tests and pull out tests, routine pullout tests (IS:11309) shall be submitted immediately within 3 hours after the test is carried out.

10.3 GENERAL

- I. For the sake of convenience, the terms used in the Chapter are defined as follows:
 - a. Reinforcement Element is a general term of rockbolts, soil nails, wiremesh etc.
 - b. Rockbolt/soil nails is a stressed (or tensioned) reinforcement element consisting of a rod, grouted anchorage, and plate and a nut for stressing by giving torque to the nut or for retaining tension applied by direct pull. It is synonymous with “active rock anchor”.
 - c. Individual rock bolting refers to the installation of reinforcement elements in localized area of in stability or weakness as determined during excavation. It is synonymous with spot bolting.
 - d. Pattern Rock bolting refers to the installation of reinforcement elements in a regular pattern over the excavation surface.
 - e. The reinforcing bar steel used shall be from sources as indicated in the Section – Material for construction. Corroded steel bars shall not be used.
- II. The following types of reinforcing elements are proposed to be used:
 - a. SN Bolts: cement grouted.
 - b. Self-Drilling anchors as Rock bolts/Soil Nails.
- III. The type, length, diameter, inclination and pattern of the rockbolts/soil nails shall be as shown on the drawings or as approved by the Client. The Contractor shall provide manufacturer’s test certificate for all batches of rockbolts/soil nails supplied. At least 5 samples shall have been tested for tensile strength until failure from each individual batch of rock bolts which is marked with the same manufacturer’s identification number. All the results of the tensile test shall comply with the specified data of the manufacturer.
- IV. Bearing plates shall conform to IS 2062 and be flat or dished steel plates having minimum dimensions suitable to carry take full load for Rock bolt is installed (At least 1 plate of 200x200x12 for 32mm dia bolts and 1 plate of 150x150x10mm for 25mm dia bolts). The washers to be used shall be bevel or hemispherical.
- V. All surfaces of the bearing plates, nuts, washers and wedges, and threads on the projecting ends of rock bolts/soil nails shall be protected and lubricated with rust preventive compound.
- VI. Corroded bolts or steel or other elements shall not be used.
- VII. When rock bolts/soil nails are used in conjunction with wire mesh, the mesh shall be connected firmly to the bolts by means of extra steel plates and nuts.
- VIII. Wire mesh shall not be placed between rock/soil and the bearing plate of the rock bolts/soil nails. Additional plates shall be provided for this purpose.
- IX. Couplers may be required for the bolts. When coupler is used, the threading in the bar shall not reduce the effective diameter of bar. Coupler itself should be able to transfer at least 125

% of the yield load of the bar. Couplers shall not be permitted for rock bolts/soil nails less than 4m in length.

- X. Minimum one PVC centralizer per rock bolt/soil nail shall be provided. In long rock bolts/soil nail, one centralizer at every 6m shall be provided along the length of the bolt.

10.4 TESTING AND MONITORING OF ROCKBOLTS / ANCHORS / SOIL NAILS

- I. The contractor shall furnish at least two sets of testing equipment including hydraulic jacks, fixing device, hydraulic pump with pressure gauge / manometer, extensometer and all necessary accessories. The testing equipment shall be capable of stressing the largest diameter bolt to the yield stress of the bolt.

a. Proof Tests

1. A detailed test program set up on basis of above-mentioned document shall be approved by the Client prior to all testing work.
 2. Specific deviations from the ISRM suggested method shall be approved by the Client.
 3. A test report shall be issued immediately after completion of the tests. It shall be submitted for approval to the Client.
 4. For each type of rock bolt/soil nail submitted information shall comprise:
 - a. type of bolts
 - b. testing equipment
 - c. location and installation records
 - d. Applied testing loads and records of deformation
 - e. Otherwise the evaluation of test results as specified in ISRM's document
 - f. Interpretation and suggested action for failed pull-out tests
 5. Proof tests shall be carried out for all types of bolts to be used for this project prior to the commencement of works to demonstrate the effect and the A service capacity of the bolts in the field.
 6. A minimum of five bolts of each type shall be tested. Depending on the testing procedure and the test results the Client may require further bolts to be tested.
 7. Adequate testing equipment, as specified in the above mentioned ISRM document shall be provided to record bolt elongation, movement of the bolts and tension forces.
 8. The maximum load to be applied shall be the bolt's yield load or as otherwise approved by the Client.
- b. Grout mortar: Prior to acceptance tests of rock bolts/soil nails, tests with available cements and sands shall be carried out to determine an appropriate mix design to achieve the specified

strength and a proper workability in association with the grouting equipment used. Additives will be used to improve workability. The grout mortar shall be tested on cubes 5x5x5 cm. The cubes shall be cured in water. Five numbers of cubes shall be prepared for each compressive strength test. The resultant strength is the average evaluated from the three remaining values after elimination of the highest and the lowest. During construction, cube sample shall be taken weekly at each five bolts drive from the grouting hose at the nozzle. Preparation and evaluation shall follow the procedure as described above.

- c. If any rockbolt/soil nail fails due to improper workmanship or defect in materials or due to any reason whatsoever, the Client may order a test on all adjacent rockbolts/soil nails and all rockbolts/soil nails so failing shall be rejected, replaced and retested.
- d. The bolts and anchors shall be checked for their straightness Tolerance with + 1 mm.
- e. The pullout trials shall be conducted in conformity with IS: 11309.
- f. Further sampling and testing for quality control will be got done as directed by the Client at contractor's cost.

10.5 DRILLING HOLES & PREPARATION FOR INSTALLATION

- I. Holes for rockbolts/soil nail shall be drilled as specified herein and in accordance with the provisions set out in Section of "Drilling and Grouting"
- II. The minimum diameter of each hole shall be as specified below or as directed by Client:
 - a. Rock Bolt/Soil Nail of 25mm dia: Hole dia 45mm with coupler and 38mm without coupler
 - b. Rock Bolt/Soil Nail of 32mm dia: Hole dia 64mm with coupler and 50mm without coupler
- III. The length of drill hole shall be such as to receive the specified rockbolt/soil nail and to provide for its satisfactory anchorage.
- IV. After drilling, each hole in compact, washable rock shall be washed out with clean water and cleaned by blowing out all drill cuttings and debris with compressed air. The holes in rock, which tend to swell or are interspersed with clay filled fissure shall be cleaned with compressed air only. The compressed air shall not contain any oil or other material preventing the bond.
- V. Prior to installing the rock bolts/soil nails, which will be stressed, the rock/soil surface adjacent to the hole shall be prepared for the bearing plate. Only bevel washers shall be used which shall be placed between the bearing plate and the nut, or dished bearing plate and hemispherical washer used to ensure uniform bearing.
- VI. If a rock bolt/soil nail is not installed immediately after drilling the hole, the hole shall be washed and cleaned as stipulated above, immediately prior to installing the rockbolt/soil nail.
- VII. Fresh holes, as directed by the Client, shall be drilled by the contractor at his expense to substitute such holes as have been drilled out of place or alignment.

- VIII. The rock surface around the drilled holes to receive the bearing plate shall be chipped smooth or be covered with a smooth quickset cement pad.
- IX. All bolts within 10 m of a blasting operation shall be retightened to the specified torque within 4 hours after each blast. If it is found that any bolt does not take the required torque without anchorage slip, a new bolt shall be installed in the immediate vicinity of the unsatisfactory bolt.

10.6 INSTALLATION RECORDS

Comprehensive records about details of the installation of rock bolts during drivage, such as grout consistency, drilling depth, length and type of rock bolts/soil nails, deviations from the theoretical position, type and time of grouting, time of tightening, special observations, etc. shall be kept for each round by the Contractor and countersigned by the Client's supervisory personnel. Copies of these records shall be submitted to the Client.

10.7 ROCK BOLTS / SOIL NAILS CEMENT GROUTED (SN BOLT)

- I. Rockbolts/soil nails shall consist of deformed steel bar of 25 mm or 32 mm Ø (Grade Fe-500D conforming to IS 1786). Each bolt shall have one end threaded with a coarse thread over a length of 200 mm.
- II. Anchor bars/anchor bolts shall be thoroughly cleaned before being placed in the drill hole. The hole shall be filled with grout constituting 1:1 cement/sand mix with low water cement ratio, by inserting the grout hose to the full depth of the hole and withdrawing as the grout is pumped in. The nozzle shall be kept buried in the grout as the pipe is withdrawn so that air is displaced as the hole is filled. The bolt is then pushed into the hole. Admixtures for fast setting and low shrinkage may also be required.
- III. In case of coupled rock bolts, partly collapsed boreholes, or major water- flow from the borehole, grouting may be done after installation of the bolt (post-grouting). The hole is then grouted by a special attachment which allows the mouth of the borehole to be sealed whilst the grout is pumped in. Air is displaced from the hole via a tube which is attached to the full length of the rock bolt as it is installed. Grout is then pumped in and the hole can be seen to be full, when grout escapes from the end of the tube.
- IV. The nut of the grouted rock bolts shall be tightened not later than 12 hours after installation to achieve a force at the anchor plate of approx. 20 KN. This force shall be applied by a calibrated torque wrench.

10.8 SELF DRILLING ROCK BOLTS / SOIL NAILS

- I. This is a high-grade (Yield load more than equal to 230KN) hollow core Seamless steel bar with continuous threaded surface for mechanical coupling. In addition to hollow core Seamless steel bar, other parts of the assembly consists of Hexagonal nut, bearing plate, extension couplings and sacrificial drill bit. Before and during installation, thread ends will be kept cleaned to allow hex nut and coupler threadability. Construction and drilling shall be as per manufacturers guidelines.

- II. SDA Bolts shall have outer dia of minimum 32mm and inner diameter less than equal to 18mm. Length of rod to be procured shall be decided in agreement with the Client.
- III. Bearing plates shall allow articulation of 5 to 7 degrees in all directions.
- IV. Drill bit to be used shall be selected according to installed length of bolt, geology and size of bolt.
- V. Couplers and Nuts shall exceed the tensile strength of bars by minimum 20%.
- VI. The bolt shall be grouted according to manufacturer's guideline (to a minimum pressure of 6 bars) with manufacturer's grout material supplied along with bolt. Alternatively, grout mix (M-35 grade) may be prepared using OPC 53 cement and sand having maximum particle size of less than 0.3mm. Grout mix shall have a water cement ratio less than 0.4 and shall contain PC based super plasticizer (Minimum 2%) and expanding plasticizer (allowing upto 3.5% expansion in neat cement) from reputed manufacturer. Admixtures containing chlorides and alkali shall not be used. Face of the Bolts shall be sealed off with GP2 or Similar rapid setting grout to prevent grout leakage during build-up of pressure.
- VII. All accessories of self-drilling bolts shall be suited to the main anchor rod type and shall be procured from original manufacturer of the bolt.

10.9 WIRE MESH AND MESH ANCHORS

- I. Welded wire mesh shall be installed in surface as reinforcement for shotcrete, usually in combination with rockbolts/soil nails.
- II. Welded wire mesh shall conform to the requirements of IS: 1566. The fabric shall have a minimum square mesh of 150x150x6, made of wires having yield strength not less than 500 Mpa and diameter 6 mm or as directed by client.
- III. Where possible, the welded wire mesh shall be placed at the same time as rockbolts/soil nails are installed. It shall not be placed between the rock/soil surfaces and bearing plates of rockbolts/soil nails but shall be placed over the heads of rockbolts/soil nails and fastened to them by separate plates and nuts. Sufficient intermediate mesh anchors, or if directed by the Client, additional rockbolts/soil nails, shall be placed to ensure that the mesh is drawn close to the excavated surface so that when shotcrete is applied subsequently, the mesh neither sags nor vibrates excessively and impairs the effectiveness of the shotcrete.
- IV. In case the welded wire mesh is placed at such locations where rockbolts/soil nails have not been provided, wire mesh anchors of a type acceptable to the Client shall be used to secure the edges of wire mesh tight to the rock/soil surface to provide anchorage at overlaps and to provide intermediate support. The wire mesh anchors shall have a minimum length of 450 mm.
- V. The use of wooden pegs and pins for fastening the wire mesh to the rock/soil surface will not be permitted.

- VI. Welded wire mesh shall be firmly stretched between the rockbolts/soil nails. Care shall be taken to ensure that air pockets are not formed behind the wire mesh, when used as reinforcement for shotcrete. Overlaps in the wire mesh shall not be less than 300mm.

11. SHOTCRETE

11.1 SCOPE OF WORK

- I. The specifications described herein under related to the work, which includes all labour, materials, equipment and services required for the shotcrete work (plain and fiber reinforced) to be carried out by the contractor under this Contract.
- II. All shotcrete work shall be carried out in accordance with guidelines specified in this section. The shotcrete work shall be performed to the dimensions as shown on the drawings or as otherwise directed by the Client.
- III. Compressive strength of shotcrete shall be met by compression testing of cylindrical cores extracted for the slope surfaces. The sample prepared for testing shall have a 100mm length and 100mm diameter (Equivalent of a cube).
- IV. The approval given by the Client to the Contractor's equipment of their operation or of any construction methods shall not relieve the contractor of his full responsibility for the proper and safe execution of Shotcrete work or any obligations under this Contract.

11.2 SUBMITTALS

- I. Within 28 days from the commencement date, but before procuring or mobilizing to the site, the equipment, the Contractor shall submit to the Client, updated and detailed plans and descriptions, of the following:
- a. Batching and Mixing Equipment
1. Description and details of the equipment, which the Contractor intends to use to determine and control the quantity of shotcrete ingredients and mixing thereof into uniform mixture. This shall also include automatic dosing equipment for various admixtures. All equipments shall be capable of monitoring and recording the dosage during production process.
- b. Placing Equipment
1. Full details, of the equipment to be used for placement of shotcrete (Robotic Shotcrete machine) and details of standby equipment.
- c. Details of methods and equipment which the Contractor proposes to use to control the temperature of aggregates and water during extreme hot and cold weather conditions.
- II. At least 28 days in advance of any shotcrete work being carried out on the site, the contractor shall submit, to the Client the following:

- a. Notifications of any admixture and Pozzolana, which the contractor proposes to use, manufacturers thereof and information about the chemical names of the principal ingredients and the effect of under or over dosage.
 - b. Description and details of methods which the contractor proposes to adopt for Shotcrete.
- III. The Client reserves the right to require any additional information deemed necessary to be included in the submitted documents.

11.3 STANDARDS

- I. The Shotcrete materials, production, methods of application, testing and admixtures shall conform to the following latest Indian Standard or, where not covered by these standards, to the equivalent International Standards.
- II. Indian Standards
 - a. IS: 456 Code of Practice for Plain & Reinforced concrete.
 - b. IS: 269 Specification for ordinary Portland cement.
 - c. IS: 383 Specification for coarse and fine Aggregates from natural source for concrete.
 - d. IS: 516 Method of test for Strength of concrete.
 - e. IS: 9012 Recommended practice for Shotcrete.
 - f. IS: 2645 Specification for Integral cement water proofing compound.
 - g. IS: 9103 Concrete Admixtures.
 - h. IS: 269 Specification for ordinary Portland cement.
 - i. IS: 15388 Silica-Fumes.
 - j. IS: 7861 Code of practice of extreme weather concreting.
 - k. IS: 1199 Methods of Sampling and Analysis of Concrete.
- III. International Standards have been mentioned at relevant locations in the section.
- IV. In case of conflict between the above standards and the specifications given herein, the specifications shall take precedence.

11.4 GENERAL

- I. Shotcrete shall be applied by either the wet or dry process as appropriate to the circumstances. All aspects of the application of shotcrete shall be subject to the agreement of the Client.
- II. The Contractor shall develop a shotcrete mix and a plan for its production and application. Specifications of constituent materials shall comply with those listed in this. Admixtures shall be compatible with each other and the mix.

- III. The shotcrete mix design shall, unless otherwise stated, comply with the characteristic strengths specified by the Designer for early-age and long-term loading.
- IV. Contractor's shotcrete expert should be on site at all times to check that the materials and workmanship are consistent with the design intent, and to ensure that ground and groundwater conditions are in accordance with design assumptions. The Contractor shall establish a procedure to respond effectively to changes in ground and groundwater conditions from the design assumptions.
- V. The Contractor shall establish and maintain the instrumentation and monitoring required by the design. The Contractor shall establish a procedure that will enable prompt and regular review and effective response to the results from the instrumentation and monitoring. The Client shall be included in the monitoring review procedure.

11.5 DEFINITIONS

- I. Shotcrete: Shotcrete for the purpose of this work is defined as wet mix of cement concrete (plain) applied from a spray nozzle by mean of compressed air. The Client may, in exceptional cases, allow use of dry mix for plain shotcrete. Shotcrete shall contain approved additives like Accelerator, Superplasticizer, retarder, stabilizer, Pumpability improving additive or curing agents suitable to attain desired properties as mentioned in these specifications and site conditions.
- II. Rebound: Rebound is defined as the portion of shotcrete mix or any of its constituents, which bounces away from a surface against which it is being projected.

11.6 MATERIAL FOR SHOTCRETE

- I. Material for shotcrete shall comprise cement, aggregates, water and approved admixtures, micro-silica/Silica fume as specified herein.
- II. Cement:
 - a. Cement used shall be ordinary Portland cement of 53/53S grade.
 - b. For M30 Grade Shotcrete: Minimum OPC 53/53S content will not be less than 385 Kg/cum. Minimum 15 Kg/cum / Micro-silica/ Silica Fume will be added to enhance mix durability and reduce life cycle cost of shotcrete.
 - c. Preferably cement fineness shall not be less than 275 m²/kg for OPC 53 and 370 m²/kg for OPC 53S.
 - d. Maximum temperature of the cement in the mixing plant silos should be limited to 70°C and it should not exceed 50°C at the time of mixing. Cement should be preferably purchased in bulk and fresh cement shall be stored in a suitable silo.
- III. Aggregates:

- a. All fine and coarse aggregates to be used shall be supplied from approved sources, which shall not be changed without permission in writing from the Client. Aggregates shall conform to the requirements of IS:383.
- b. The aggregate shall be checked for chemical reactions, such as alkali–aggregate reaction, with latent hydraulic binders and admixtures, especially accelerators.
- c. The aggregates size for shotcrete shall not exceed 10 mm. The proportion of aggregate larger than 8mm in size should not exceed 10%. The aggregate shall be well graded, and no fraction shall constitute more than 25 % of the total. The contents of the crushed and non-cubical material under 0.1mm shall not exceed 8 %.
- d. Acceptance of source by Client shall not be construed as constituting the acceptance of all aggregates to be taken from that source or grading of aggregates to be in conformance with contract.
- e. It is the responsibility of the CONTRACTOR to choose the most suitable grading for the process and materials available from the range given in table below. The grain size distribution of aggregates shall be within $\pm 2\%$ for each sieve size as shown below:

Standard Sieve	Sieve Size [mm]	Passing in %
IS	10.0	100
IS	8.0	90-100
IS	4.0	73-100
IS	2.0	55-90
IS	1.0	37-72
IS	0.50	22-50
IS	0.25	11-26

- f. Testing
 1. The flexural toughness of steel fiber shotcrete shall be tested according to ASTM C 1018-89. Field suitability tests shall be performed for different quantities of steel Fiber in the shotcrete. During construction, the flexural toughness shall be measured for every 200m³ of steel Fiber shotcrete installed.
 2. The actual fiber content of steel fiber shotcrete shall be tested by washing out and weighing the steel fibers from a 10l container of fresh shotcrete. Three tests shall be performed for every 100m³ of steel fiber shotcrete applied.
- IV. Air used for spraying shotcrete shall be clean and free of oil.
- V. Water used for mixing shall comply with IS-456. Water to cement ratio shall be less than 0.43.

VI. Admixtures: Admixtures conforming to IS:9103 shall be used to develop quick set and high early strength, to ensure good workability, low pumping pressure, adequate slump retention and low rebound as approved by the Client, conforming to the requirements of the relevant standards. The proportion of admixtures shall be kept less than 10-12% of the weight of cement or as determined by testing prior to any shotcrete work.

a. General

1. Technical criteria, approved documentation, test reports and test certificates shall be furnished to the CLIENT for approval.
2. Admixtures shall be stored under the conditions specified and recommended by the manufacturers. The related storage Specifications and recommendations shall be presented to the CLIENT before approval of such admixtures.
3. The manufacturer's safety instructions shall be observed Admixtures shall be free of chlorides such that the percentage of chlorides shall not exceed 0.1% by weight.
4. The required characteristic values and consistency of delivery to the site shall be agreed in writing with the manufacturer of each admixture before commencement of concrete spraying.
5. Written confirmation of the stability of admixtures with the mix water shall be provided prior to commencement of site trials.
6. The content of SO₃ shall not exceed 4.8% by weight of total binder content.

b. Accelerators

1. Accelerators are used to produce a fast set and to get sufficient early strength development. Accelerating admixtures shall be compatible with the cement used.

The compatibility shall be tested in the laboratory by the Manufacturer and verified by the CONTRACTOR in field suitability tests to achieve the required properties for early and final strength.

2. The accelerator must mix with the concrete in the nozzle and begin the hardening immediately after the concrete hits the rock.
3. Only liquid alkali-free accelerators (pH 2.0 to 8.0 and having alkali content less than 1% by weight Na₂O equivalent) shall be used. Additives based on Lingo sulphates (P agents) shall not be used due to retarding and reduced early strength.
4. The accelerators shall be added at the nozzle and only the minimum quantity of accelerator necessary shall be permitted in normal concrete spraying operations. The quantity shall be determined by site trials, subject to maximum dosage of 7% by weight of cementitious materials. Higher dosages of upto 8% accelerator can be considered subject to establishing the effect of the dosage rate on the medium and long-term strength development on the in-situ concrete. At no stage in the strength development should the strength of the accelerated mix drop below 0.7 times the strength of the unaccelerated concrete mix.

5. Testing of accelerators and the base mix with respect to acceleration of setting, early strength and decrease of strength at a later age (28 days), shall take place in due time before commencement of concrete spraying.
 6. Laboratory testing of the selected type(s) of accelerator shall be carried out at dosages as recommended by the manufacturer, to establish the variability of the above properties with dosage. Accelerators showing excessive variability with dosage will not be permitted.
 7. Accelerators shall be selected so that, at the dosage chosen for use in the Works, the characteristic compressive strength of any shotcrete at an age of 28 days can be achieved. Compliance with this clause shall be demonstrated by site trials.
 8. Accelerators delivered to site shall be tested at least once every two months for their reaction with the Portland cement used, with particular reference to the setting behavior and strength decrease after 28 days. The stability of accelerators during storage shall be visually inspected at similar intervals. Storage times and working temperature ranges shall be in accordance with the manufacturer's recommendations. The manufacturer's safety instructions shall be observed.
- c. Super Plasticizers and retarders
1. Used to reduce the quantity of the mixing water and to improve the pumpability of the concrete. The effects and optimum dosages shall be determined by site trials.
 2. The above-mentioned desired properties shall only be attained through superplasticizers.
 3. Shall be added at the batching plant to keep the shotcrete mix workable during transportation and to ensure good pumpability to an acceptable low water cement ratio.
 4. The influence of the superplasticizers and retarders within the concrete mix shall be checked regularly for setting time, water reduction, and development of strength. These values shall be compared with the results from the pre-commencement trials.
 5. Compatibility of superplasticizers and retarders with Portland cements, latent hydraulic binders and accelerators shall be verified by observation and site trials. Traditional retarders shall not be allowed.
6. Hydration control admixtures
7. Hydration control admixtures may be used to control the hydration of the mix as appropriate to expedite construction of the Works. The effects and optimum dosages of hydration control admixtures shall be determined by site trials.
 8. Compatibility of hydration control admixtures with Portland cements, latent hydraulic binders and accelerators shall be verified by observation and site trials. Hydration control admixtures shall be used in accordance with the manufacturer's instructions.
- VII. Additives: Micro-silica or silica fume

- a. Micro-Silica or Silica fume shall conform to ASTM C1240 / IS-15388. Contractor shall submit MTC from original manufacturer. Manufacturer shall furnish evidence of factory production control systems.
- b. The performance of the shotcrete mix with optimum dosage of additives shall be determined by field suitability tests. Testing of Silica fume shall be carried out by contractor before or anytime during its usage at discretion of Client.

VIII. Curing agents

- a. External curing agents and internal curing admixtures shall be allowed to maximize hydration of the cement by reducing uncontrolled water evaporation.
- b. The curing agent selected should not affect the bond of further layers/coatings or be easy to remove. Solvent based curing agents should be avoided
- c. External curing agents are sprayed onto the surface of the shotcrete shortly after it has been applied. When set accelerators are used, an external curing agent should be applied within 15 minutes after the end of spraying. When no accelerators are used it should be applied within 30 minutes.
- d. Internal curing admixtures are special admixtures added to the mix (see 4.6). Compatibility of curing agents with cements, hydraulic binders, accelerators and other admixtures should be verified in site trials. Particular care must be taken to ensure adequate mixing when used in the dry-mix process.

11.7 MIX DESIGN AND PROPORTIONING

- I. The type of shotcrete to be used in a particular location shall be as per drawings and as directed by the Client.
- II. The mix proportions of cement, aggregates, and permitted admixtures in each class shall be determined by the Contractor satisfying the requirements given in Table no. 1 below and shall be subject to the approval of the Client. The mixes shall be such as to permit placement without excessive rebound and segregation.

Table-1

28-day compressive strength of Cylindrical cores (after applying a factor of 0.85 for In-Situ coring effects)	Characteristic strength of	Aggregate size/grading	Cementations content, (C) kg/M3	Water cement ratio
30 MPa (Average of 4 consecutive non-overlapping tests)		Size grading: Dmax ≤10 mm, Aggregate flattening coefficient ≤20.	Refer para 16.6	≤ 0.43

- III. The water content of the mixes shall be limited to prevent sloughing. The water: cement ratio of fresh shotcrete in place shall be less than 0.43.
- IV. Slump of mix shall be kept less than 200mm, as high value of slump will affect fiber distribution in the shotcrete.
- V. The Mixes shall be such that aggregate gradation and cement content after placing are as those obtained from samples taken from test panels produced from approved trial mixes. All constituents shall be uniformly dispersed throughout the mix.
- VI. Proportioning of aggregates and cement shall be only by weigh batching.
- VII. Moisture content of the combined aggregate at the time of mixing with cement shall not exceed 6 % (Six percent) by weight of the over dry aggregate.
- VIII. Mixed material shall be used within 90 minutes after addition of water to cement. This period may be extended by the use of hydration control admixtures, subject to the approval of the Client.
- IX. Approved mix proportions may have to be varied, during execution stage, to obtain required strength of shotcrete, to maintain rebound to the minimum and to meet other requirements of Contract. The Contractor shall notify to the Client of all variations to the mixes.
- X. The Contractor shall carry out all field tests before hand and then propose mix design for shotcrete to meet the requirements of the specifications for prior approval of the Client. The quantities of super plasticizers may be adjusted to compensate the slump loss because of fiber. The mix design shall provide the following details for one cubic meter of Shotcrete.

- a. Ordinary Portland Cement Kg
- b. Microsilica Kg
- c. W/C Ratio
- d. Aggregate
 1. Natural fine aggregate Size Kg
 2. Natural coarse aggregate Size Kg
 3. Crushed fine aggregate Size Kg
 4. Crushed coarse aggregate Size Kg
- e. Super Plasticizer Agent Kg
- f. Retarder or Stabiiser Kg
- g. Internal curing Kg
- h. Pumpability iimprover Kg
- i. Alkali free Accelerator Kg

- j. Fibre (Aspec Ratio/Length) Kg
- k. Slump mm
- l. Density (Wet) Kg/cum

11.8 EQUIPMENT

- I. Details of all equipment to be used shall be made available to the Client prior to commencement of site trials.
- II. The equipment selected and approved by the Client will be capable of maintaining the ratio of concrete and accelerator as selected from the trials and approved by the Client. The actual ratio of accelerator to concrete selected shall be identified at the nozzle and take into account the filling efficiency of the equipment and the efficiency of the accelerator dosage equipment to overcome the air and concrete pressure at the nozzle while spraying at typical outputs and air flows. Contractor shall provide shotcrete machine data in digital format after every cycle whenever required by the Client.
- III. Equipment shall be thoroughly cleaned at least once per shift. The spray nozzle shall be checked for wear and where necessary replaced.
- IV. Transport pipes consisting of hoses and pipes shall be designed to convey the concrete efficiently and without leakage or blockage. The transport pipes shall have uniform diameter appropriate to the mix characteristics determined by site trials and be free of any dents or kinks between the shotcrete machine and the nozzle.
- V. Working area for sprayed concreting shall be well illuminated and ventilated. Dust pollution shall be minimized by choice of appropriate equipment and by means of additional ventilation, water sprays, and by maintaining equipment in good order. Protective clothing and dust masks shall be provided for and used by all persons present during spraying.
- VI. The equipment shall allow for air and water in any combination to be available for preparation of surfaces and/or cleaning of finished work.
- VII. Recipe of mix shall be entered into PLC control prior to spraying.
- VIII. A boom mounting or similar device shall be provided for the spray nozzle unless it can be demonstrated to the Client that the use of such equipment is impractical.
- IX. In particular, the spray nozzle shall be kept as perpendicular as possible to the surface and care shall be taken to achieve a regular properly compacted coating of the correct thickness.
- X. The shotcrete shall emerge from the nozzle in a steady uninterrupted flow. Should the flow become intermittent for any cause, the nozzleman shall direct it away from the work until it again becomes constant.
- XI. The thickness and position of the shotcrete shall be defined by screed boards, lattice arches, guide wires, depth pins, lasers or other means.

- XII. The site trials shall employ the equipment which will be used in the Works and the constituent materials shall be fully representative of those to be used in the Works. A clean, dry mixer shall be used, and the first batch discarded.
- XIII. The equipment proposed for the application of concrete in the Works shall be used for the trial. The trial will establish whether the selected equipment is capable of efficiently mixing concrete, accelerator and air at the nozzle, and be capable of positioning the nozzle at a suitable distance and orientation to the surface geometry of the structure to which the concrete is to be applied.
- XIV. During the trials the Contractor will establish the volume of air required to give adequate compaction of the material using the nozzle and conveyance lines selected for the Works. If the delivery equipment or nozzles are to be changed during the course of the works, the volume of air required will need to be verified again. The equipment will be maintained adequately, to ensure that the required volume of air can be maintained while spraying. Air pressure can only be used as a control if the air delivery system is not altered from the original verification trial. No additional taps or restrictions will be permitted to be added into the system without repeating the verification trials.
- XV. The static compressed air capacity measured at the shotcrete pump shall be according to the manufacturer's recommendations and generally as per EFNARC guidelines G 8.3.2 for wet process and G 8.3.3 for dry process.

11.9 QUALITY CONTROL AND TESTING

- I. The Contractor shall enable the Client access to the shotcrete Works at all times and shall allow the Client access to inspect the excavated ground surface prior to spraying if requested.
- II. The quality control and testing of shotcrete (Plain) shall be carried out by the contractor in the presence of Client. Tests for Field suitability (to determine mix design) and In-situ suitability (to control quality) shall be carried out separately. Field suitability tests shall be carried out on minimum three test panels for initial establishment of suitable range of accelerator/superplasticizer dosage (All types of Shotcrete). The pressure at which the shotcrete shall be applied to the test panels shall be the same as will be used in actual works at the place of application. Mechanical rebound hammers shall not be used to obtain indirect compressive strength of shotcrete.
 - a. Control of Fresh shotcrete:
 - 1. Water/Cement ratio: Daily by calculation or test method.
 - 2. Aggregate gradation: Weekly by standard sieving.
 - 3. Accelerator/Superplasticizer: Daily through record of quantity added.
 - 4. Slump: For Each batch separately, measured any time during application, at the pump and should conform within 25mm of the target slump range established earlier and approved by the Client.

5. Early (0-24hrs) strength development: Strength results shall conform to Class J2 as per EN-144887-1 unless specified otherwise in the design drawings. In-situ test shall be carried out every 250m² of shotcrete applied subject to minimum 2 test per month in accordance with EN 14488-2 (Strength up to 1.0 N/mm² shall be determined by Penetrometer and in the range between 1.0 and 16 N/mm² shall be determined using the HILTI shot bolt method).

b. Control of hardened shotcrete:

1. In-situ strength shall be carried out on shotcrete applied at the slope face and shall be determined by crushing of cylindrical shotcrete specimens. Samples shall be collected with core drilling equipment from In-situ shotcrete applied on slopes/or from test panels as the case may be, after lapse of 1 day. Cores for strength testing shall be obtained from random locations. The cores will be visually inspected and the dimensions and comments regarding the quality of the cores will be recorded. The cores will be free from lamination. No sets of cores to be tested at any given age shall come from the same panel/In-situ location. Sets of cores to be tested at different age may come from the same panel/In-situ location. For each test at least one spare specimen shall be provided. The cores for determination of strength shall be cured in temperature-controlled water until 3 days before further testing. The specimens shall have a diameter of 100mm and be cut to a height of 100mm. Where the nominal required shotcrete thickness is less than 100 mm, the cores for the compressive strength testing shall be taken from areas where the actual thickness is greater than 100 mm. Alternatively additional shotcrete thickness shall be applied in selected areas agreed by the Client for subsequent coring of test specimens.
 2. Further (1-7days) Strength Development: Average strength of 3 cores tested at 3 days and 7 days each shall exceed 12.5MPa and 70% of 28-day strength requirements respectively. The Client may also require the drilling of cores from the test panels perpendicular to the spraying direction.
 3. Final strength: 3 cores shall be further tested at 28th day and at completion of 6 month each and the 28-day strength obtained shall exceed 28-day strength requirements mentioned in Table-1 at 11.7.2. Strength results at 6 months shall not be less than 28-day results.
- c. Shotcrete thickness: The contractor will be required to undertake confirmatory shotcrete thickness testing of the in-situ shotcrete thickness. The basic test shall consist of 4 nos. drill holes drilled on a 1m² pattern. The average thickness of the 4 holes shall exceed the specified design thickness. If not, the Client shall propose remedial measures and/or further drill testing. All such drill holes shall be subsequently filled back by Non shrink mortar. Nothing extra shall be paid on this account.
- d. Bond Strength: Bond strength of shotcrete shall be tested every 1250m² (in case of Ground strengthening) or min 3 tests (in other cases) of the shotcrete applied in accordance to EN 14488-4. Bond strength between plain shotcrete and fiber reinforced shotcrete shall also be established.
- e. Contractor shall keep at site various testing tools like Penetrometer, HILTI shot bolt, Shotcrete core cutter, Test panels etc. along with all spares required as per standards and

specification mentioned above. The frequency of testing, test type or the testing method will not be altered without approval of Client. Shotcrete from both the field suitability test panels and the In-situ quality control shall be tested by the Contractor in the presence of Client. Client may ask contractor to undertake further tests for examination purposes.

- III. The Contractor shall propose to and agree with the Client trial mixes for the works at least 56 days before their commencement. Excavation shall not be permitted to start until the Field suitability tests have been approved by the Client.
- IV. The site trials shall be repeated if the source or quality of any of the materials, mix proportions or placing equipment is to be changed during the course of the Works.
- V. Where shotcrete does not comply with the required strength, the Contractor shall execute remedial work which may involve additional shotcrete or replacement in sections where it is safe to do so. The Contractor shall submit to the Client for agreement, a method statement, specification and calculations for remedial work. The Client shall, in the event of repeated failure in Quality Control, require the Contractor to adjust the mix to achieve the required strength.
- VI. The Contractor shall keep a record in a form to be agreed with the Client of all tests on shotcrete, which shall be kept on site identifying the tests with the section of work to which they relate.

11.10 PROFICIENCY OF WORKMEN

- I. Nozzle men shall have had sufficient previous experience in the application of shotcrete or shall work under the immediate supervision of foreman or instructor having such experience.
- II. Each crew shall demonstrate acceptable proficiency in the application of shotcrete to trial areas before being employed on the Works to the agreement of the Client.
- III. Subject to the Client's agreement, tests for proficiency may be combined with trial mix tests.
- IV. Contractor shall be bound to arrange 2 visits (First visit within a month of start of shotcrete work and second visit after next 6 months) of an expert nozzleman who has successfully completed EFNARC Nozzleman Certification course in last 5 years at no extra cost to the employer. Each visit shall be arranged for at least 3-4 days giving prior intimation to the Client. The EFNARC certified personnel will check the application of shotcrete and its quality according to EFNARC guidelines and guide the existing nozzlemen for required improvements to the satisfaction of the Client.

11.11 PLACING OF SHOTCRETE

- I. Rock or previously applied shotcrete surfaces to be shotcrete shall be carefully cleaned of all loose material, scale and other contaminations. It may be necessary to use compressed air and a water jet. The surface to receive shotcrete shall be damp but shall not exhibit free water.

- II. Where groundwater flow could interfere with the application of shotcrete or cause reduction in the quality of shotcrete the Contractor shall take all action necessary to control groundwater. Such action shall include the channeling of water by means of pipes and chases.
- III. The optimum distance between nozzle and surface of application is 1.5 to 2.0 meter. The nozzle shall be positioned at right angles to the surface of application.
- IV. For vertical and near-vertical surfaces application shall commence at the bottom and the leading edge of the work shall be maintained at a slope. Downward spraying shall be avoided where possible. The nozzle may be inclined sufficiently to ensure reinforcement is properly embedded.
- V. If the design thickness must be applied in more than one layer, then the previous layer must have developed sufficient strength to support the additional layer(s). Wire mesh and other reinforcement shall be embedded in shotcrete as shown on the drawings. Prior to continuation of spraying from a joint or leading-edge position or in any other circumstances where shotcrete has hardened beyond its initial set, loose material shall be removed by jetting with a compressed air lance. Any laitance which has been allowed to take final set shall be removed and cleaned by jetting with air and water.
- VI. If more than one layer of reinforcement is used, the second layer shall not be positioned before the first one is embedded and covered with shotcrete. Exemptions are to be approved by the Client.
- VII. The temperature of the mix before placing shall not be below 150C and shall not exceed 350C unless special provisions are made. Spraying shall not be undertaken when ambient temperature is below 150C unless special measures can be taken to provide protection against frost until the shotcrete has developed a compressive strength of at least 5 MPa.
- VIII. A system of delivery notes shall be maintained to record the date, the time of mixing, mix design number, quantity, delivery point, time of delivery and completion of placing. The delivery notes shall be available to the Client for inspection.
- IX. Rebound shall be removed immediately after finishing of each shotcrete application. In particular at horizontal shotcrete connections due to separate excavation sequences and at all construction joints the rebound shall be removed, if necessary, by pneumatic hammers, prior to further application of shotcrete.
- X. Under no circumstances rebound material shall be worked back into the construction. The work shall be continuously kept free of rebound material.
- XI. Measures to establish the thickness of shotcrete shall be set up by the CONTRACTOR and approved by the Client. These may include visual guides installed prior to shotcrete, holes drilled after completion of shotcrete or a full control by laser scanning.
- XII. Shotcrete shall be left in its natural finish without further working except as required to trim excess thickness where the shotcrete shall be allowed to stiffen sufficiently before being trimmed with an approved cutting screed.

- XIII. If deemed necessary by the Client, curing of the shotcrete shall be performed by water spraying or other appropriate measures subject to the approval of the Client in the first 48 hours after application.
- XIV. Major ground water seepages shall be drained off or sealed off by grouting prior to spraying or after application of a first sealing layer.
- XV. Nozzle men shall be trained in the correct application of shotcrete.
- XVI. Full personal protection equipment to protect the nozzle man from eye and skin contact and inhalation of shotcrete and/or admixtures shall be provided. The admixture manufacturer's precautions and actions for accidental contact shall be provided and adhered to.
- XVII. Before a succeeding layer of shotcrete is placed, the preceding layer shall be checked for defects. Areas of work shall be properly compacted and bonded and free from honeycombing, laminations, dry or sandy patches, voids, sagged or slumped material, rebound, excessive cracking and overspray.
- XVIII. Where defects occur, the Contractor shall agree with the Client proposals for the removal of the defective material and replacement by material without defect and the area to be replaced shall in any event be not less than 300mmx300mm at such locations.
- XIX. Gloves and necessary protective clothing shall be worn to protect against dermatitis.

11.12 MEASUREMENT AND PAYMENT

- I. FOR SURFACE WORKS (SLOPES):
 - a. Measurement for payment for shotcrete shall be made for the theoretical volume in cum of the shotcrete placed as indicated in drawing or as directed by the Client and shall be paid as per relevant item in the Bill of Quantities (BOQ).
 - b. No payment shall be made for filling of "overbreak" with shotcrete.

12. REINFORCED SOIL WALL/SLOPE

12.1 Reinforced Soil Wall/Slope System Provider

The past experiences and credentials with necessary supporting documents as per the requirement of eligibility criteria mentioned in the EQC shall be submitted to the Client during the tender for approval of the specialized agency for reinforced soil wall work.

The reinforced soil wall technology shall have a proven adoption in Indian environment. Documentary proof of adoption of the proposed technology shall be provided for period not less than 15 years. The technology Provider shall have independent third-Party certification by accredited certification body like BBA for soil reinforcing elements for walls and abutment.

The specialized agency shall have in-house design and manufacturing of soil reinforcing element or shall have a tie up with manufacturers & same shall be ISO 9001:2015, ISO 45001:2018 credited by an internationally accredited organization. The specialized agency shall have inhouse computer

controlled tensile testing machine for ensuring quality of soil reinforcement. Reinforced soil structure being a specialized technology, shall furnish design, drawings, method statement, QA plan etc through contractor for approval by the Client and make his own arrangements to secure the supplies and services needed.

12.2 SCOPE

The work includes detailed design and drawings for the entire reinforced soil structure for different sectional heights, supply of soil reinforcing elements, facia, accessories and fittings, construction of reinforced soil structure including placement of facia, reinforcing elements, providing and placing earthwork/fill in layers and all associated components in conformity with the specifications and in compliance with the lines, grades, design and dimensions as per approved drawings including supervision of all work. The work also includes preparing, submitting & getting approval to all the designs and drawings and method statement and QA Plans along with program to match with over all completion of the work. The work shall also include getting the design proof checked from the design proof checker for which the agency will propose three names and IRCON will approve one. IRCON will be at liberty to accept or reject the names proposed by the agency. The quoted rates shall be inclusive of proof checking of design

12.3 DESIGN OF REINFORCED SOIL STRUCTURE

The reinforced soil wall/slope shall be designed for a service life of 120 years. The contractor shall maintain professional indemnity insurance for the amount in INR equal to the contract **cost of design and construction of Reinforced Soil wall based on format approved by IRCON. The Contractor shall provide the evidence of coverage of the professional indemnity insurance before any payment**

is released. The insurance which shall ensure the contractors liability by reasons of professional negligence and errors in the design & construction shall be valid from the date of commencement of works till 10 years after the defect liability period. This indemnity shall be in favour of IRCON. In addition, the contractor(s) shall furnish the Bank Guarantee for a value equivalent to 5% of Reinforced soil wall, valid for a period of 10 years from the date of completion, for design & construction of Reinforced soil wall. The Bank Guarantee will be encashed on failure of any portion of the wall. The decision of engineer in charge will be final in this regard.

The work shall generally be done in conformity to RDSO GE 18 Guidelines, FHWA – NHI -00-043, BS 8006 “Guidelines for Design and Construction of Reinforced Soil Walls” and MORTH “Specification for Road and Bridge Works: Latest Revision, Section 3100.

The detailed design and drawings of the work done in accordance with the following specification.

- i. RDSO GE 18 - Guidelines on Design & Construction of Reinforced Earth Structures
- ii. BS: 8006:2010 - Strengthened/Reinforced Soils and Other Fills

- iii. FHWA - NHI- 00-043 - Design and Construction of Mechanically Stabilized Earth Walls, Reinforced Soil Slopes.
- iv. IS 1893: 2002, for Earthquake Loads & Indian Railway Standard Code for Earthquake Resistant Design of Railway Bridges.
- v. RDSO GE 18 & MORTH Section 3100 for minimum spacing of reinforcing elements
- vi. IS 17372:2020 for selection of reinforcing elements

The Contractor shall submit within 45 days from the date of commencement to the Client, the complete design, selection of reinforcement elements, connection system, fascia system, computation and working drawing/s, and the methodology proposed to be adopted for the works in line with specified technical specifications. The submission shall include the following: -

- i. Existing ground levels including cross-sections that have been verified by the contractor for each location involving the construction wholly or partially in the original ground.
- ii. Layout of walls, detailed design calculations and drawings, material specifications and construction methodology including quality control and quality assurance of different components.
- iii. Earthwork requirements, and results of tests conducted on selected fill material.
- iv. Details of drainage systems and any other facilities.
- v. Test results of soil reinforcing structural element from manufacturers/ suppliers.
- vi. Test results of various materials from an independent laboratory in India or abroad.
- vii. Detail sub-soil investigation report including field and laboratory test results in complete.
- viii. Any other information required in the plans or special provisions or requested by the Client.
- ix. Design life 120 Years

All the above details and documents must be approved by IRCON prior to commencement of works at site.

12.3.1 Design Loads

The following loads shall also be considered while designing the Reinforced Soil Wall/Slope structures apart from all applicable loads for its tendered use: -

- I. Buildings Live load surcharge: 6 t/m²
- II. Seismic loads as per (IS 1893 (Part 1): 2002) for Zone IV.
- III. Wherever railway loading is to be considered, the design will cater for railway axle load of **25** MT as per IRS standard. Specialized system provider's Specifications shall also be incorporated wherever relevant for design and construction.

- IV. The design of reinforced soil slopes should be verified by analyzing the system using geotechnical finite element analysis program like PLAXIS 2D or equivalent. The lateral and vertical deformations, forces in different reinforcement layers predicted by the finite element analyses should be verified against the design requirements.

12.3.2 Design Temperature

For designing the RS wall with geostrips as soil reinforcing elements, the creep reduction factor should be based on up to design temperature of 40°C and durability reduction factor should be based on design temperature of 30°C. In the sub-zero climatic conditions, the geostrips should not get deteriorated. Special care shall be taken for storage of geostrips during cold weather and shall not be kept in open during winter and rainfall.

12.3.3 Slope Stability Analysis

The slope stability shall specifically be checked for global slip failures using latest version of design software prior to commencement of all works. The stability analysis shall cater for minimum factor of safety of 1.3 in static and 1.1 in seismic working load condition. The designs shall be checked by performing 2-dimensional analysis using geotechnical finite element program PLAXIS or equivalent. All estimated deformations and reinforcement forces should be lesser than the allowable quantities.

The proof Checking of Design and drawing of reinforced soil steep slope structure as per BS 8006:2010, FHWA NHI-10-024 (2009) and also by performing finite element analysis using geotechnical engineering program or equivalent Software shall be done by IRCON/proof consultant approved by IRCON.

12.4 Technical Specifications

12.4.1 Reinforced soil backfill

The reinforced soil backfill shall be a select granular fill having high frictional resistance, low compressibility and free draining. Coarse-grained soils with limited fines adequately satisfy these requirements. Thus, the select granular fill shall not contain fines (passing 75 micron sieve) more than 10%. Co-efficient of uniformity (Cu) of the backfill shall be greater 2 and the peak angle of internal friction should be greater than or equal to 30°, however the desired friction angle for the reinforced soil wall is 34°. The plasticity index shall not exceed 6.

The backfill shall also be free from organic or otherwise deleterious materials so as not to cause corrosion of the soil reinforcement and the facia.

Desirable Gradation for Reinforced Soil Fill shall be as given below

Sieve Size	Percentage Finer (in %)
75mm	100
4.75 mm	85 - 100
425 micron	60 - 90
75 micron	< 15

The select backfill shall be compacted to ensure achieving peak angle of friction not lower than 34° as established from test as per Annexure C, BS 8006. For design, effective cohesion of backfill shall be taken as zero.

The compacted layer should not be more than 200mm thick. The compaction of backfill material shall be 95% of maximum dry density obtained from modified Proctor compaction test performed as per IS 2720 (Part-8).

12.4.1.2 Tests for Reinforced and Retained Fill

To ascertain the suitability of the fill, samples should be drawn from the borrow area by drawing a grid of 25 m c/c to full depth, logging and sampling for ascertaining suitability of the borrow material as per MORTH 2013 Specifications. Following tests shall be carried out as per Indian Standards.

1. Sieve Analysis - IS: 2720 Part - 2 tests per 3000 cu.m. of soil
2. Atterberg Limit Tests- IS: 2720 Part- 5-2 tests per 3000 cu.m. of soil
3. Compaction Tests - IS: 2720 relevant part corresponding to modified as well as Standard Proctor test - 2 tests per 3000 cu.m. of soil
4. Direct Shear Tests - IS: 2720 Part 13 & 39 and IS 13326 Part 1 to ascertain the peak angle of shearing resistance. The tests should be done at 95 percent of Modified Proctor Density at -2 percent of OMC at a frequency of 1 per 3000 cu.m. of fill

During construction the quality control should be exercised by conducting one set of density test of 3000 sq.m. of compacted area considering the importance of compaction in reinforced soil walls. (Clause 903.2.2 of MORTH 201 3) One set shall consist of 6 tests.

At the end of each day's operation, the contractor shall shape the last level of backfill as to permit runoff of rainwater away from the structure face.

12.4.2 Reinforcing elements

12.4.2.1 Material Specification

Reinforcing materials shall be made of geosynthetics as per **IS 17372:2020** shall be used for reinforcing the select fill. Geosynthetics in the form of high tenacity high modulus polyester tendons encased within polyethylene sheathing shall be used as reinforcing element. High Adherence Geostrips shall be used in top 3 m of RS Structure to generate superior frictional resistance. In addition, High adherence galvanized steel strips are also permitted to be used as reinforcing element. The selection of suitable reinforcing element shall be approved by the Client.

It is mandatory to comply to the following statements as per RDSO GE 18 Guidelines

“Steel Strips/Geostraps with either ribs or protrusions or with geometry which has high adherence capacity (HA strip / Geostraps) are also used as reinforcing element, especially in top 3 m depth where pull-out is critical”.

High Adherence (HA) Geostraps shall mean that High Adherence (HA) geosynthetic strap soil reinforcement with higher friction coefficients. The high adherence reinforcing elements used in the top 3 m shall must a elongation less than (7%) and shall made from inert material as polyvinyl alcohol (PVA) to provide strong resistance against long term durability damages against biological and chemical agents like oil spills, lubes, night soil and long term leaching of infiltrating salts and adverse chemical agents.

The long-term design strength shall be derived as per guidelines given in ISO TR 20432 for design life of 120 years and should be designed to sustain temperature from sub-zero to 40°C considering following factors.

$T_{allow} = T_{UTS} / RF$

$RF = R_{FCR} \times R_{FID} \times R_{FW} \times R_{FCH} \times FS$

T_{allow} = Allowable tensile strength

T_{UTS} = Ultimate tensile strength (95 % confidence limit)

RF = Reduction factor

R_{FCR} = Reduction factor for creep

R_{FID} = Reduction factor for the effect of installation damage

R_{FW} = Reduction factor for weathering

R_{FCH} = Reduction factor environmental degradation (chemical and biological) at the service temperature

FS = Reduction factor related to the mass of information available and to the production quality

Use of default reduction factors mentioned in codes like FHWA or MoRTH shall not be permitted. The adoption of reduction factors should be strictly based on reliable test data and performance data available with the manufacturer from accredited independent agency or the manufacturer should provide a valid third party accredited certification from BBA (British Board of Agreement) certifying the Reduction Factor (RF) value for their geostrip for temperature range of 0°C - 40°C and design life of 120 years. Manufacturer should have creep test data from independent accredited laboratory for period over 10 years at temperature range of 0°C - 40°C.

12.4.2.1.1 Geosynthetic

The material factors as per the specified design life of reinforced soil wall structure and design temperature for the project, shall be used to determine the long term strength of the geosynthetic reinforcement for design of reinforced soil wall structure. The design life shall be 120 years. The agency should provide independently certified partial material factors to be considered in the design

of RS Wall for the geosynthetic reinforcement for design temperature and design life of reinforced soil wall structure.

All quantity control strength of geosynthetics must represent minimum average roll values (MARV) corresponding to 95% confidence limit. Testing of geosynthetic for tensile strength shall be performed in accordance with ISO 10319 for every 20000 linear m of geostrips and test data for each lot of material shall accompany shipments.

The geosynthetic strap shall be made from high molecular weight and high tenacity polyester (PET) yarns. The reinforcing elements to be used for the project shall be manufactured at ISO 9001 –2015 and ISO 45001 : 2018 certified production facility only and the system provider should also be ISO 9001:2001 certified. The polyester used for manufacturing geostrips should satisfy the following requirements:

Minimum molecular weight no. > 25000

Maximum carboxyl end group no. (CEG) < 30

Geosynthetic straps shall be provided with a protective LLDPE coating to maximize the resistance to hydrolysis and enhance durability and increase survivability during construction and in service.

12.4.2.1.2 Connection:

The connection between the reinforcing element and fascia shall be as per RDSO GE 18 Guidelines and suitable for seismic Zone IV & above. The connection system shall be such that the force transfer mechanism between the connector (embedded in facing) and main reinforcement shall be through positive mechanical connection, such that it is low strain with an end-bearing connection device. At ultimate failure either the connection device or soil reinforcement shall yield without any possibility of slippage. No friction-based connection system shall be used. All panels in the top two meters shall be connected with main or secondary reinforcement to cater to impact loading.

Steel mechanical connectors must be used to connect the soil reinforcing strap to the soil nail comprising of either loops or hooks having rotational flexibility in both horizontal and vertical planes for 100% load transfer from the soil reinforcing strap to the soil nail.

The steel elements used for connection system must be galvanized with minimum 500 gms / sqm.

The minimum connection strength between the fascia system, connection elements and the straps shall be such to enable transfer of load from fascia to reinforcement. This shall be certified from an accredited International or NABL laboratory and can be substantiated at site if required.

It is once again reiterated that the connection strength and layout once used in design calculations, shall not be changed during execution, unless approved by the Client. The method statement for construction of fascia shall be approved by the Client. Designers and construction personnel should note that, several failures have occurred due to improper connections and deviation from the connections proposed in the approved designs.

In addition, the method of construction shall have quality assurance plan and tolerances as specified by Clause 3106.6 of MORTH 2013 Specifications.

The RS Wall system may be accepted by the Client if it has certification for material (mainly reinforcement) and connection strength, from accredited laboratories referred in IRC:113-2013 and Table 3, IRC: SP:102.

12.4.2.2 Handling and storage of reinforcing elements

1. Reinforcing elements shall not be subjected to rough handling, shock loading or dropping from a height.
2. Reinforcing elements shall be stored in such a manner to eliminate the possibility of any damage and shall be clearly labelled to identify items with different dimensions and properties.
3. Nylon, rope or padded slings shall be used for lifting galvanized reinforcing elements; bundles of reinforcement shall be lifted with a strong back or with multiple supports to prevent abrasion or excessive bending.
4. Polymeric reinforcing elements shall be properly stored and protected from precipitation, extended ultraviolet radiation, direct sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperature in excess of 50°C, and any other environmental condition that may damage the physical property values.

12.4.2.3 Tests for reinforcements

Tests should include Tensile tests, (Stress strain graph), creep test results, tests to determine resistance to mechanical and environmental damage, raw material used and other properties characterizing the reinforcement e.g. Aperture size, wt./sq.m. etc.

The tests performed to evaluate the in-situ/life time performance like resistance to installation damage, environmental damage, creep, type of raw material, carboxyl end group and molecular weight, should also be provided by the supplier. Creep test results for 0°, 20°, 30° and 40°C should be provided. The testing should also include tests to evaluate block to block and block to reinforcement testing as specified by ASTM tests. The supplier should also clearly indicate the methodology of identifying the reinforcement vis-a-vis its strength in the field.

12.4.3 Facia units

The facia units, which help maintain a near vertical face of the reinforced soil structure, avoid erosion of the fill and provide aesthetic appearance to the reinforced soil, shall be the following:

- a) Galvanized welded mesh panel of minimum 8 mm dia. steel bars with coir non-woven geotextile. The bars shall be fusion welded at junctions. The galvanization shall not be less than 610 grams/ sqm on the surface of the steel bars and shall demonstrate durability and design life of 120 years. The maximum Aperture size of welded mesh panel shall be 100mm x 100mm.

The type and shape of the fascia units to be finally adopted shall be subject to approval by the IRCON.

The RS Wall system may be accepted by the Client if it has certification for material (mainly reinforcement) and connection strength, from accredited laboratories referred in IRC:113-2013 and Table 3, IRC:SP:102.

12.4.3.1 Wire Material

Tensile strength:

The wire used for the manufacture of Mesh shall have a tensile strength minimum 350 N/mm² in accordance with IS 280. Wire tolerances (Table 1) shall be in accordance with IS 16014:2018 (Class T1).

Elongation:

Elongation shall not be less than 10%, in accordance with IS 16014:2018 and MoRTH(Fifth Revision) Clause 3100. Test must be carried out on a sample at least 20 cm long.

Metallic Coating:

The wire shall have minimum quantities of Zn alloy shown at Table 1 in accordance with IS 4826:1979. The adhesion of the metallic coating to the wire shall be such that, when the wire is wrapped ten turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers in accordance with IS 4826:1979.

The coating shall ensure safety against deterioration for design life of 120 years.

Origin of ore for manufacturing welded wire grid:

The wire used for manufacturing the welded wire grid shall be produced from virgin ore which has very few impurities and steel shall be silicon kilned. Aluminium kilned steel which has low silicon content shall not be allowed for manufacturing which can lead to poor adhesion of Zinc to the steel.

12.4.3.2 Fill material in face of construction

For slope angle > 70 Deg. with horizontal, dressed boulders of Size 125mm to 200mm shall be used in fascia.

12.4.4 Soil Nail/Self Drilling Anchors

12.4.4.1 Material specification

Soil nails or self-drilling anchors must be designed for mechanically connecting the soil reinforcement to form composite or hybrid structure in case of non-availability of adequate space behind fascia for providing reinforcement. The grout shall be made of OPC grade 53 with suitable

admixtures. The soil nail/SDA, nuts, bearing plates and couplers shall be galvanised and epoxy coated (combi coat corrosion protection).

Load transfer mechanism between the soil reinforcing geostrip and soil nail shall be direct and mechanical, comprising of either loops or hooks with rotational flexibility in both horizontal and vertical planes for 100% load transfer from the geostrip to the soil nail.

Drilling shall be carried out by suitable equipment. The soil nail/SDA shall be made of yield strength of min. 670 N/mm². The soil nail/SDA rod shall be continuously threaded. For convenience of installation, appropriate arrangement (coupler) shall be made to connect two smaller lengths of soil nail/SDA to achieve the required length.

Length of Soil Nails or SDA Anchor shall be validated on the basis of actual pull out strength obtained at site.

12.4.4.2 Installation guideline

- 1) The soil nail/SDA is driven in the required position with help of sacrificial drill bit at the bottom of the anchor bar which facilitates in drilling the hole. The diameter, length and spacing of soil nail/SDA shall be as specified. Additional/reduced length or spacing of anchoring/nailing shall be carried out as per site condition and as directed by the Client.
- 2) The grout is pumped through the hollow bar during the drilling process. Grouting shall be done by using OPC grade 53 along with addition of suitable admixture. Mixing shall be done along with potable water so as to form the cementitious paste.
- 3) The base plates of size 200mm x200mm x 8 mm shall be placed at slope surface for tightening the nuts.
- 4) The fascia (if applicable) shall be installed in front and connected to the steel rods with base plate and nuts.

Further specifications on soil nails and rock bolts refer to Chapter 9.

12.4.5 Drainage Layer

12.4.5.1 Material Specification

The drainage provision shall be strictly followed as per the approved working drawing. The retained fill shall have a suitably designed drainage bay and associated drainage system to allow for free drainage of the reinforced fill. The minimum drainage gallery width just behind the facing units shall be 600mm with well – graded crushed aggregate (materials of 19.5mm to 9.1mm size as per IS: 383). The desirable gradation of the aggregate used in the drainage layer is indicated in the table below. Besides meeting gradation requirements, it should be ensured that the aggregates are not friable, flaky, elongated and are sound in strength. Relevant tests as per MORTH 2013 specifications may be used to judge the suitability of the material used in the drainage layer.

Sieve Opening, mm Percentage Finer

37.50 90-100

20.00 80-100

12.50 0-20

Alternatively, geo composite conforming to IRC 34:2011 which ensure adequate drainage may be provided. Specifications for Geo-composite should be as recommended in MORTH Specifications 2013 Tables 700-9 and 700-10.

The main collection drain pipe just behind the precast facing, if used, shall be a minimum of 150 mm in diameter. The secondary collection drainage pipes should be sloped a minimum of two percent to provide gravity flow into the main collection drainpipe. Drainage laterals shall be spaced at a maximum 15 meters spacing along the wall face. The drainage collection pipe shall be a perforated or slotted, PVC or corrugated HDPE pipe. The drainage pipes shall be wrapped with geotextile.

12.4.6 Geotextile Type III as filter media behind RS Wall and around perforated pipes

Geotextile Type III shall be as per MoRTH (Fifth Revision) Clause 700.

The nonwoven needle punched, or any equivalent geotextile shall be used. The geotextile shall be made of 100% Polypropylene manufactured through machine made process of needle punching techniques. The mean Values of Geotextile shall be as shown in table below, referred from Table 700-1 and 700-3 in MoRTH Clause 702.

PROPERTIES:	Mean Values	Test Method
Mechanical:		
Tensile Strength	7 kN/m	ASTM 4595
Elongation at maximum load	> 50 %	ASTM 4595
Grab Tensile Strength	500 N	ASTM D4632
Grab Elongation	>55 %	ASTM D4632
Trapezoidal Tear Strength	180 N	ASTM D4533
CBR Puncture Strength	1200 N	ASTM D6241
Mullen Burst Strength	950 N	ASTM D3786
Hydraulic:		
Apparent Opening Size, AOS90	120 micron	ASTM D4751
Permittivity	0.5 Sec-1	ASTM D 4491
Physical:		
Mass per Unit Area	150 g/sq.m	ASTM D5261

12.4.7 Geosynthetic Clay Liner (GCL)

The berms, if any, in the Reinforced Soil Wall, slope shall be covered with one layer of Geosynthetic Clay Liner and 100 mm thick Plain Cement Concrete (PCC) of M-15 grade to mitigate ingress of any water into the subsequent tier of Reinforced Soil Wall/ slope. Provision for drainage on the berms shall also be provided.

The specification of GCL shall be as under:

SPECIFICATION FOR GEOSYNTHETIC CLAY LINER			
MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY (ft²/m²)	REQUIRED VALUES
Bentonite Swell Index ¹	ASTM D 5890	1 per 50 tonnes	24 mL/2g min
Bentonite Fluid Loss¹	ASTM D 5891	1 per 50 tonnes	18 mL max
Bentonite Mass/Area ²	ASTM D 5993	40,000ft ² (4,000m ³)	0.75 lb/ft ² (3.6kg/m ²)min
GCL Tensile Strength³	ASTM D 6768	200,000ft²(20,000m²)	30lb/in(53N/cm)MARV
GCL Peel Strength ³	ASTM D 6496	40,000ft ² (4,000m ²)	1 lb/in (1.75 N/cm) min
GCL Index Flux⁴	ASTM D 5887	Weekly	1x 10⁸ m³/m²/sec max
GCL Hydraulic Conductivity ⁴	ASTM D 5887	Weekly	5x10 ⁹ cm/sec max
GCL Hydrated Internal Shear Strength³	ASTM D 5321 ASTM D 6243	Periodic	150 psf (7.2kPa) typical

12.5 CONSTRUCTION REQUIREMENTS

The construction of Reinforced Soil Structures shall be carried out in accordance with the specifications and in conformity with the lines, grades, design and dimensions shown on the approved drawings.

12.5.1 Excavation

The plan area of the of Reinforced Soil Structures shall be excavated in accordance with the requirements of General and Special Specifications and in reasonably close conformity to the limits and to the lines and grades during construction stages as shown on the approved drawings. The contractor shall take precautions to minimise over- excavation. Excavation support, if required shall be designed by the Contractor.

12.5.2 Foundation preparation

The foundation for Reinforced Soil Structures shall be graded level for width equal to or exceeding the length of reinforcing geosynthetics. Prior to wall construction, the foundation shall be compacted with a smooth wheeled roller. The depth of foundation below the finished ground level shall not be less than as specified in BS 8006.2010 or 1 m whichever is greater.

12.5.3 Ground improvement

Where foundation soil is found to be unsuitable, either removal and replacement technique or ground improvement is required to be carried out, as required by the Client. The need for ground improvement, design and ground improvement methodology shall be verified and approved by the Client prior to construction.

Suitable ground improvement technique shall be identified based on the results of subsoil exploration. Foundation preparatory works and foundation treatment/ improvement shall be treated as integral part of the reinforced soil structure and accordingly Contractor shall arrange for detailed sub-soil investigation works and employ his resources to design and construct the foundation/ ground improvement treatment, wherever necessary to satisfy the requirements of reinforced soil structure. The design check and validation for foundation treatment/ ground improvement and the methodology shall be verified and approved by the Client prior to construction.

12.5.4 Levelling concrete

A levelling concrete pad shall be provided under the reinforced soil structures. Concrete shall have a minimum grade M-15. Maximum size of aggregates shall be 20 mm and the pad shall be cured for at least 48 hours before placement of fascia elements

12.5.5 Erection

Reinforcing elements shall be installed at the proper elevation and orientation as shown in approved drawings or as directed by the Client. The reinforcement strips shall be placed normal to the face of the wall unless otherwise shown on the drawings.

12.5.5.1 Facia Elements

Prior to installing the assembled facia units, the foundation on which these units are to be placed shall be cut or filled and graded to the lines and grades shown on the construction drawings. Surface irregularities, loose material, and vegetation shall be removed during the preparation of the foundation.

The units are carried to their final position and connected with the adjoining empty units along the vertical and top edges of their contact surfaces. Whenever a structure requires more than one layer of units, the upper layer shall be connected to the top of the lower layer along the front and back edges of the contacts.

12.5.5.2 Reinforced soil backfill placement

The reinforcing elements shall be laid free from all kinks, damage and displacement during deposition, spreading, leveling and compaction of the fill. The programme of filling shall be such that no construction plant runs directly on the reinforcement. It shall be ensured that the exposure of soil reinforcement to ultraviolet rays is minimal and should be covered with fill within one day of placement.

During construction, the retained material beyond the reinforcement at the rear of the structure shall be maintained at the same level as reinforced fill. The entire works related to compaction should be carried out generally in a direction parallel to the facing. Fill placement methods near the facing shall ensure that no voids exist below the reinforcing elements.

At the end of each day's operations, the contractor shall shape the last level of backfill as to permit run-off rainwater away from the wall face.

12.5.5.3 Drainage material placement

Drainage material shall be placed to finished thickness and widths shown on the construction plans or as modified by the Client. During placement and compaction of drainage material, care must be taken to ensure that there is no contamination with undesirable materials. Vertical layers of drainage material shall be brought up at the same level as the adjoining fill material.

Drainage collection pipes shall be installed to maintain gravity flow of water outside of the reinforced soil zone. The drainage collection pipe should discharge into a storm sewer, manhole or along a slope at an elevation lower than the lowest point of the pipe within the aggregate drain.

More efficient drainage system, if possible, may be suggested by the proprietary Supplier/ Contractor for the review and approval of Client.

12.6 INSPECTION

Client and/or the representative shall verify the materials supplied and quality of work to ensure that all the requirements of the specifications are satisfactorily met with. This includes all submittals and proper installation of the system.

The reinforced soil structure system supplier shall provide one qualified and experienced representative at site on full time basis during the entire working phase to ensure that the quality of the works performed by the Contractor is in accordance with the specifications and to assist the Contractor regarding proper wall installation.

The Contractor's field construction supervisor shall have demonstrated experience and should be qualified to direct all work at the site. All expenses relating to this presence on site shall be deemed to have been included in the rate and no extra claim on this account shall be admissible.

12.7 QUALITY CONTROL AND TESTING OF MATERIALS

- a. The system provider should provide the following test certificates: -
- i. Manufactures test certificate for tensile strength, yield strength, elongation and galvanization of the reinforcement materials are to be supplied. The different geosynthetic reinforcement-soil interaction parameters under pull-out are to be supported by suitable experimental results. The various reduction factors for creep, construction induced damage, chemical and biological degradation of polymeric reinforcement elements, should be supported by manufacturers certification/accredited laboratories.
 - ii. Thirds party test report from any NABCB (National Accreditation Board for Certification Bodies) or NBAL accredited laboratories or agencies mentioned in Annexure 2 of IRC 113-2013 or reputed academic institutes like IITs or NITs are to be supplied. The steel and the galvanization shall be independently checked by any NBAL accredited laboratories or a global testing authority like TUV, Bureau Veritas (BV) or Societe Generale de Surveillance (SGS).

Any other Testing if required shall also be done if stated elsewhere in this specification on all materials required for reinforced soil structure construction. The tests shall be done from a reputed independent agency or at the manufacturer's facility under the presence of the Client or his representative as and when required. All tests and testing certificates shall be submitted to the Client at least 7 working days prior to use of any material. Tests on materials before and during construction shall not be limited to the following types.

12.7.1 Reinforcing elements & Facia elements:

Tensile strength certificate from the supplier for each lot.

Testing at manufacturer's facility witnessed by Client's representative to verify the test results.

Determination of interaction coefficients by shear box test, maximum once in a project, if the values used in design are not as per the codes of practices or as specified by certified body, otherwise at owners' costs.

The following particulars of the proposed geosynthetic reinforcing elements and connections shall be submitted to the Client:

- o Literature on the proposed reinforcing element and connection.
- o Copies of valid quality assurance certificate such as ISO 9001 or equivalent certifying the quality system for the manufacturing of the reinforcing elements.
- o A certificate showing the manufacturer's name, the date and place of manufacture and showing that the reinforcing element complies with the requirements stated in the contract and including the results of tests specified in the contract or as specified by the Client.

Samples of the reinforcing elements and connections shall be submitted to the Client at the same time as particulars of the material are submitted.

Galvanization for wire mesh/facia panels - The steel shall be manufactured from virgin ore which has very few impurities and steel shall be silicon kilned. Aluminium kilned steel which has low silicon content shall not be allowed for manufacturing which can lead to poor adhesion of Zinc to the steel.

12.7.2 Fill material

At source approval, the borrow area shall be divided into grid of 25m c/c (or closer if variability is high) as per Clause. No. 903.2 of MORT&H specifications and trial pit shall be taken to full depth in each grid. These trial pits should be logged and plotted for proper identification of suitable source of fill material. Following tests on representative samples shall be carried out:

- o Grain size analysis - 2 tests per 3000 cu.m of fill.
- o Plasticity test – 2 tests per 3000 cu.m of fill
- o Shear test for ϕ_{Peak} as per Appendix C of BS 8006 – one test for every 3000 cu.m of fill material.
- o Modified Procter test as per IS:2720 (Part-8) – 2 tests per 3000 cu.m of fill material.
- o Electrochemical properties of soil if steel reinforcing elements are used – 1 test per 3000 cu.m of fill material.
- During construction:
 - o Grain size analysis for every 3000 cu.m of fill
 - o Shear test for ϕ_{Peak} as per Appendix C of BS:8006 for every 10,000 cu.m of fill if the grain size analysis matches with the tests that were carried out during source approval or else one test per 3000 cu.m of fill material.
 - o Modified Procter test as per IS:2720 (Part-8) – 2 tests per 10,000 cu.m of fill material if the grain size analysis matches with the tests that were carried out during source approval or else two test per 3000 cu.m of fill material.
 - o Electrochemical properties of soil if steel reinforcing elements are used – 1 test per 10000 cu.m of fill matieral.
 - o Density of each compacted layer (>95% of MDD) at frequency as per clause 903.2.2 – one set of 10 tests in every 500 sq.m.
- The following particulars of the proposed fill material shall be submitted to the Client for approval:
 - o Statement identifying each source of supply and showing that sufficient suitable material is available for the works.
 - o For material from borrow areas, a plan showing the location and extent of each proposed borrow area, and the location, depth and test results for each sample obtained.

- o Certificates from a laboratory approved by the Client which show that each material proposed for use complies with the requirements of the Contract and has been tested in accordance with the appropriate test methods given in this Specification.

On receipt of the above particulars, the Client may require the Contractor to carry out additional sampling and testing to demonstrate that the properties of the proposed sources of fill will meet the requirements of the Contract.

SEVOK-RANGPO RAIL LINE PROJECT

TECHNICAL SPECIFICATIONS

CONSTRUCTION OF MELLI YARD

Bridge Sub Structure

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1-General

These specifications for certain items contained herein are the Employer's minimum and specific requirements. These specifications are based on the provisions of various Codes and Employer's Requirements for the Works required to be undertaken by the Contractor under this Contract and for better understanding of the Contractor. However for details, the respective Codes shall be referred to. The order of precedence for various Codes has been specified in Clause 2.2 of these specifications.

Any modification / change in arriving at Specifications from the minimum specifications defined in this document shall not constitute a Variation

The Contractor shall also develop Method Statements and Test Procedures / Work Procedures / Plans and Manuals / Construction Drawings / Sketches etc. for all the items of Work, based on the Specifications, applicable Codes & Standards, best Engineering practices etc. and shall submit to the Engineer for his consent.

2 Standards

2.1 Introduction

The Materials and workmanship specification as follows has been based on Indian Standards and International Standards as scheduled below. Apart from the basic data, specifications etc. all items of works shall be governed by the Codes & Specifications as detailed hereunder and as revised / corrected / amended up to 28 days before the due date of submission of the Bid Proposal.

The Contractor will be responsible for detailing in his specification of the standards on which his materials and workmanship will be based, and these will be of similar or higher standard than those listed below.

The Contractor shall also be responsible for getting the approval from Engineer for the International Standards which are not specifically included herein below and the Contractor intends to apply the same for the detailing of his specification, additionally. The Contractor is required to review in the first instance the relevant Indian Standards and other Standards / Codes as mentioned. The specifications will be primarily based on the said standards to the extent that they are applicable. However in case the Contractor intends to use any other International Standards, he should indicate the same in his proposal for consideration of the Employer. Usage of the same shall be subject to approval of the Engineer

2.2 Relevant Standards

Apart from the basic data, Specifications and specific requirements listed in the Bid document, all items of works shall be governed by the latest versions of the following Codes, Specifications as revised/corrected/amended (with latest correction slip) up to the time of bidding. In case of any contradiction in various codal provisions, the order of precedence shall be as follows

a) Technical Specifications (Bid Documents)

b) IRS Codal provisions

c) IRC Codal Provisions

-
- d) IS Codal Provisions
 - e) Provisions in other International Codes

Notwithstanding the precedence specified above, the Contractor shall always seek advice from the Engineer and Employer in the event of any conflict, immediately for a final decision.

Relevant standards are scheduled as below:

2.2.1 Indian Railway Standard Codes and Specifications (IRS)

- (1) Indian Railway Bridges Rules, specifying the loads for Design of Superstructure and Substructure of Bridges (with up to date correction slip) including Chapter – VII for the rule for the opening of Railway adopted in 1941 – Revised – August 1982.
- (2) Loading Standards as given in Design Criteria
- (3) Indian Railway Schedule of Dimensions for Broad Gauge
- (4) Indian Railway Code for Practice of Plain/Reinforced and Pre-stressed concrete for general / bridge construction (Concreted Bridge Code) Second Revision 1997 with correction slip up-to-date.
- (5) IRS Specifications for Steel Bridges Code
- (6) IRS : Welded Bridge Code for steel bridge girders
- (7) Indian Railway Bridge Manual 1998 with correction slip up-to-date
- (8) Indian Railways Permanent Way Manual.
- (9) Indian Railways Works Manual.
- (10) IRS Standard Code of Practice for design of Sub-structure & Foundation.
- (11) IRS: Manual on the design and construction of well and pile foundation.
- (12) Guidelines for Earthwork in Railway Projects: Guideline No. GE: G-1, July, 2003.
- (13) Guidelines on Erosion Control and drainage of Railway Formation - Guideline No.GE: G-4
- (14) Report No. RDSO/2007/GE: 0011: Guidelines for blanket layer provision on track formation with emphasis on heavy axle load train operation.
- (15) Guidelines and Specifications for Design of Formation for Heavy Axle Load – Report No. RDSO / 2007 / GE : 14
- (16) Report No. GE:R-50: Transitional System on approaches of bridges issued by RDSO.
- (17) RDSO Specification No. GE: IRS-2 (Final): Specification for mechanically produced blanketing material for railway formation including guidelines for laying.
- (18) Indian Railway – Engineering Code.
- (19) Indian Railway Manual for Long Welded Rails
- (20) IR Manual for Flash Butt Welding of Rails

- (21) IR Standard Specification for Fusion of Welding of Rails by Alumino Thermit Welding Process 2006.
- (22) IRS T 29-2000 Cast Manganese Steel Crossings
- (23) IRS T 39-1985 Prestressed Concrete Sleepers
- (24) IRS GE: 1 June 2004 Ballast specification
- (25) IRS T 1966 Fish Plates and Fish Bolts
- (26) IRS Fabrication and Erection of Steel Girder Bridges & Locomotive Turn Tables (BI-1979)
- (27) RDSO/M&C/RP-194/94 – Wiper seal & dust seal.
- (28) IRS: T-12 2009 Rail Specifications
- (29) Indian Railways Manual for Ultrasonic Testing of Rails and Welds – 2006 (with latest Correction Slips)

2.2.2 Indian Road Congress (IRC) Codes and Specifications

- (1) IRC: 5 Standard Specifications and Codes of Practice for Road Bridges Section – I – General features of design.
- (2) IRC: 6 Standard Specifications and Codes of Practice for Road Bridges – Section – II – Loads and Stresses – Seismic provisions of this standard are to be adopted for the bridge design.
- (3) IRC:18 Design Criteria for Pre-stress Concrete Road Bridges (Post-tensioned concrete).
- (4) IRC : 21 Standard Specifications and Codes of Practice for Road Bridges – Section – III – Cement concrete (Plain & reinforced)
- (5) IRC : 22 Standard Specifications and Codes of Practice for Road Bridges – Section – VI – Composite Construction.
- (6) IRC:24 Standard Specifications and Codes of Practice for Road Bridges – Section V, Steel Road Bridges
- (7) IRC : 54 – 1974 – Lateral and Vertical Clearances for Vehicular Traffic
- (8) IRC : 83 (Part – III) - Standard Specifications and Codes of Practice for Road Bridges– Section – IX – Bearings Part –III, Pot, POT cum PTFE Pin and Metallic Guide Bearings
- (9) IRC-78:Sub-structure for Road Bridges.
- (10) IRC-87:Design and erection of false work for road bridges.
- (11) Specifications for Road and Bridge Works issued by Ministry of Road Transport & Highways. (MORTH).
- (12) SP 6, 7, 16, 21, 22, 23, 24, 34, 36, 52, 60, 70.

2.2.3 Indian Standard Specifications

- (1) IS : 975 (all 5 parts) – Design loads (other than earthquakes) for buildings and structures.

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- (2) IS : 456 Plain and reinforced concrete.
 - (3) IS: 269 Indian Standard Specifications for Ordinary & Low Heat Portland Cement.
 - (4) IS : 8112 43 Grade OPC
 - (5) IS : 383 Coarse and fine aggregate from natural sources for concrete.
 - (6) IS : 2386 (all 8 parts) – Tests for aggregates for concrete
 - (7) IS : 3025 (all 49 parts) – Methods of sampling and test for water and waste water.
 - (8) IS : 3085 Method of test for permeability of cement mortar and concrete.
 - (9) IS:1199 Indian Standard Specifications for Method of Sampling and analysis of concrete.
 - (10) IS :7320 Concrete slump test apparatus.
 - (11) IS : 5515 Compaction factor apparatus.
 - (12) IS : 1791 Batch type concrete mixers.
 - (13) IS : 4634 Methods of testing performance of batch type concrete mixers.
 - (14) IS: 2722 Indian Standard Specifications for Portable Swing Weight batches for concrete (Single and Double Bucket type)
 - (15) IS : 6925 Methods of test for determination of water soluble chlorides in concrete admixtures.
 - (16) IS : 9103 Admixtures for concrete.
 - (17) IS : 516 Method of test for strength of concrete.
 - (18) IS : 4031 (all 15 parts) – Physical tests for hydraulic cement.
 - (19) IS : 5513 Vicat apparatus.
 - (20) IS : 10080 Vibration machine for casting standard cement mortar cubes.
 - (21) IS : 10262 Concrete mix design.
 - (22) IS: 4926 Indian Standard Specifications for Ready Mixed Concrete.
 - (23) IS : 1892 Subsurface investigations.
 - (24) IS : 2720 (all 41 parts) – method of tests for soil.
 - (25) IS : 2132 Thin walled tube sampling of soils.
 - (26) IS : 2131 Standard penetration test for soils.
 - (27) IS : 2911 (Part I to IV) - Code of practice for design and construction of pile Foundations
 - (28) IS: 1893-2002 Criteria for Earthquake Resistance Design of Structures

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- (29) IS: 4326 Earthquake Resistance Design and Construction of Building – Code of Practice
- (30) IS : 13920 Ductile detailing of reinforced concrete structures subjected to seismic forces
- (31) IS : 5624 Foundation bolts
- (32) IS : 3955 Design and construction of well foundations.
- (33) IS: 875 (Part 3) – 1987 – Code of Practice for Design Loads (Other than Earthquakes) for Buildings and Structures – Wind Loads (Second Revision)
- (34) IS: 1786-1985-High Strength Deformed Steel Bars & Wires for Concrete Reinforcement (Third Revision).
- (35) IS: 432 (Part-I & Part-II) – 1982 – Mild Steel, Medium Tensile Steel Bars and Hard Drawn.
- (36) IS: 280 Mild steel wire for general purposes.
- (37) IS: 2502 Code of practice for bending and fixing of Bars for concrete reinforcement.
- (38) IS: 1343 Prestressed concrete.
- (39) IS: 14268 Prestressing Strands.
- (40) IS: 4082 Recommendations of stacking and storage of construction materials at site.
- (41) IS: 800 General construction in steel.
- (42) IS: 2062-1992-Steel for General Structural Purposes – Specifications (Fourth Revision)
- (43) IS: 1261 – 1959 – Seam Welding in Mild Steel (Reaffirmed 1998)
- (44) IS: 1367 – Technical Supply conditions for Threaded steel fasteners.
- (45) IS: 3502:1994-Steel Chequered Plates – Specifications (Second Revision)
- (46) IS: 7215 – 1974 – Tolerances for Fabrication of Steel Structures (Reaffirmed 1995, Sixth Reprint July, 1997)
- (47) IS: 816 Metal arc welding for general construction in mild steel.
- (48) IS: 819 Resistance spot welding for light assemblies in mild steel.
- (49) IS: 814-1991-Covered Electrodes for Manual Metal Arc Welding (Fifth Revision)
- (50) IS: 1323 – 1982-Oxy-acetylene Welding for Structural Work in Mild Steel (Second Revision)
- (51) IS: 1161 – 1998 – Steel Tubes for Structural Purposes – Specifications (Fourth Revisions)
- (52) IS: 8629 (Parts I to III) – 1977 – Protection of Iron and Steel Structures from Atmospheric Corrosion (Reaffirmed 2002).

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- (53) IS: 3757 – 1985 – High Strength Bolts.
 - (54) IS: 6623 – 1985 - High Strength Nuts.
 - (55) IS: 6911 – Stainless Steel.
 - (56) IS: 1363 (all 3 parts) – Hexagon head bolts, screws and nuts of product grade C.
 - (57) IS: 6639 Hexagonal bolts for steel structures.
 - (58) IS: 102 Ready mixed paints, brushing, red lead, non-settling priming.
 - (59) IS: 123 Ready mixed paints, brushing, finishing, semi-gloss, for general purposes to Indian
 - (60) IS: 104 Ready mixed paint, brushing, zinc chrome, priming.
 - (61) IS: 2074 Ready mixed paint, air drying, red oxide-zinc chrome.
 - (62) IS: 34 White lead for paints.
 - (63) IS: 2339 Aluminum paints for general purposes, in dual container.
 - (64) IS: 2751 Code of Practice for Welding of Mild Steel Bars used for reinforced concrete construction.
 - (65) IS: 3400 (all 22 parts) – Methods of tests for vulcanized rubbers.
 - (66) SP 70: 2001 Handbook on construction safety practices.
 - (67) IS: 3764 Safety code for excavation work.
 - (68) IS: 4081 Safety code for blasting and related drilling operations.
 - (69) IS: 7293 Safety code for working with construction machinery.
 - (70) IS: 7205-1974-Safety Code for erection of Structural Steel Work (Fifth Reprint July, 2001).
 - (71) SP 22 (S&T): 1992 Explanatory Hand Book on codes for Earth Quake Engineering.
 - (72) IS: 3696:1987 (Part – I & Part-II)) Safety code for scaffolds and Ladders.
 - (73) IS: 3016 :1965 Code of practice for Fire precaution in welding and cutting operations.
 - (74) IS: 14881:2001Method for Blast Vibration Monitoring – Guidelines.
 - (75) IS: 1852 Rolling and cutting tolerances for hot rolled steel products.
 - (76) IS: 817 Training and testing of metal arc welders.
 - (77) IS: 1270 Metric steel tape measure.
 - (78) IS: 1200 (all relevant parts) – Method of measurement of building and civil Engineering works.
 - (79) IS: 786 Conversion factors and conversion tables.
 - (80) IS: 8500-1991 Structural steel – Micro alloyed (Medium and high strength qualities – specification (first Revision)

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- (81) IS: 1024-1999 Use of Welding in Bridges and Structures subject to Dynamic Loading – code of Practice – Second Revision (Reaffirmed 1998)
- (82) IS: 9595-1996 Metal Arc welding of Carbon and Carbon Manganese Steels – Recommendations (First Revision)
- (83) IS: 1148-1982 Specification for hot rolled rivet bars (upto 40mm dia) for structural purposes (third revisions)
- (84) IS: 1149-1982 High tensile steel rivet bars for structural purposes (third revision) (85) IS: 1030 Grade 280-520W- Cast Steel
- (86) IS: 1929 Hot forged steel rivets for hot closing (12 to 36 mm dia)
- (87) IS: 57 Red lead for paints and other purposes
- (88) IS: 75 Linseed oil, raw and refined
- (89) IS: 77 Linseed oil, boiled for paints
- (90) IS: 1182 Radiographic examination of butt joints in steel plates
- (91) IS: 2595 Radiographic testing
- (92) IS: 487 Brush, paint and varnish
- (93) IS: 1915 Steel bridge code
- (94) IS: 6586 Metal spraying for protection of iron steel
- (95) IS: 5666 Etch primer
- (96) IS: 887 Animal tallow
- (97) IS: 816 Metal arc welding for general construction in mild steel
- (98) IS: 1024 Welding in bridges and structures subject to dynamic loading
- (99) IS: 1493 Design of Bored and Cast in Situ Piles Founded in Rock.- Guide lines
- (100) IS: 1785 Part 1 High Tensile Steel Wire
- (101) IS: 1080-1985 Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
- (102) IS: 1498-1970 Classification and identification of soils for general engineering purposes
- (103) IS: 1725-1982 Specification for soil based blocks used in general building construction
- (104) IS: 1888-1982 Method of Load Test on Soils
- (105) IS: 1904-1986 Code of practice for design and construction of foundations in soils: General Requirements
- (106) IS: 2809-1972 Glossary of Terms and Symbols Relating to Soil Engineering

(107) IS: 2810-1979 Glossary of terms relating to soil dynamics

(108) IS: 2974-1982 Part I : Code of Practice for Design and Construction of Machine Foundations - Part I : Foundation for Reciprocating Type Machines

(109) IS: 4091-1979 Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles

2.2.4 Other International Codes

(1) En 1990-2002 (Eurocode – Basis of Structural Design) – (For Safety, comfort deformation including twist and deflection

(2) EN 1991-2-2003 (Eurocode 1 – Action on Structures, part 2 – Traffic Loads on Bridges)-(Natural frequency range and Loading for fatigue estimation)

(3) EN 1992 – 1:2004 (Eurocode 2 – Design of Concrete Structures, Part – 1 – General Rules and Rules for Buildings

(4) EN 1992 – 1-1:2004 (Eurocode 3 – Design of Steel Structures, Part 1 – 1 -1 General Rules) – (Classification of cross sections).

(5) EN 1993 – 1-8:2002 (Eurocode 3 – Design of Steel Structures, Part 1 – 8 Design of Joints) – (Classification of HSBG Bolts)

(6) EN 1993 – 1-9:2002 (Eurocode 3 – Design of Steel Structures, Part 1 – 9 Fatigue Strength of Steel Structures).

(7) EN 1993 – 2:2004 (Eurocode 3 – Design of Steel Structures, Part 2 – Steel Bridges) - (Requirements for fatigue assessment, Road and Rail Bridges).

(8) EN 1994 – 2:2003 (Eurocode 4 – Design of Composite Steel & Concrete Structures, Part 2 – Rules for Bridges) – (Width of effective flange, shear connectors).

2.2.5 UIC Codes

(1) UIC 774 – 3R –Track Bridge interaction Recommendation for calculation (for Forces due to LWR).

(2) UIC 772R: Bearings of rail bridges

(3) UIC 774-3R Track/Bridge interaction

2.2.6 BS Codes

(1) BS – 3784 Grade “A” Specifications for Polytetrafluoroethylene

(2) BS-5350: Standard Method of test of adhesives, Part C9, Floating roller peeltest.

(3) BS-5400 : Part – 1 General Statement.

(4) BS-5400 : Part – 2 Specifications for loads.

(5) BS-5400: Part – 3 Code of Practice for Steel Bridges.

- (6) BS-5400: Part – 5 Code of Practice for composite Bridges.
- (7) BS-5400 : Part- 9 Bridge Bearings.
- (8) BS-5400: Part-10 Code of Practice for Fatigue.
- (9) BS-1449, 3484, 1134, 5296.

3 Earthworks

3.1 General

This section deals with the Selection of Materials for Earthwork, Execution of Earthwork in excavation and formation, Quality Control of the Earth work, Maintenance of Records and Quality Assurance. In principle the earth work shall be carried out as per the provisions of “Guidelines and Specifications for Design of Formation for Heavy Axle Load, Report No. RDSO / 2007 / GE: 0014 – November 2009) and “Guidelines for Earthwork in Railway Projects, Guideline No. GE: G-1 – July 2003 (with latest amendments)” issued by RDSO/ Lucknow.

4 Material for Structures

4.1 General

Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these Specifications.

If any material, not covered in these Specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements consented by the Engineer.

4.2 Sources of Material

Approval of all sources of material for the Work shall be obtained from the Engineer before their use on the Project.

The Contractor shall notify the Engineer of his proposed sources of materials prior to delivery. If it is found after trial that proposed or previously approved sources of supply do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from the other acceptable sources at his own expense.

4.3 Bricks

Burnt clay bricks shall conform to the requirements of IS: 1077, except that the minimum compressive strength when tested flat shall not be less than 8.4 MPa for individual bricks and 10.5 MPa for average of 5 specimens. They shall be free from cracks and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp corners and emit a clear ringing sound when struck. The size may be according to local practice with a tolerance of ± 5 per cent.

4.4 Stones

Stones shall be of the type specified and consented by Engineer. It shall be hard, sound, free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stone with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water by more than 5 per cent of their dry weight when tested in accordance with IS: 1124.

The length of stones shall not exceed 3 times its height nor shall they be less than twice its height plus one joint. No stone shall be less in width than the height and width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

4.5 Cast Iron

Cast iron shall conform to IS: 210. The grade number of the material shall not be less than 14.

4.6 Cement

4.6.1 Cement to be used in the works shall be any of the following types and with the prior consent of the Engineer :

- (1) Ordinary Portland Cement, 33 Grade, conforming to IS:269.
- (2) Rapid Hardening Portland Cement, conforming to IS:8041.
- (3) Ordinary Portland Cement, 43 Grade, conforming to IS:8112.
- (4) Ordinary Portland Cement, 53 Grade, conforming to IS:12269.
- (5) Sulphate Resistant Portland Cement, conforming to IS:12330.

4.6.2 Cement conforming to IS:269 shall be used only after ensuring that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 500 kg/cum of concrete.

4.6.3 Cement conforming to IS: 8112 and IS: 12269 may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, these cements shall be used with a certain caution as high early strengths of cement in the 1 to 28-day range can be achieved by finer grinding and higher constituent ratio of Tricalcium Silicate and Dicalcium Silicate. In such cements, the further growth of strength beyond say 4 weeks may be much lower than that traditionally expected. Therefore, further strength tests shall be carried out for 56 and 90 days to fine tune the mix design from strength considerations.

4.6.4 Cement conforming to IS: 12330 shall be used when sodium sulphates and magnesium sulphates are present in large enough concentration to be aggressive to concrete. It shall not be used under such conditions where concrete is exposed to risk of excessive chlorides and sulphates attack both. The recommended threshold values as per IS: 456 are sulphates concentration in excess of 0.2 percent in soil substrata or 300 ppm (0.03 per cent) in ground water. Tests to confirm actual values of sulphate concentration are essential when the structure is located near the sea coast, chemical factories, agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS:12330 shall be carefully selected from strength

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- considerations to ensure that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 500 kg/cum of concrete,
- 4.6.5 Cement conforming to IS: 8041 shall be used only for precast concrete products with prior consent of the Engineer.
- 4.6.6 Ordinary Portland Cement, not less than 53 Grade, conforming to IS:12269 / IRS T 40 shall be used for pre-stressed concrete works
- 4.6.7 Total chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride (SO_3) shall in no case exceed 2.5 per cent and 3.0 percent when tri-calcium aluminate per cent by mass is up to 5 or greater than 5 respectively.
- 4.6.8 Use of Fly Ash as shall not be permitted
- 4.6.9 Cement is included in concrete, hence no additional measurement of cement shall be required as this is payable under the item concrete as per BoQ items.
- 4.6.10 Cement quantity shall be as per Mix Design, however, minimum quantity mentioned in BoQ shall be used in case mix design result shows less than the quantity mentioned in BoQ or Quantity considered for rate analysis or the quantity mentioned in USSOR-2010 for particular grade of Concrete.
- 4.6.11 Variation of cement content for special cases may be agreed on site between the engineer and the Contractor. The cement content shall be designed to meet the strength requirement, however, it may be noted that no payment shall be made to the contractor for any additional consumption of cement compare to mix design and USSOR-2010.
- 4.7 Coarse Aggregates
- 4.7.1 For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel etc.. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials beyond the tolerance limits specified in the relevant IS Codes. Coarse aggregate having positive alkali-silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, Parts I to VIII.
- 4.7.2 Marine aggregates shall not be used.
- 4.7.3 The Contractor shall submit for the consent of the Engineer, the entire information indicated in Appendix A of IS:383.
- 4.7.4 Maximum nominal size of coarse aggregate for various structural components in PCC, RCC or PSC, shall conform to Clause 5.7 of these Specifications.

TABLE 4.1: REQUIREMENTS OF COARSE AGGREGATES

Sl. No.	IS Sieve Size	Percent by Weight Passing the Sieve		
		40mm	20mm	12.5mm
1	63mm	100	-	-
2	40mm	95-100	100	-
3	20mm	30-70	95-100	100
4	12.5mm	-	-	90-100
5	10mm	10-35	25-55	40-85
6	4.75mm	0-5	0-10	0-10

4.8 concrete, or to attack the embedded steel. Motorised sand washing machines / screw type mechanical washers should be used to remove impurities from sand. Fine Sand / Fine Aggregates

4.8.1 For masonry work, sand shall conform to the requirements of IS: 2116.

4.8.2 For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383 for his consent. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

4.8.3 Creek /Marine sand shall not be used in permanent works

4.9 Steel

4.9.1 Cast Steel

The use of cast steel shall be limited to bearings and other similar parts. Steel for castings shall conform to Grade 280-520N of IS: 1030. In case where subsequent welding is unavoidable in the relevant cast steel components, the letter N at the end of the grade designation of the steel casting shall be replaced by letter W. 0.3 per cent to 0.5 per cent copper may be added to increase the corrosion resistance properties

4.9.2 Steel for Pre-stressing

The pre-stressing steel shall conform to either of the following :

- (1) Plain hard drawn steel wire conforming to IS: 1785 (Part I).
- (2) High tensile steel bar conforming to IS: 2090
- (3) Uncoated stress relieved strands conforming to IS: 6006.
- (4) Uncoated Stress relieved low relaxation strands conforming to IS; 1426

All pre-stressing steel shall be free from splits, harmful scratches, surface flaws, rough, jagged and imperfect edges and other defects likely to impair its use in pre-stressed concrete.

The value of modulus of elasticity of steel used for design of pre-stressed concrete members shall preferably be determined by tests on samples of steel to be used for construction. For the purpose of this, the value given by the manufacturer of the pre-stressing steel shall be considered as fulfilling the necessary requirements.

Where it is not possible to ascertain the modulus of elasticity by test or from the manufacturer of the steel, the values as specified in Table 4.2 below may be adopted

Table 4.2 : Modulus of Elasticity for Pre-stressing Steel

Sl. No.	Type of Steel	Modulus of Elasticity Es kN/mm ²
1	Plain cold drawn wires conforming to IS: 1785(Part-I)	210
2	High tensile alloy steel bars conforming to IS: 2090	200
3	Strands conforming to IS: 6006	195
4	Strands conforming to IS: 14268	195

Coupling units and other similar fixtures used in conjunction with the wires or bars shall have an ultimate tensile strength of not less than the individual strength of the wires or bars being joined

4.9.3 Reinforcement / Untensioned Steel

For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, the reinforcement / untensioned steel as the case may be shall consist of the following grades of reinforcing bars as specified in Table 4.3 below.

Table 4.3:

Sl. No.	Grade Designation	Bar Type governing IS Specifications	Characteristic Strength f _y MPa	Elastic Modulus GP _a

1	S 240	Grade 1 Mild Steel & Medium Tensile Steel bars conforming to IS:432 Part I Mild	240	200
2	S 415	Cold twisted bars conforming to IS: 1786 High Yield Strength Deformed Bars (HYSD) / TMT bars	415 / 500	200

Requirements of Reinforcement / Untensioned Steel Other grades of bars conforming to IS:432 and IS:1786 shall not be permitted.

All the steel shall be procured only from the primary steel producers and having BIS license.

Primary steel producers are those steel (crude and / finished steel) producers using iron ore as the basic raw material / input. It therefore, includes in-house iron making followed by production of liquid steel & crude steel with / without in-house rolling. So all Integrated Steel Plants adopting BF-BOF route and major producers adopting Corex- BOF or DRI-EAF or MBF-EOF technology would fall under this category.

The Contractor shall notify the name of such primary steel producers to the Engineer, from whom he intends to procure the steel, along with copy of primary steel producer certificate and BIS license. All reinforcing steel shall be free from loose small scales, rust and coats of paint, oil mud etc. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

4.9.4 Structural Steel

- (1) All structural steel shall before fabrication comply with the requirements of the following Indian Standards:
 - (i) IS:226 : Structural Steel (Standard Quality)
 - (ii) IS:961 : Structural Steel (High Tensile)
 - (iii) IS:2062 : Weldable Structural Steel
 - (iv) IS:8500 : Weldable Structural Steel (medium & high strength qualities)
 - (v) IS:1148 : Hot rolled rivet bars (upto 40mm dia) for structural purposes
 - (vi) IS:1149 : High tensile rivet bars for structural purposes
 - (vii) IS:1161 : Steel tubes for structural purposes
 - (viii) IS:4923 : Hollow Steel sections for structural use
 - (ix) IS:11587 : Structural weather resistant steel

- (x) IS:808 : Specifications for Rolled Steel Beam, Channel and Angle Sections
- (xi) IS:1239 : Mild Steel Tubes
- (xii) IS:1730 : Dimension for Steel Plate, sheet and strip for structural and general engineering purposes
- (xiii) IS: 1731 : Dimension for Steel flats for structural and general engineering purposes
- (xiv) IS:1732 : Dimension for round and square steel bars for structural and general engineering purposes
- (xv) IS:1852 : Rolling and cutting tolerances for hot rolled steel products

The use of structural steel not covered by the above standards maybe used with the specific consent of the Engineer. Engineer shall seek the approval of Employer before communicating his consent to the Contractor in this regard.

- (2) Structural Steel for Railway Bridges shall also conform to the special requirements as specified below:
 - (i) IS: 2062, Quality “A” Grade Designation E250 (Fe 410W) as rolled semi- killed or killed shall be used for foot-over bridges and other structures subjected to non-critical loading
 - (ii) IS: 2062, Quality “B” Grade Designation E250 (Fe 410W) fully killed and normalized / controlled cooled, where service temperature does not fall below 0°C, shall be used for welded / riveted girders subjected to Railway loading. Plates less than 12mm thick need not be normalized / controlled-cooled.
 - (iii) IS: 2062-2006 Grade designation E 410 (Fe 540) or E 450 (Fe 570) Quality D (both copper bearing quality) according to the welded or riveted work specifically for High Tensile Steel
 - (iv) For superior and enhanced corrosion resistance for sections, plates and bars for welded, riveted or bolted construction, the material shall comply with the requirement of IRS: M-42, Gr. I or Gr. II for riveted / bolted or welded work respectively
 - (v) Steel, which is to be cold pressed, shall comply with the requirements of IS:2002.
 - (vi) Steel for bolts shall conform to property class 4.6 or 6.6 as specified in IS: 1367 accordingly, as the structural steel specification is for mild steel or high tensile steel.
 - (vii) Steel for drifts shall be in accordance with IS: 1875 for forged quality steel or IS: 7283 for hot rolled bars.
 - (viii) Steel for rivets shall comply with the requirement of IS: 1148 for hot rolled rivet bars for general structural purposes and IS: 1149 for high tensile steel rivet bars for high strength structural purposes. For high strength

low alloy structural steel rivet bars with enhanced corrosion resistance for use in bridges, steel shall comply with the requirement of IRS: M-43.

- (ix) The dimensions of all rolled sections must agree with the drawings or as consented by the Engineer.
- (x) The rolling and cutting tolerances shall be in accordance with IS: 1852 or as consented by the Engineer. If closer tolerances are desired they shall be shown in the drawing.
- (xi) All the steel sections used in the fabrication must have mill test certificate clearly indicating the specification to which the steel conforms and whether steel is killed and normalized. All the cast mark numbers/ heat mark numbers, shall be recorded along-with the number of plates in a register as soon as the plates are received in the workshop. Whenever the steel is received without any test certificate, a sample test piece from plate of each cast mark number is to be cut and sent for testing. Only when it is established that the plates are of required specification, these shall be processed for cutting.
- (xii) Use of steel of any quality other than those mentioned above would require the prior consent of the Engineer.
- (xiii) Welding Consumables :
 - a) Parent metal shall be of fusion welding quality conforming to IS: 2062.
 - b) Electrodes shall conform to IRS Specification M-28. The filler wire and flux combinations for submerged arc welding shall conform to IRS Specification M-39. Wire for CO₂ welding shall conform to RDSO/M&C/Specification.
 - c) All consumables shall be stored and handled with care and in accordance with the manufacturers recommendations. This shall be governed as per relevant para of IS: 9595.
- (3) All structural steel shall be procured only from the primary steel producers (as defined above) and having BIS license

4.10 Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. As a guide, the following concentrations represent the maximum permissible values :

- (1) To neutralize 200 ml sample of water. using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.

- (2) To neutralize 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCl.
- (3) The permissible limits for solids shall be as follows when tested in accordance with IS:3025 :

Permissible Limits (Max.)

- (i) Organic : 200 mg/lit.
- (ii) Inorganic : 3000 mg/lit
- (iii) Sulphates (SO₄) : 500 mg/lit
- (iv) Chlorides (Cl) : 2000 mg/lit for plain concrete works, 1000mg/lit for reinforced concrete works and 500mg/lit for Prestressed concrete works
- (v) Suspended matter : 2000 mg/lit

All samples of water (including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements stated herein.

- (4) The pH value shall not be less than 6.
- (5) In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time tests as specified below:
 - (i) The sample of water taken for testing shall represent the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.
 - (ii) Average 28 days compressive strength of at least three 15cm concrete cubes prepared with water proposed to be used shall not be less than 90 percent of the average of strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS:516.
 - (iii) The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by + 30 minutes from the initial setting time of control test block prepared and tested in accordance with the requirements of IS:4031.

(iv) Water found satisfactory for mixing is also suitable for curing concrete.

However, water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds is objectionable.

4.11 Concrete Admixtures

4.11.1 General

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state.

Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers duly approved by the Engineer having proven track record, quality assurance and full-fledged laboratory facilities for the manufacture and testing of concrete.

The Contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

- (i) Normal dosage and detrimental effects, if any, of under dosage and over dosage.
- (ii) The chemical names of the main ingredients in the admixtures.
- (iii) The chloride content, if any, expressed as a percentage by the weight of the admixture
- (iv) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.
- (v) Whether or not the admixture leads to the entrainment of air when used as per the manufacturer's recommended dosage, and if so to what extent
- (vi) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.
- (vii) There would be no increase in risk of corrosion of the reinforcement or other embedments as a result of using the admixture
- (viii) Retardation achieved in initial setting time

4.11.2 Physical and Chemical Requirements

All admixtures shall conform to the requirements of IS:9103. In addition, the following conditions shall be satisfied:

- (i) "Plasticisers" and "Super-Plasticisers" shall meet the requirements indicated for "Water reducing Admixture".
- (ii) Except where resistance to freezing and thawing and to disruptive action of deicing salts is necessary, the air content of freshly mixed concrete in

accordance with the pressure method given in IS: 1199 shall not be more than 1 percent higher than that of the corresponding control mix.

- (iii) Calcium chloride or admixtures containing calcium chloride shall not be used in structural concrete containing reinforcement, prestressing tendons or the embedded metal.
- (iv) Admixtures containing Cl, SO₃ ions, nitrates and admixtures based on thiocyanate shall not be used.
- (v) Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

The tests that shall be performed along with permissible variations in the same are indicated below:

- a) Dry Material Content: to be within 3 per cent and 5 per cent of liquid and solid admixtures respectively of the value stated by the manufacturer.
 - b) Ash content : to be within 1 per cent of the value stated by the manufacturer.
 - c) Relative Density (for liquid admixtures): to be within 2 per cent of the value stated by the manufacturer.
- (vi) Use of such admixtures does not have adverse effect on the properties of concrete or mortar particularly with respect to strength, volume change durability and has no deleterious effect on reinforcement.
 - (vii) All tests relating to the concrete admixtures shall be conducted periodically at an independent laboratory having NABL certification and compared with the data given by the manufacturer.
 - (viii) While qualifying the admixture, the infra-red spectrograph plot should be given. Each batch of supply should be tested for infra-red Spectrograph and prove the consistency of supply
 - (ix) When an expanding agent is used, the total unrestrained expansion shall preferably be between 4% to 6%. Aluminum powder as an expanding agent shall not be permitted.

4.12 Handling & Storage of Materials

- a) All materials shall be stored as per IS: 4082
- b) Cement : Cement of different specifications shall be stacked separately and quality of stored cement actually used in any member or part of the structure shall fulfill the design and construction requirement of the same. Cement shall be stored at work site in such a manner as to prevent deterioration either through moisture or intrusion of foreign matter. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirement at site

and should be cleaned at least every 3 months. Cement older than 3 months should not be used.

- c) Aggregates : Coarse Aggregates supplied in different sizes shall be stacked in separate stockpiles and shall be mixed only after the quantity required for each size has been separately weighed or measured. The quantity of coarse aggregates, thus recombined shall be that required for a single batch of concrete.
- d) Steel : The storage of all reinforcing steel shall be done in such a manner as will assure that no deterioration in its quality takes place. The coil of HTS wires & strands shall be given anti-corrosive treatment such as water soluble oil coating before wrapping it in hessian cloth or other suitable packing. During transportation, it shall be ensured that no damage is done to coils while loading and unloading. Care shall be taken to avoid mechanically damaging, work hardening or heating prestressing tendons while handling.
- e) Any material, which has deteriorated or has been damaged, corroded or contaminated, shall not be used for concrete work.

The procedures to be adopted for transportation & storage of the materials shall be subject to the consent of the Engineer. All the materials even though stored in approved godowns / places must be subjected to acceptance test prior to their immediate use

4.13 Tests and Standards of Acceptance

- a) Cement: A sample shall be tested from every batch of cement delivered on site or once for every 1000 bags whichever is more frequent. Tests shall be carried out for fineness, initial and final setting time and compressive strength (IS: 4031) and results approved by Engineer before use. The methods and procedures for sampling shall be in accordance with IS: 3535. Engineer may require any other form of sampling and tests including chemical analysis (IS: 4032) in case the cement supplied is of doubtful quality
- b) Steel : Physical tests as per IS: 2062 and IS: 1786. Various physical tests shall be carried out as per IS: 226, IS: 1608, IS: 1599 and IS: 1387
- c) All materials shall be subjected to an acceptance test prior to their immediate use.
- d) The Contractor shall furnish test certificates from the manufacturer/supplier of materials along with each batch of material(s) delivered to site.
- e) The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction.
- f) The testing of all the materials shall be carried out by the Contractor at the field laboratory or from the laboratory approved by the Engineer and in the presence of the Engineer. The Contractor shall make all the necessary arrangements and bear the entire cost.
- g) Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's cost at any recognised laboratory / testing establishments having NABL certification and duly approved by the Engineer.
- h) If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall be borne by the Contractor

5 Piling Work

5.1 Description

- 5.1.1 This work shall consist of construction of all types of piles for structures in accordance with the details shown on the drawings and conforming to the requirements of these specifications.
The construction of pile foundations requires a careful choice of the piling system depending upon sub-soil conditions and loading characteristics and type of structure. The permissible limits of total and differential settlements, unsupported length of pile under scour, impact/ entanglement of floating bodies and any other special requirements of project are also equally important criteria for selection of the piling system.
- 5.2 Submittals
The method of installing the piles, including details of the equipment shall be submitted by the Contractor and got approved from the Engineer.
The work shall be done as per IS:2911 except as modified herein.
- 5.3 Type of Piles
The piles shall be of reinforced concrete. Piles shall be bored cast-in-situ. The shape of piles may be circular or any other shape consented by Engineer.
- 5.4 Pile Installation
- 5.4.1 Installation of piles shall be carried out as per pile layout drawings, installation criteria and methodology as consented by the Engineer.
- 5.4.2 The permissible limits / tolerances for deviations with respect to cross-sectional dimensions, position, alignment, levels etc. shall be as specified in Clause 5.10 of these Specifications and as per IS; 2911.
- 5.4.3 Safe load capacity of the pile of various diameters in vertical compression, horizontal (lateral) shall be clearly specified by the Contractor in the Drawings
- 5.4.4 The Contractor shall ensure and guarantee the safe load capacities both for initial test pile and working pile
- 5.4.5 Before installing the test pile, the Contractor shall finalise the pile testing arrangement and obtain the consent of the Engineer.
- 5.4.6 It is envisaged that the working piles shall be installed after then successful completio of the initial pile load test.
- 5.4.7 The equipment and accessories for installation of piles shall be selected by the Contractor giving due consideration to the sub-soil conditions, ground water conditions, type of founding material and shall be subject to consent of the Engineer.
- 5.4.8 Each pile shall be identified with reference number. The convenience of installation may be taken in to account while scheduling the sequence of piling in a group.
- 5.4.9 Level marks shall be accurately painted on each pile immediately after its installation. Subsequently, if any pile displays any tendency to heave up due to installation of other pile or due to any other reason, the same shall be re-installed as consented by the Engineer without any extra cost to the Employer.
- 5.4.10 The Contractor shall record all the information during installation of piles. The format for data sheet for recording of the pile data shall be as consented by the Engineer. On completion of the pile installation, complete pile record in triplicate shall be submitted to the Engineer within two days of completion of concreting of the pile.
- 5.4.11 Consent to the termination depth by the Engineer in no way absolve the Contractor of his responsibility to guarantee the safe load capacities of the piles

5.5 Materials

5.5.1 The basic materials like cement, coarse aggregates, fine aggregates, reinforcing steel, structural steel, water and concrete admixtures shall conform to the requirements as specified in the Clause 3: Materials for Structures of these Specifications

5.5.2 Concrete in Piles

Grade of concrete to be used in cast- in-situ piles shall not be less than M 20 and the cement content shall not be less than 370 kg per cubic meter of concrete or 10% more than determined from the mix design whichever is higher. Water cement ratio shall be maintained as specified in Clause 5.3 of these Specifications. The minimum slump of concrete for bored cast- in-situ piles shall be 150 mm to 180 mm. The slump should not exceed 180mm in any case. Concrete mix should have homogeneous mixture with required workability for the system of piling adopted. Suitable and approved admixtures may be used in concrete mix where necessary. Where piles are exposed to action of harmful chemicals or severe conditions of exposure due to presence of sulphate, chloride etc. Special types of cement, such as sulphate resistant cement may be used where considered appropriate.

5.6 Test Piles

Test piles for initial load test to be installed by the Contractor to determine the lengths of piles shall conform to the requirements for piling as indicated in these Specifications. Test piles shall be installed with the same type of equipment that is proposed to be used for piling in the actual structure.

A minimum time period of four weeks shall be allowed between the time of pile casting and testing. Test pile head shall be prepared for testing purposes only, one week after casting the pile.

Test piles shall be cut off at the proper level and provided with a proper cap / head, so as to provide a plane bearing surface for the test plate and for proper arrangements for seating of the jack and dial gauges. Pile installation data along with the load test results and analysis report in triplicate shall be furnished to the Engineer

Test piles which, are not to be incorporated in the completed structure shall be removed to at least 600 mm below the proposed soffit level of pile cap and the remaining hole shall be backfilled with earth or other suitable material. The piles shall be load tested in accordance with provisions laid down in this section.

5.7 Bored Cast-in-situ Concrete Piles

5.7.1 Boring for Pile

- (1) Bored cast-in-situ concrete piles shall be installed by making a bore into the ground by removal of material. Boring shall be carried out using conventional rigs or by rotary hydraulic feed drilling rig. Wherever considered necessary, reverse mud circulation technique shall be adopted. The cutting tools shall have suitable ports for bentonite slurry circulation. The rotary drilling rigs shall have suitable and adequate accessories for boring / drilling through all type of strata expected at site. The working level shall be above cutoff level
- (2) Cast- in-situ concrete piles may be cast in metal shells which may remain permanently in place. The metal casing shall be of sufficient thickness and strength to hold its original form and show no harmful distortion after it and adjacent casings have been driven.

- (3) For bored cast- in-situ piles, a guide casing of 3 to 4m length of top of bore shall invariably be provided. In cases in which the side soil can fall into the hole, the side of the bore hole should be stabilized with a suitable steel casing / liner. The casing / liner may be left in position permanently specially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of piles could be exposed due to scour. Inner diameter of steel casing / liner shall be equal to the required diameter of pile as specified in the Drawings. The centre line of the guide casing / liner shall be checked before continuing further boring.
- (4) The size of the cutting tool shall not be less than the diameter of the pile by more than 75mm. However the pile bore shall be of the specified size. The diameter of the bore- holes shall be not more than the inside diameter of the casing / liner.
- (5) MS liners (temporary and permanent) for the piles shall be provided wherever required depending upon the site conditions and as directed by the Engineer. The Contractor shall fabricate the MS liner from MS sheets to suit to the diameter of the pile. The required length of the liner will be made up by welding each unit at site. The thickness of the MS liners shall not be less than 6mm. This thickness can be increased suitably for the bottom length of 1,2 m of the liner or for such increased length as directed by the Engineer. The bottom end of the MS liner shall be stiffened by welding additional plates to withstand the impact during driving.
- (6) Casing / liner shall be driven open ended with a pile driving hammer or bailer capable of achieving penetration of the casing / liner to the length shown on the drawing. Materials inside the casing shall be removed by the means consented by Engineer.
- (7) Where bored cast- in-situ piles are used in soils liable to flow, the bottom of the casing shall be kept enough in advance of the boring tool to prevent the entry of soil into the casing. The water level in the casing should generally be maintained at the natural ground water level. The joints of the casing shall be made tight to minimise inflow of water or leakage of slurry during concreting.
- (8) In case hard rock is encountered, chiseling shall essentially be required for softening of the rock and the same shall be done with the consent of the Engineer at no extra cost to the Employer. In case of use of rotary hydraulic drilling rig, advancement of pile bore shall be done by drilling only.
- (9) Any liner or bore-hole which is improperly located or shows partial collapse that would affect the load carrying capacity of the pile shall be rejected or repaired as consented by the Engineer, at the cost of the Contractor.
- (10) Drilling Mud (bentonite slurry) shall be used for stabilizing the sides of the pile bore. Drilling mud to be used shall meet the following requirements :
 - (a) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of freshly prepared bentonite suspension shall be between 1.034 and 1.1 gm / ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However the density of the bentonite after mixing with deleterious materials in the pile bore may be upto 1.25 gm/ml
 - (b) Liquid Limit of the bentonite when tested in accordance with IS: 2720 (Part V) shall be more than 300 percent and less than 450 percent
 - (c) Sand contents of the bentonite powder shall not be greater than 7 percent

- (d) The marsh viscosity when tested by a marsh cone shall be between 30 to 60 seconds
- (e) The differential free swell shall be more than 540 percent
- (f) The pH value of the bentonite suspension shall be between 9 and 11.5
- (11) The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. The bentonite slurry shall be under constant circulation till start of concreting and shall meet the requirements as stipulated hereunder.
- (12) Cleaning of the pile bore
 - (a) After completion of the pile bore up to the required depth, the pile bore shall be cleaned by three stage flushing of slurry using airlift technique. The bottom of the pile bore shall be thoroughly cleaned by airlift technique. Cleaning shall ensure that the pile bore is completely free from sludge / bored material, debris of rock / boulder etc. Necessary checks shall be made so as to confirm the thorough cleaning of the pile bore.
 - (b) Pile bore shall be cleaned by fresh drilling mud through tremie pipe before and after placing the reinforcement and just before the start of concreting.
 - (c) Concreting operations shall not proceed if the contaminated drilling mud at the bottom of the pile bore possesses a density is more than 1.25 t / cu.m. The drilling mud sample shall be collected from the bottom of pile bore. For this a solid cone shall be lowered by a string to the bottom of pile bore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimise the leakage, while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.
 - (d) Consistency of the drilling mud suspension shall be controlled throughout concreting operations in order to keep the bore stabilized, as well as to prevent concrete getting mixed up with the thicker suspension of the mud.
 - (e) A protocol shall be maintained regarding the strata at the founding level, SPT value, percent core recovery, Unconfined Compressive Strength (UCS) from the nearest borehole, socketing horizon, flushing of pile bore, time interval between end of borin and start of concreting, bentonite density before start of concreting.
- (13) The bored spoil material and contaminated mud / bentonite slurry shall be disposed off at the designated areas and as per the procedure consented by the Engineer.
- (14) Guide casing shall be withdrawn cautiously after the concreting is done upto the required level. While withdrawing the casing, the concrete shall not be disturbed.
- (15) Where the casing is withdrawn from cohesive soils for the formation of cast- in-situ pile, the concreting should be done with necessary precautions to minimise the softening of the soil by excess water. Where mud flow conditions exist, the casing of cast-in-situ piles shall not be withdrawn.

5.7.2 Reinforcement

- (1) Prior to the lowering of the reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials

- (2) Steel reinforcement for the piles and pile caps shall be as per Clause 6.22 of these Specifications.
- (3) The longitudinal reinforcement shall project 50 times its diameter above cut-off-level unless otherwise indicated.
- (4) The minimum clear spacing between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage and they shall be held firmly in position by tack welding suitable stiffeners. For links, the spacing shall not be less than 150mm and in no case more than 250mm.
- (5) Proper cover to reinforcement and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose. Placement of reinforcement cage to its full length shall be ensured before concreting.
- (6) Minimum clear cover to the reinforcement shall be 75 mm, unless otherwise mentioned.

5.7.3 Concreting for Pile

- (1) For bored holes, the finishing & cleaning of the bore, lowering of reinforcement cage and concreting of the pile for full height must be accomplished in one continuous operation without any stoppage.
- (2) Before concreting, the bottom of the hole shall be cleaned of drilling mud and all soft or loose material.
- (3) Concreting shall not be done until the Engineer is satisfied that the termination level of pile, is as per the approved installation criteria.
- (4) Concrete in the pile shall be coherent, rich in cement with high slump and restricted water cement ratio as per Clause 5.5.2 and Chapter 6 of these Specifications.
- (5) Concreting for the piles shall be done by tremie method. The requirements operation of tremie concreting shall be governed by the following and IS; 2911
 - (i) The tremie pipe for concreting should be large enough with due regard to the size of aggregate. For 20 mm aggregate the tremie pipe should be of diameter not less than 200 mm. Aggregates more than 20mm in size shall not be used.
 - (ii) The tremie should have uniform and smooth cross-section inside,
 - (iii) The tremie shall be water-tight throughout its length and have a hopper attached at its head by a water-tight connection
 - (iv) The tremie pipe shall be lowered to the bottom of the bore-hole, allowing water or drilling mud to rise inside it before pouring concrete.
 - (v) The sides of the bore-hole have to be stable throughout
 - (vi) The tremie pipe shall always be kept full of concrete and shall penetrate well into the concrete in the bore-hole with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.
 - (vii) While concreting the tremie shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal.
 - (viii) All tremie tubes should be scrupulously cleaned after use.
- (6) The first charge of concrete should be placed with a sliding plug pushed down the tremie tube ahead of it to prevent mixing of water and concrete.
- (7) The concrete shall be properly graded, self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silty clays and other soils with the tendency to squeeze into the newly deposited

- concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.
- (8) The time interval between the completion of the boring and start of concreting shall not exceed 6 hours. In case this time interval exceeds 6 hours, the further activities in the pile bore and handling of the pile bore shall be subject to the consent of the Engineer and at no extra cost to the Employer. Placing of concrete shall be a continuous process from the toe level to the top of the pile. To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.
 - (9) Segregation of the ingredients should be prevented. The displacement or distortion of reinforcement during concreting and also while extracting the tube shall be avoided.
 - (10) While concreting uncased piles, voids in concrete shall be avoided and sufficient head of concrete is to be maintained to prevent inflow of soil or water into the concrete. It is also necessary to take precautions during concreting to minimise the softening of the soil by excess water. Uncased cast-in-situ piles shall not be allowed where mudflow conditions exist
 - (11) Concreting by tremie shall continue to allow initial pours of concrete mixed with Bentonite slurry, sludge and cut spoils from the bore overflow till the consistency and quality of the overflowing concrete is comparable to that of the designed mix. The length of the overflow shall be as consented by the Engineer
 - (12) Cutoff level of piles shall be as indicated in the Drawings.
 - (13) The top of the concrete in a pile as cast shall be above the cut-off level by from 0.6m to 1.0m (maximum) to permit removal of all laitance and weak concrete and to ensure good concrete at cutoff level for proper embedment in to the pile cap. The cutoff level of the piles shall be as indicated in the Drawings.
 - (14) It shall be ensured that the volume of the concrete poured is at least equal to the theoretically computed volume of the pile shaft being cast. Accordingly a continuous record shall be kept by the Contractor as to the volume of concrete placed in relation to the pile length cast.
 - (15) For long or large diameter piles, use of retarding plasticiser in concrete is desirable.
 - (16) Where possible, it may be desirable to grout the base of pile with cement slurry under suitable pressure after concrete in the pile attains the desired strength. For this purpose, conduit pipes with easily removable plugs at the bottom end should be placed in the bore along with reinforcement cage before concreting.
- 5.7.4 Copy of the complete log in respect of each pile bore from start of the boring of the pile to completion shall be submitted to the Engineer within 24 hours of concreting of the Pile. The format of the pile log shall be as consented by the Engineer.

5.7.5 Building Up of Piles / Breaking Off of Piles

If any pile, already cast as per construction drawing, requires any extra casting due to any change in Cut-off-Level, then the pile shall be built up by using at least one grade higher concrete than specified for piles, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement, as per design requirement and suitable shuttering shall be provided, before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction, to ensure lateral capacity of the pile. If any

pile already cast requires breaking, due to subsequent change of Cut-off-Level, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile, such as loosening, cracking etc., and to the satisfaction of the Engineer.

5.7.6 Preparation of Pile Head

The area surrounding the piles shall be excavated up to the bottom of the pile caps. After seven days of concreting of pile. The exposed part of concrete above the Cut- off Level shall be removed / chipped off and made rough at Cut-off Level. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete.

The clear cover between the bottom reinforcement in pile cap from the top of the pile shall be not less than 25 mm. The projected reinforcement above Cut-off Level shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap. The minimum embedment of cast- in-situ concrete piles into the pile cap shall be 150 mm or clear cover to reinforcement whichever is higher.

All loose material on the top of pile head after chipping to the desired level shall be removed and disposed off.

5.7.7 100mm Dia Bore Hole

Bore hole shall be made as per IS: 1892 for determining (which is one of the criteria of establishing) start of socketing horizon and termination level of piles.

- (1) Standard Penetration Test (SPT), as per IS: 2131, in a bore hole shall be conducted at 1.0 m interval in the overburden soil and rock portion having core recovery <0%.
- (3) Number of bore holes for determining termination shall vary depending on the site condition and as decided by the Engineer. In case of uniform strata, 1 borehole may be sufficient for 40-50 piles or in a pile group. In case of erratic strata, the number of boreholes may be 1 in 20 to 40 piles. However, at the location of initial load test piles, one such borehole shall be done at each location.

5.7.8 Sequencing of Piling

- (1) In a pile group the sequence of installation of piles shall normally be from the centre to the periphery of the group or from one side to the other.
- (2) Consideration should be given to the possibility of doing harm to a pile recently formed by driving the tube nearby before the concrete has sufficiently set. The danger of doing harm is greater in compact soils than in loose soils.

5.8 Pile Tests / Acceptance of Pile

- 5.8.1 For acceptance of piles, vertical and lateral load, testing of piles as required will be carried out as per procedure laid down in IS : 2911 (Pt-IV)- 2013 “ Code of Practice for Design and Construction of Pile Foundation -Load test on piles.”

5.8.2 The bearing capacity of a single pile may be determined from test loading a pile. The load test on a concrete pile may not be carried out earlier than 28 days from the time of casting of the pile. The test pile head shall be prepared one week after casting the pile.

5.8.3 Type of Tests

There shall be three categories of tests on piles, namely, initial load tests, routine load tests and pile integrity tests.

(1) Initial Load Test

Initial load tests should be carried out on test piles, which are not to be incorporated in the work, to assess the safe load carrying capacity of the pile before start of installation of working piles. This shall include the following type of tests

- (a) Vertical (compression) load test to assess vertical load capacity
- (b) Lateral load test to assess lateral load capacity

(2) Routine Load Tests

Routine load tests shall be carried out to verify the load capacity of working piles. This shall include the following type of tests

- (a) Direct vertical (compression) load test for vertical load capacity
- (b) Lateral load test for lateral load capacity

(3) Pile Integrity Tests

Pile integrity testing shall be used as a method of proof testing a pile as work progress with the aim of indirectly assessing one or more of the following

- (a) Structural integrity of the pile
- (b) The relative shape of the pile shaft and an estimate of the physical dimension of the pile
- (c) The continuity of the pile

(4) Where integrity testing is required, the test to be adopted shall be one of the following

- (a) Sonic Impact Test
- (b) Sonic Vibration Test

The scheme of the test shall be as consented by the Engineer. Pile tests shall be carried out under the direct supervision of the person having experience in supervision of pile integrity tests

5.8.4 Number of Tests

The number of initial and routine load tests on piles shall be depending upon the number of foundations, span length, type of superstructure and uncertainties of founding strata.

In any case, the initial load tests shall not be less than 4 in number for each diameter of pile, while the routine load tests shall not be less than 2 per cent of the total number of piles in the structure. Test piles for routine load test shall be identified by the Engineer. These stipulations hold good for both vertical as well as lateral load tests on pile foundations. However, both initial and routine tests may be suitably increased for cases with large variation in the subsurface strata as directed by the Engineer. Pile Integrity Tests has to be conducted on 100% of the piles on each Bridge

5.8.5 Load Test on Pile

- (1) This part of the Specifications covers the requirements for initial and routine load tests on reinforced concrete single vertical piles of specified diameter to assess their vertical, horizontal (lateral) and pull out load carrying capacities.
- (2) The work shall include mobilization of all necessary equipment, kentledge, anchor piles / rock anchors, or combination of kentledge and anchor piles / rock anchors, providing necessary engineering supervision and technical personnel, skilled and unskilled labour, etc., as required, to carry out the complete pile testing and submission of test reports.
- (3) The Contractor shall carry out all works meant within these Specification, even if not explicitly mentioned under the scope.
- (4) All the works shall be carried out to the satisfaction of the Engineer.
- (5) All pile testing including arriving at the safe load shall conform to IS: 2911(Part IV) -2013 and modified to the extent given below.
- (6) It is essential that all the equipment and instruments are properly calibrated both at the commencement and immediately after the completion of tests, so that they represent true values. If the Engineer so desires, the Contractor shall arrange for having the instruments calibrated in presence of the Engineer, at an approved laboratory at Contractor's own cost and the test report / calibration certificate shall be submitted to the Engineer.
- (7) The complete jacking system including the hydraulic jack, hydraulic pump and pressure gauge shall be calibrated as unit. The complete unit shall be calibrated over its complete range of travel for increasing and decreasing loads same as that of test loads. The calibration certificate shall be submitted to the Engineer.
- (8) The reaction load to be made available for the test shall be at least 25% greater than the maximum jacking force. The reaction system as relevant shall be designed for the total reaction load. All reaction loads shall be stable and balanced during all operations of testing. During testing, stability of reaction system shall be ensured.

- (9) The load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack with a least count of not more than 10% of the safe load.
- (10) Load test shall be conducted at pile Cut-off Level (COL).
- (11) If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable de-watering methods.
- (12) In case of initial vertical load test, where the water table level is higher than the Cut-off Level, Contractor may use anchor piles / rock anchors for testing purposes. Engineer at his discretion, may decide to raise the COL above water table.
- (13) The displacement of pile (in vertical, horizontal and uplift) shall be measured using dial gauges having a least count of 0.01mm.
- (14) Full details of the equipment proposed to be used, the test setup and pile testing scheme along with detailed design, drawings shall be submitted to the Engineer, before making arrangements to carry out the tests, for his consent. Consent of the Engineer shall also be obtained after the test set up is complete prior to commencement of loading.
- (15) All operations in connection with pile load test shall be carried out in a safe manner so as to prevent the exposure of people to hazard and also to ensure the safety of men and material.
- (16) Proforma for pile load tests shall be got approved from the Engineer and shall be submitted in triplicate to him immediately on completion of each test. The record shall also include the plots of (a) load Vs settlement, (b) time Vs settlement (for each increment of Load) and characteristics of the piles and interpretation of the pile load test curve as per the criteria for safe loads, as mentioned in the Specifications.
- (17) Two fixed independent benchmarks shall be established as reference point at least 15m from the test pile to monitor the settlements.
- (18) If any initial pile load test gets abandoned and / or is not successfully completed then the Contractor shall install another test pile and repeat the initial test after correcting the fault, at his own cost.

5.8.6 Vertical Load Test

- (1) Equipment and Test Setup
 - (a) A steel plate of sufficient thickness but not less than 50mm shall be centered on the pile head / cap to prevent it from crushing under applied load. The size of the circular test plate shall not be less than the pile size nor less than the area covered by the base of the hydraulic jack (s).
 - (b) The datum bars shall be supported on immovable supports preferably of concrete pillars or steel sections placed sufficiently far away from the test pile. The distance shall not be less than 3times the diameter of test pile and in no case less than 2 metres from the edge of test pile. These supports

shall be placed at a sufficient depth below ground to be unaffected by ground movements.

(2) Loading System

The test load on pile shall be applied in one of the following ways as approved by the Engineer.

- (a) By means of hydraulic jack(s), which obtain reaction from kentledge heavier than the required test load. While using this method care shall be taken to ensure that the center of gravity of kentledge is on the axis of the pile. The load applied by the jack(s) shall also be coaxial with the pile. The nearest edge of the crib supporting the kentledge stack shall not be closer than 1.5 metres to the edge of the test pile.
- (b) By means of hydraulic jack(s), which obtain reaction from anchor piles (for initial pile load test) and / or suitable loading frame. While using this method all anchor piles shall be at a centre to centre distance of at least three times the test pile shaft diameter from the test pile and in no case less than 2metres. Care shall be exercised to ensure that the datum bar supports are not affected by heaving up of the soil.
- (c) By means of hydraulic jack(s), which obtain reaction from suitable rock anchors (for initial pile load test). When this method is adopted, the anchor transferring the load to the ground shall not be closer than two times the test pile shaft diameter to the test pile and in no case less than 1.5m.
- (d) By means of combination of kentledge, anchor pile / rock anchors.
- (e) The measurement of strains for load monitoring may also be done by load cell connected to a digital read out unit.

(3) Measurement System

- (a) Settlement of the pile shall be recorded by four dial gauges placed at diametrically opposite locations and suspended from the datum bar around the pile. Settlement / movement of the pile top can also be made by three Linear Variable Differential Transducers (LVDTs) having at least 100mm of travel. The readout unit shall have a minimum display of 3½ digits, capable of monitoring output at least 10 DC/PC type LVDTs.

(b) Additionally a graduated scale of at least 150mm long and divided in graduations of 500 μ shall be fixed to the pile and tungsten wire shall be fixed in opposite side. Measurement of the pile settlement shall also be done by a suitable total station / digital theodolite. Typical set up for measuring system shall be submitted by the Contractor.

(4) Test Procedure

(a) The test shall be carried out by the direct loading method in successive increments for initial and routine load test.

(b) Direct Loading Method: The test shall be carried out as per the procedure outlined below:

(i) The load shall be applied to the pile top in increments (steps) of about 20% of the rated capacity of the pile or as directed by Engineer. Each increment of load shall be applied as smoothly and expeditiously as possible. Settlement reading shall be taken before and immediately after the application of next increment and at 15, 30 minutes and thereafter at every 1/2 hour until application of the next load increment.

(ii) Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2mm / hr or until two hours have elapsed, whichever is earlier.

The rate of movement of pile shall not be permitted to be extrapolated from period of test less than one hour.

(v) Loading on the pile shall be continued till one of the following takes place:

(vi) In case of initial load test Applied load reaches 2.5 times the safe vertical load carrying capacity

OR

The maximum settlement of pile exceeds a value of 10 percent of pile diameter.

In case of Routine Load Test Applied load reaches one and half times the safe vertical load carrying capacity

OR

The maximum settlement of Test Loading in position attains 12mm.

(v) Where yielding of the soil / rock does not occur, full test load shall be maintained on the pile head for a minimum period of 24hrs, after the last increment of load has been applied. Settlement/values shall be recorded at every 6 hrs interval during this period.

(vi) Unloading shall be carried out in the same steps as loading. A minimum period of 30 minutes shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.

(5) Assessment of Safe Load

The safe vertical load carrying capacity of single pile from the initial and routine vertical load tests shall be the least of the following values:

(a) Two-third of the final load, at which the total settlement is 12mm

(b) 50 percent of the final load, at which the total settlement equals to 10 percent of the pile diameter

5.8.7 In case of any doubt of workmanship or load carrying capacity of working piles not subjected to routine tests, or when ordered by the Engineer, load tests on working piles may be supplemented by non-destructive testing, other than Pile Integrity Tests, which gives an indication of pile capacity in end bearing and side friction.

5.9 Pile Cap

5.9.1 Pile Caps shall be of reinforced concrete. A minimum offset of 150 mm shall be provided beyond the outer faces of the outer most piles in the group. If the pile cap is in contact with

earth at the bottom, a leveling course of minimum 100 mm thickness of M 15 nominal mix concrete shall be provided.

5.9.2 The attachment of the pile head to the cap shall be adequate for the transmission of loads and forces. A portion of pile top may be stripped of concrete and the reinforcement anchored into the cap. Manual chipping may be permitted after three days of pile casting, while pneumatic tools for chipping shall not be used before seven days after pile casting.

The top of pile after stripping shall project at least 150 mm into the pile cap. A layer of surface reinforcement may be provided with a cover of 25 mm to retain the integrity of concrete below the main cap reinforcement which is to be laid 25 mm above the pile top.

5.9.3 Concreting of the pile cap shall be carried out in dry conditions. The bottom of the pile cap shall be laid preferably as low as possible taking account of the water level prevalent at the time of casting. The top of concrete in a pile shall be brought above cut-off level to permit removal of all laitance and weak concrete before pile cap is laid. This will ensure good concrete at the cut-off level.

5.10 Tolerances

5.10.1 Permissible Tolerances for Pile shall be as per Table 5.1 below

Table 5.1: Permissible Tolerances for Pile

Sl. No.	Items	Permissible Tolerance
1	Bored Piles	
a)	Variation in cross-sectional dimensions	+50mm, -10mm
b)	Variation from vertical	1.5%
c)	Variation in the final position of	75mm,
d)	Variation of level of top of piles	± 25mm

In case of piles deviating beyond these limits and to such extent that the resulting eccentricity cannot be taken care of by re-design of the pile cap or pile ties, the piles should be replaced or supplemented by one or more additional piles

Any deviation from the designed location, alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting of the pile cap and plinth beam.

5.10.2 Defective Piles / Defective Pile Bore

In case defective piles are formed, they shall be removed or left in place as consented by the Engineer without affecting the performance of the adjacent piles or the group as a whole. Additional piles shall be provided to replace them as necessary. The cost of

such additional pile and any increase in the pile cap size, if any, on account of additional piles shall be borne by the Contractor.

If any bore hole is defective or is abandoned, it shall be filled up with lean concrete 1:4:8 at the cost of Contractor. If there is a major variation between the depths at which adjacent piles in a group meet refusal, a boring shall be made nearby to ascertain the cause of this difference. If the boring shows that the soil contains pockets of highly compressive material below the level of the shorter pile, it may be necessary to take all the piles to a level below the bottom of the zone which shows such pockets.

5.10.3 Permissible Tolerances for Pile Caps

Table 5.2: Permissible Tolerances for Pile Cap

Sl. No.		Permissible Tolerance
1	Variation in dimensions	+50mm, -10mm
	Misplacement from specified position in plan	15mm
3	Surface irregularities measured with 3 m straight edge	5mm
	Variation of levels at the top	± 25mm

6 Concrete Works

6.1 General

This section refers to the construction of concrete structures including concrete mix design, trial mix, testing and workmanship for concreting. The work shall consist of furnishing and placing structural concrete and incidental construction in accordance with these Specifications and in conformity with the lines, grades and dimensions, as shown on the approved drawings.

6.2 Materials

All the materials shall conform to the requirements as specified in Chapter 4: Materials for Structures of these Specifications

6.3 Grades of Concrete

6.3.1 The grades of concrete shall be designated by the characteristic strength as given in Table 6.1 below, where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Table 6.1 : Grades of Concrete

Sl. No.	Grade Designation	Specified Characteristic Compressive Strength of 150mm cubes at 28 days in MPa
1	M 10	10
2	M 15	15
3	M 20	20
4	M 25	25
5	M30	30
6	M 35	35
7	M 40	40
8	M 45	45
9	M 50	50
10	M 55	55
11	M 60	60

6.3.2 Durability :The durability of concrete depends on its resistance to deterioration and the environment in which it is placed. The resistance of concrete to weathering, chemical attack, abrasion, frost and fire depends largely upon its quality and constituents materials. Susceptibility to corrosion of the steel is governed by the cover provided and the permeability of concrete. The cube crushing strength alone is not a reliable guide to the quality and durability of concrete; it must also have an adequate cement content and a low water-cement ratio. The general environment to which the concrete will be exposed during its working life is classified in three levels of severity that is moderate, severe and extreme, as described in Table 6.2 below

Table 6.2 : Environmental Exposure Conditions of Concrete

Sl. No	Environment	Exposure Condition
1	Moderate	Concrete surface protected against weather or aggressive conditions. Concrete surface sheltered from severe rain or freezing whilst wet. Concrete exposed to condensation. Concrete structure continuously under water. Concrete in contact with non-aggressive soil/ground water.
2	Severe	Concrete surface exposed to severe rain, alternate wetting and drying or occasional freezing or severe condensation. Concrete exposed to aggressive sub-soil/ ground water or coastal environment.
3	Extreme	Concrete surface exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. Concrete structure surfaces exposed to abrasive action, surfaces of members in tidal zone. All other exposure conditions which are adverse to exposure conditions covered above

6.3.3 The lowest grades of concrete in structures and corresponding minimum cementitious material contents and water-cement ratios shall be maintained as indicated in Tables 6.3,6.4, and 6.5 below based on the environmental exposure conditions

Table 6.3 : Minimum Grade of Concrete for Bridges

Sl. No.	Structural Member	Moderate Exposure	Severe Exposure	Extreme Exposure
1	PCC Member	M 25	M 30	M 35
2	RCC Member	M 30	M 35	M 40
3	PSC Member	M 35	M 40	M 45

Table 6.4 : Minimum Cementitious Material Contents

Sl. No.	Exposure Conditions	Minimum Cementitious Material Contents in Kg/m ³		
		Plain Concrete (PCC)	Reinforced Concrete (RCC)	Prestressed Concrete (PSC)
1	Moderate	240	300	400
2	Severe	250	350	430
3	Extreme	300	400	440

Note :-

1. For under water concrete 10% extra cement should be used over and above the normal cement content of the concrete mix specified above
2. Maximum cementitious material content shall be limited to 500kg/m³

Table 6.5 : Maximum Water-Cement Ratio

Sl. No.	Environment	Maximum Water-Cement Ratio		
		Plain Concrete	Reinforced Concrete (RCC)	Prestressed Concrete (PSC)
1	Moderate	0.50	0.45	0.40
2	Severe	0.45	0.40	0.40
3	Extreme	0.40	0.35	0.35

6.3.4 Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e. "Design Mix". For all items of concrete, only "Design Mix" shall be used,

6.4 Permeability

One of the main characteristics influencing the durability of any concrete is its permeability. Therefore, tests for permeability shall be carried out for concrete bridges as recommended herein.

- a) Permeability test shall be mandatory for all RCC/PSC bridges under severe and extreme environment.
- b) Under moderate environment, permeability test shall be mandatory for all major bridges.
- c) For other bridges permeability test is desirable to the extent possible.

With Strong, dense aggregates, a suitably low permeability is achieved by having a sufficiently low water-cement ratio, by ensuring as thorough compaction of the concrete as possible and by ensuring sufficient hydration of cement through proper curing methods. Therefore, for given aggregates, the cement content should be sufficient to provide adequate workability with a low water-cement ratio so that concrete can be completely compacted by vibration. Test procedure for penetration measuring permeability has been given in Appendix-G of IRS Concrete Bridge Code-1997. The depth of penetration of moisture shall not exceed 25mm.

6.5 Proportioning of Concrete

6.5.1 Prior to the start of construction, the Contractor shall design the mix and submit to the Engineer for approval, the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticisers or super-plasticisers) may be used at the Contractor's option, subject to the approval of the Engineer. Other types of admixtures shall be prohibited, unless specifically permitted by the Engineer.

6.5.2 Requirements of Consistency

The mix shall have the consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency.

The optimum consistency for various types of structures shall be as indicated in Table 6.6 below or as consented by the Engineer. The slump of concrete shall be checked as per IS:516. Table

6.6: Optimum Consistency Requirements.

Sl. No.	Type of Structure	Slump (mm)
1	Structures with exposed inclined surface requiring low slump concrete to allow proper compaction	25
2	Plain cement concrete	25

3	RCC structures with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40-50	
4	RCC structures with fair degree of congestion of reinforcement e.g. pier and abutment caps, box culverts	50-75	
	well curb, well cap, walls with thickness greater than 300 mm		
5	RCC and PSC structures with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75-125	

6.5.3 Requirements for Designed Mixes

(1) Target Mean Strength

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the "current margin".

(i) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.65 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.

(ii) Concrete of each grade shall be analysed separately to determine its standard deviation. The standard deviation of concrete of a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified in the "Tests and Standards of Acceptance" of this section. Estimated standard deviation $S_d = \sqrt{\sum \Delta^2 / (n - 1)}$ Where, Δ is the deviation of the individual test strength from the average strength of n samples and n is the number of sample test results. When significant changes are made in the production of concrete batches (for example changes in the materials used, mix design, equipment or technical control), the standard deviation value shall be separately calculated for such batches of concrete and current margin as well as target mean strength shall be worked out again.

(iii) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table 6.7 below

Table 6.7: Current Margin for Initial Mix Design

Sl. No.	Concrete Grade	Current Margin (MPa)	Target Mean Strength (MPa)
1	M 15	10	25
2	M 20	10	30

3	M 25	11	36
4	M 30	12	42
5	M 35	12	47
6	M 40	12	52
7	M 45	13	58
8	M 50	13	63
9	M 55	14	69

The initial current margin given in the Table 6.7 shall be used till sufficient data is available to determine the current margin as per sub-clause (i) above.

(iv) The concrete mixes shall be designed to produce the grade of concrete having the required workability, durability and characteristic strength.

(2) Trial Mixes

The Contractor shall give notice to enable the Engineer to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor shall prepare trial mixes, using samples of approved materials typical of those he proposes to use in the works, for all grades prior to commencement of concreting. The initial trial mixes shall generally be carried out in an established laboratory approved by the Engineer. In all cases complete testing of materials forming the constituents of proposed Design Mix shall have been carried out prior to making trial mixes and consented by Engineer. When the site laboratory is utilised for preparing initial mix design, the concreting plant and means of transport employed to make the trial mixes shall be similar to that proposed to be used in the works. Test cubes shall be taken from trial mixes as follows.

For each mix, set of six cubes shall be made from each of three consecutive batches. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Engineer. The cubes shall be made, cured,

stored, transported and tested in accordance with these specifications. The average strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa.

(3) Control of Strength of Design Mixes

(i) Adjustment to Mix Proportion

Adjustments to mix proportions arrived at in the trial mixes shall be made subject to the approval of Engineer, in order to minimise the variability

of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

(ii) Change of Current Margin

When required by the Engineer, the Contractor shall recalculate the current margin in accordance with procedure specified above. The recalculated value shall be adopted as consented by the Engineer, and it shall become the current margin for concrete produced subsequently,

(iii) Additional Trial Mixes

During production, the Contractor shall carry out trial mixes and tests, if required by the Engineer, before substantial changes are made in the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with sub-clause (i) above

6.5.4 Additional Requirements

Additional requirements shall also consist of the following overall limits of deleterious substances in concrete :

(1) The total chloride content of all constituents of concrete as a percentage of mass of cement in mix shall be limited to values given below :

(i) For Pre-stressed Concrete work under extreme environment : 0.06%

(ii) For Pre-stressed Concrete work under severe and moderate environment:0.1%

(iii) For Reinforced Concrete works : 0.15

(2) The total sulphuric anhydride (SO₃) content of all the constituents of concrete as a percentage of mass of cement in the mix shall be limited to 4%

6.5.5 Suitability of Proposed Mix Proportions

The Contractor shall submit the following information for the approval of Engineer :

(i) Nature and source of each material

(ii) Quantities of each material per cubic meter of fully compacted concrete

(iii) Either of the following :

a) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement(s) as specified.

b) Full details of tests on trial mixes.

(iv) Statement giving the proposed mix proportions for nominal mix concrete. Whenever there is a significant change in the quality of any of the

ingredients for the concrete, the Engineer may order the carrying out fresh trial mixes at no extra cost.

Any change in the source of material or in the mix proportions shall be subject to the prior approval of Engineer

6.6 Admixtures

Engineer may permit use of admixtures for imparting special characteristics to the concrete or mortar on satisfactory evidence that the use of such admixtures does not adversely affect the properties of concrete or mortar particularly with respect to strength, volume change, durability and has no deleterious effect on reinforcement.

Use of admixtures such as superplasticisers for concrete may be made with the prior approval of the Engineer and should meet the requirements as specified in Chapter 4: Materials for Structures of these specifications.

Manufacturers shall recommend the use of any one of his products only after obtaining complete knowledge of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the project.

6.7 Size of Coarse Aggregates

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be as specified in Table 6.8

Table 6.8: Maximum Size of Coarse Aggregate

Sl. No.	Component	Maximum Nominal Size of Coarse Aggregate (MM)
1	Reinforcement Cement Concrete (RCC) for solid type piers & abutments and Pile Cap	20
2	All other RCC & Pre-stressed Concrete Works	20

The proportions of the various individual size of aggregates shall be so adjusted that the grading produces densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

6.8 Equipment

The type, numbers, capacity, their location & mobilization & de-mobilisation schedule of the equipment for production, transportation and compaction of concrete including the measuring devices and their accuracy, to be used for the project shall be subject to the consent of the Engineer.

6.9 Batching & Mixing

6.9.1 In proportioning concrete, the quantity of cement, aggregate and water should be determined by weigh batching. Any solid admixture that may be added, may

be measured by weight, liquid and paste admixtures by volume or weight. Batching plant should conform to IS: 4925. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy periodically checked, Coarse and fine aggregates shall be batched separately. The grading of the aggregates should be controlled by blending the different sizes of aggregates in right proportion. The amount of added water shall be adjusted to compensate moisture contents in aggregates.

6.9.2 Concrete shall be mixed in a batching and mixing plant. Hand mixing shall not be permitted. The plant shall be at a location consented by Engineer considering the properties of the mixes and the transportation arrangements available with the Contractor. Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

6.10 Transporting, Placing and Compaction of Concrete

6.10.1 The method of transporting and placing concrete shall be approved by the Engineer.

Concrete shall be transported and placed as near as practicable to its final position without re-handling, so that no contamination, segregation or loss of its constituent materials takes place. Concrete shall not be freely dropped into place from a height exceeding 1.5 meters.

6.10.2 Ready Mixed Concrete:

- (1) Ready Mixed Concrete may be used subject to prior consent of the Engineer. It shall conform to the specifications of concrete as specified herein and IS: 4926.
- (2) The quality of admixtures like water reducing agent, retarders, super plasticisers cum retarders etc. should meet the requirements of Chapter 4: Materials for Structures of these Specifications and its suitability tested as per IS: 9103 at the time of finalizing the mix design.
- (3) Under any circumstances, retempering of concrete shall not be allowed.
- (4) Ready mixed concrete shall be transported in transit agitators conforming to IS:5892. Agitating speed of the agitators during transit shall not be less than 2 revolutions per minute and not more than 6 revolutions per minute.
- (5) The concrete shall be delivered completely to the site of work within 1½ hours (when the atmospheric temperature is above 20°C) and within 2 hours (when the atmospheric temperature is at or below 20°C) of adding the mixing water to the dry mix of cement and aggregate or adding the cement to the aggregate, whichever is earlier. Time of such introduction shall be recorded on the delivery note together with the weight of constituents of each mix. In case, location of site of construction is such that this time period is considered inadequate, increased time period may be specified provided that

properties of concrete have been tested after lapse of the proposed delivery period at the time of finalising mix design.

- 6.10.3 When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without the use of excessive quantity of water and without segregation of its ingredients.
- 6.10.4 In case of pumped concrete conveyed by pressure through rigid pipe or flexible hose and discharged directly in to the desired area, the pumping rate should be 10 to 70m³ per hour. Effective pumping range is 300m horizontally and 90m vertically.
- 6.10.5 All formwork and reinforcement contained in it shall be cleaned and made free from standing water & dust.
- 6.10.6 All corners of concrete shall have chamfers of 25mm
- 6.10.7 No concrete shall be placed in any part of the structure until the consent of the Engineer has been obtained.
- 6.10.8 If concreting is not started within 24 hours of the consent being given, it shall have to be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.
- 6.10.9 Except where otherwise consented to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used. Concrete cover blocks of the same strength and density as parent concrete shall be used.
- 6.10.10 Concrete when deposited shall have a temperature of not less than 5 degrees Celsius, and not more than 40 degrees Celsius, It shall be compacted in its final position within 30 minutes of its discharge from the mixer or agitator (in case of Ready Mixed Concrete) as the case may be,
- 6.10.11 No concrete shall be allowed without vibration except under water concreting or tremie concreting.
- 6.10.12 Concrete shall be thoroughly compacted by vibration during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. To achieve proper compaction mechanical vibrators shall be used. The vibrators can be internal or external type and depending on the shape and size of the member, both the types may be used in combination. When internal vibrators are used, they shall be used vertically to the full depth of the layer being placed and shall penetrate into the layer below while it is still plastic to the extent of 100mm. The vibrator shall be kept in place until air bubbles cease to escape from the surface and then withdrawn slowly to ensure that no hole is left in concrete, care being taken to see

that it remains in continued operation while being withdrawn. Vibrators should not be used to move the concrete as it can cause honeycombing.

- 6.10.13 Internal vibrators shall be inserted in an orderly manner and distance between insertions should be about 1.5 times the radius of the area visibly affected by vibration. For horizontal and vertical operations of the vibrators, the spacing of points of vibration shall be such that the zone of influence overlap
- 6.10.14 Form vibrators shall be used in addition to internal vibrators in case of pre-stressed concrete girders / slabs etc.
- 6.10.15 The use of vibrators complying IS: 2505, IS:2506, IS; 2514 and IS: 4656 for compacting the concrete is recommended. Over-vibration and under vibration of concrete should be avoided .
- 6.10.16 Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns.
- 6.10.17 Concrete should be compacted before setting commences and should not be subsequently disturbed
- 6.10.18 Bearing areas for members shall be finished to true plane so as to give uniform bearing on the entire area. Bearing plane shall be horizontal even for the bridges on grade

6.11 Clear Cover to Reinforcement

- (1) Clear cover shall not be less than the size of the bar or the maximum aggregate size plus 5mm. In case of a bundle of bars, it should be equal to or greater than the size of single bar of equivalent area plus 5 mm.
- (2) From durability consideration, minimum clear cover shall be as per Table 6.9:

Reinforcement.	Type of Structure	Clear Cover (in mm) for Environmental		
		Extreme	Severe	Moderate
1	Slab	50	35	25
2	Beam / Girder	60	50	35
3	Column	75	75	50
4	Well, Pile & Footing	75	75	50

- (3) Clear cover shall not exceed 75mm in any type of structure
- (4) For pre-stressing wires and strands, a minimum cover of 50mm shall be provided for all types of environment conditions
- (5) The cover to any pre-stressing duct shall not be less than 75mm

- (6) Clear cover shall be uniform and as per the drawings

6.12 Construction Joints

- 6.12.1 Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings, except with prior consent of the Engineer in case of emergencies. The joints shall be provided in a direction perpendicular to the member axis. Cold joints should be totally eliminated. The location of the construction joint, procedure for surface preparation of construction joint and sequence of concreting shall be subject to consent of the Engineer.
- 6.12.2 Concreting shall be carried out continuously up to the construction joints, the position and arrangement of which shall be predetermined by the designer.
- 6.12.3 The use of construction joints in pre-stressed concrete work should be avoided. However, if found unavoidable, they shall be provided by adopting proper construction techniques.
- 6.12.4 Properly designed reinforcement shall be provided for transfer of full tensile stress across the joints prior to casting of the next lift.
- 6.12.5 Position of Construction Joints:
 - (1) Construction joints should be positioned to minimise the effect of the discontinuity on the durability, structural integrity and appearance of the structure.
 - (2) As far as possible, joints should be positioned in non-aggressive zones, but if aggressive zones cannot be avoided, joints should be sealed.
 - (3) Joints should be positioned where they are readily accessible for preparation and concreting, the preparation of the joints is more likely to be satisfactory where the cross section is relatively small and where reinforcement is not congested.
 - (4) As far as possible, joints for fair faced concrete should be located where they conform with the architectural features of the construction. Unless they are masked in this way, the position of the joints are always obvious, even when the concrete is given a textured finish.
 - (5) If substantial changes in the cross section of a member are necessary, the joints should be formed where they minimise stresses caused by temperature gradients and shrinkage.
 - (6) Joints should be located away from regions of maximum stress caused by loading, particularly where shear and bond stress are high. Construction joints between slabs and ribs in composite beam should be avoided. As a general rule, joints in column are made as near as possible to the beam hunching, joints in beams and slabs should normally be made at the centre or within the middle third of the span.
- 6.12.6 Preparing the surface of the Joint

- (1) The minimum number of joints should be used and their construction should be simple. They should be either horizontal or vertical, because concreting sloping surfaces are usually unsatisfactory.
- (2) Where concrete is placed in vertical members e.g. walls, columns and the like, the lift of concrete shall finish level or at right angles to the axis of the member, the joint line matching the features of the finished work. Concreting shall be carried out continuously upto the construction joint.
- (3) Laitance, both on the horizontal and vertical surfaces of the concrete, should be removed before fresh concrete is cast. The surface should be roughened to promote good adhesion. Various methods for removal can be used but they should not dislodge the coarse aggregate particles. Concrete may be brushed with a stiff brush soon after casting while the concrete is still fresh, and while it has only slightly stiffened.
- (4) If the concrete has partially hardened, it may be treated by wire brushing or with a high pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed.
- (5) Fully hardened concrete should be treated with mechanical hand tools or grill blasting, taking care not to split or crack aggregate particles.
- (6) The best time for treating the joint is a matter of judgment because it depends on the rate of setting and hardening (which is itself dependent on the temperature of the concrete). Before further concrete is cast, the surface should be thoroughly cleaned to remove debris and accumulated rubbish, one effective method, being air jet.
- (7) Where there is likely to be a delay before placing the next concrete lift, protruding reinforcement should be protected. Before the next lift is placed, rust, loose mortar or other contamination should be removed from the bars and where conditions are particularly aggressive and there has been a substantial delay between lifts, the concrete should be cut back to expose the bars for a length of about 50mm to ensure that contaminated concrete is removed.
- (8) In all cases, when construction joints are made, to essential it is ensure that the joint surface is not contaminated with release agents, dust or curing membrane, and that the reinforcement is fixed firmly in position at the correct cover.

6.12.7 Concreting at Construction Joints

- (1) When the form work is fixed for the next lift, it should be inspected to ensure that no leakage can occur from the fresh concrete. It is a good practice to fix a6mm thick sponge which seals the gap completely.
- (2) The practice of first placing a layer of mortar or grout is not recommended. The old surface should be soaked with water without leaving puddles, immediately before starting concreting, then the new concrete should be thoroughly compacted against it. When fresh concrete is cast against

existing mature concrete or masonry, the older surfaces should be thoroughly cleaned and soaked to prevent the absorption of water from the new concrete. Standing water should be removed shortly before the new concrete is placed and the new concrete should be thoroughly vibrated in the region of the joint.

6.13 Protection and Curing

6.13.1 Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor. Curing and protection of concrete shall start immediately after compaction of the concrete to protect it from :

- a) Premature drying out particularly by solar radiation and wind
 - b) High internal thermal gradients
 - c) Leaching out by rain and flowing water
 - d) Rapid cooling during the first few days after placing
 - e) Low temperature or frost
 - f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement
- Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

6.13.2 Moist Curing

The concrete should be kept constantly wet for a minimum period of 14(fourteen) days. Water should be applied on unformed surfaces as soon as it can be done without marring the surface and on formed surfaces immediately after the forms are stripped. The concrete shall be kept constantly wet by ponding or covered with a layer of sacking, canvas, hessian or a similar absorbent material. When air temperature is expected to drop below 5°C during the curing period, additional covering of cotton/gunny bags, straw or other suitable blanketing material shall be provided so that concrete temperature at surface does not fall below 10°C.

6.13.3 Curing Compound

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer. Such compounds shall be applied to all exposed surfaces of the concrete along with stripping of form work. Tests shall be done to ascertain:

- a) Loss of moisture in concrete with and without curing compound.
- b) Cube strength of concrete with moist curing and curing compound.
- c) Permeability of concrete.

Curing compound shall not be used on any surface requiring further finishing to be applied. All construction joints shall be moist, cured and no curing compound will be permitted in locations where concrete surfaces are required to be bonded together. Curing compounds shall be continuously agitated during use. Concrete to be cured by this method shall receive two applications of curing compound.

6.13.4 Steam Curing

Steam curing can be advantageously used to save time of curing of concrete for transfer of pre-stress. The optimum steam curing cycle for a particular situation can only be determined by trial and error. However, it has been found satisfactory to use a pre- steaming period of 4 to 5 hour or rate of temperature rise between 22-33°C per hour and a maximum curing temperature of 66-82°C for a period such that entire curing cycle does not exceed 18 hour. Rapid temperature changes during the cooling period should be avoided and drop in ambient temperature in the enclosure is not sharper than 20°C per hour. The reuse of casting beds and forms along with 18 hour steam curing makes it a total 24 hour cycle. Pre-stress to members in pretension beds should be transferred immediately after the termination of steam curing while the concrete and forms are still warm, otherwise the temperature within the enclosure shall be maintained at over 15°C until the pre-stress is transferred to the concrete. The steam curing will be considered complete when the concrete has reached the minimum strength at 'Strength at Stress transfer' or handling strength.

6.14 Finishing

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with suitable epoxy mortar. All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges. Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance shall be rejected.

6.15 Setting out for Bridges

6.15.1 Alignment for Bridges: In order to facilitate the setting out of the work, the centre line of the bridges must be accurately established by the Contractor and shall be consented by the Engineer.

6.16 Open Foundations

- 6.16.1 Where the bearing surface is earth, a layer of M-15 concrete shall be provided below foundation concrete. Thickness of lean concrete shall be 100mm minimum, unless otherwise specified.
- 6.16.2 Before laying lean concrete layer, the earth surface shall be cleaned of all loose materials. No construction joint shall be provided in lean concrete.
- 6.16.3 For foundation concrete work, side formwork shall be used. Form work for top of foundation shall also be provided, if top has slopes steeper than 1(vertical) to 3(horizontal). Where concrete is laid in slope without top form work, the slump of the concrete shall be carefully maintained to ensure that compaction is possible without slippage down of freshly placed concrete.
- 6.16.4 Foundation concrete of required dimensions and shape shall be laid continuously up to the location of construction joint shown on the drawings. Dewatering, where

necessary for laying the concrete shall be carried out adopting the method duly consented by the Engineer.

6.16.5 Form work shall be removed not earlier than 24 hours after placing of concrete. Where form work has been provided for top surface, the same shall be removed as soon as concrete has hardened.

6.16.6 Before backfilling is commenced, loose sand on foundation shall be removed & disposed. Protective works where provided shall be completed before the floods so that the foundation does not undermined

6.17 Sub-structure

6.17.1 Piers and Abutments:

- (1) In case of concrete piers, the number of horizontal construction joints shall be kept to minimum. Construction joints shall be avoided in splash zones unless specifically consented by the Engineer and provided they are treated in accordance with special provisions. No vertical joint shall be provided.
- (2) In case of tall piers and abutments, use of slip form shall be preferred. The design, erection and raising of slip form shall be subject to special specifications which shall be furnished by the Contractor. The concrete shall also be subject to additional specifications as necessary. All specifications and arrangement shall be subject to consent of the Engineer.
- (3) In case of abutments likely to experience considerable movement on account of backfill of approaches and settlement of foundations, the construction of abutment shall be followed by filling up of embankment in layers to the full height to allow for the anticipated movement during construction period before casting of super- structure.
- (4) Where pier type abutments are provided without wing walls and return walls, the earth fill around the abutment shall be protected by providing properly designed stone pitching on slopes and apron at toe of the fill
- (5) Stone pitching on the slopes of the embankment on approaches of the bridge shall be as per the Specifications contained herein

6.17.2 Pier Cap and Abutment Cap:

Surface of the cap shall have slope for draining of water. For short span slab bridges with continuous support on pier caps, the surface shall be cast horizontal. The top surface of the pedestal on which bearings are placed shall also be cast horizontal. The surface on which elastomeric bearings are to be placed shall be wood float finish to a level plane which shall not vary more than 1.5mm from straight edge placed in any direction across the area. The surface on which other bearings are to be placed shall be cast about 25mm below the bottom level of bearings and as indicated in drawings.

6.17.3 Ballast Wall, Return Wall, Retaining Wall and Wing Wall : In case of cantilever return walls, no construction joint shall generally be permitted. Wherever feasible, the concreting in cantilever return wall / retaining wall shall be carried out in continuation of ballast wall. For gravity type return/ retaining and wing walls, no horizontal construction joint shall be provided. Vertical expansion gap of 20mm shall be provided in return wall/ wing wall / retaining wallat every 10 meter intervals or as consented by the Engineer.

6.17.4 Joints :Butt joints should be provided between wing walls and abutment, wing wall and return walls and for various tracks when the bridge is for more than one track to cater for differential settlement in case of poor soil.

6.17.5 Weep Holes:

- (1) Weep holes shall be provided through abutments, wing or return walls/ Retaining wall and parapets. Weep holes shall be provided with 100mm dia pipe for structures in plain / reinforced concrete. Weep holes in the ballast wall shall be provided with 75mm dia pipes. Weep holes shall extend through full width of the concrete with slope 1 vertical : 20 horizontal towards draining face. Spacing of the weep holes shall generally be 1m in either direction in a staggered manner with the lowest at about 150mm above the low water level or ground level whichever is higher.

6.17.6 Backfill Material :

- (1) Backfill Behind Abutment, Wing Walls, Retaining Wall and Return Walls Behind abutments, wing walls and return walls/ Retaining wall, boulder filling and backfill material shall be provided as per clause 7.5 of ‘Code of Practice for the Design of Sub-structures and Foundations of Bridges. Boulder filling shall consist of well hand packed boulders & cobbles to thickness not less than 600mm with smaller size towards the back. Behind the boulder filling, backfill material shall consist of granular materials of GW, GP, SW groups as per IS: 1498-19706.18

6. 18 Tolerances

Tolerances for the finished concrete bridge structures shall be as specified in Table 6.10 below

Table 6.10: Tolerances for Finished Concrete Bridge Structures

Sl. No.	Description	Tolerances
1	Shift from Alignment	± 25 mm
2	Deviation from plumb or specified batter for face of exposed piers	1 in 250, subjected to a maximum value of 0.5 times the least lateral dimension of pier

3	Deviation from plumb or specified batter for face of back filled abutments	1 in 125
4	Cross Sectional dimensions of piers, abutments and girders.	- 5 mm + 20 mm
5	Thickness of deck slab of bridges	+ 6 mm - 3 mm
6	Size and location of openings	\pm 12 mm
7	Plan dimensions of footings(formed)	+ 50 mm - 25 mm
8	Plan dimensions of footings(unformed excavation)	+ 75 mm - 00 mm
Sl. No.	Description	Tolerances
9	Thickness of footings	+ No limit - 5%
10	Footing eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
11	Reduced level of top of footing/pier / bed block	\pm 5 mm
12	Centre to centre distance of pier and abutments at pier top	\pm 30 mm
13	Centre to Centre distance of bearings along span	\pm 5 mm
14	Centre to centre distance of pier bearings across span	+ 5 mm

6.19 Tests and Standards of Acceptance of Concrete

6.19.1 Concrete shall conform to the surface finish and tolerance as prescribed in these specifications for respective components

6.19.2 Random sampling and lot by lot of acceptance inspection shall be made for the 28 days cube strength of concrete.

6.19.3 Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following :

- a) No individual lot shall be more than 30 cu.m. in volume
- b) At least one cube forming an item of the sample representing the lot shall be taken from concrete of the same grade and mix proportions cast on any day.
- c) Different grades of mixes of concrete shall be divided into separate lots
- d) Concrete of a lot, shall be used in the same identifiable component of the bridge

6.19.4 Sampling and Testing

Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure hid down in IS: 1199. A random sampling procedure to ensure that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes shall be adopted. 150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS:516. The 28-day test strength result for each cube shall form an item of the sample.

6.19.5 Test specimen and sample strength: Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS: 9013. The specimen shall be tested as described in IS: 516

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than ± 15 percent of the average.

6.19.6 Frequency : The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 6.11 below

Table 6.11: Minimum Frequency of Sampling of Concrete

Sl. No.	Quantity of Concrete in	No. of Samples
1	1-5	1
2	6-15	2
3	16-30	3
4	31-50	4

5	51 and above	4 plus one additional sample for each additional 50 m ³ or part thereof
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6.19.7 Acceptance Criteria

- (1) Compressive Strength : When both the following conditions are met, the concrete complies with the specified compressive strength:
 - (i) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in Column A of Table 6.12 below;
 - (ii) Any individual test results complies with the appropriate limits in Column B of Table 6.12 below.
- (2) Flexural strength: When both the following conditions are met, the concrete complies with the specified flexural strength:
 - (i) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm²
 - (ii) The strength determine from any test result is not less than the specified characteristic strength less 0.3 N/mm².

Table 6.12: Characteristic Compressive Strength Compliance Requirements

Sl. No	Specified Grade	Group of Test Results	A	B
			The mean of the group of test result exceeds the specified characteristic compressive strength by at least:	Any individual test result is not less than the characteristic compressive strength less:
1	M 20 & above	Any consecutive 4	3 N/mm ²	3 N/mm ²

(2) Quantity of Concrete Represented by Strength Test Results:

- (i) The quantity of concrete represented by a group of 4 consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

- (ii) For the individual test result requirements given in Column B of Table 5.12 above or in item (ii) of para (2) above only the particular batch from which the sample was taken shall be at risk.
- (iii) Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60m³.
- (4) If the concrete is deemed not to comply pursuant to the Flexural Strength Criteria, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.
- (5) Concrete of each grade shall be assessed separately.
- (6) Concrete shall be assessed daily for compliance.
- (7) Concrete is liable to be rejected if:
 - (i) it is porous or honey combed;
 - (ii) its placing has been interrupted without providing a proper construction joint
 - (iii) the reinforcement has been displaced beyond the tolerances specified; or
 - (iv) construction tolerances have not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer.

6.20 False Work

6.20.1 Falsework shall be designed to meet the requirements of the permanent structure, taking into account the actual conditions of materials, environment and site conditions. Careful attention shall be paid to the detailing of connections and function with a view to avoiding gross errors leading to significant damage or failure. All false work as designed by the Contractor shall be subject to the consent of the Engineer before starting of the work

6.20.2 Falsework shall be designed to cater for following loads:

- a) Dead load of wet concrete and reinforcement;
- b) Weight of form work;
- c) Plant and equipment including impact;
- d) Impact due to deposition of concrete; e)
Construction personnel;
- f) Pre-stressing loads;
- g) Lateral loads;
- h) Wind loads; and

i) Force due to water current, if any.

6.20.3 Materials: All the materials shall conform to the specified quality consistent with the intended purpose and actual site condition as applicable.

6.20.4 Falsework Plans: Falsework plans shall include the following information:

- (1) Design Assumptions – All major design values and loading conditions shall be shown on these drawings. They include assumed values of superimposed load, rate of placement, mass of moving equipment which may be operated on formwork, foundation pressures, camber diagram and other pertinent information, if applicable.
- (2) Types of materials, sizes, lengths and connection details.
- (3) Sequence of removal of forms and shores.
- (4) Anchors, form ties, shores and braces
- (5) Field adjustment of the form during placing of concrete.
- (6) Working scaffolds and gangways.
- (7) Weep holes, vibrator holes or access doors for inspection and placing of concrete.
- (8) Construction joints, expansion joints.
- (9) Sequence of concrete placements and minimum/maximum elapsed time between adjacent placements.
- (10) Chamfer strips or grade strips for exposed corners and construction joints.
- (11) Foundation details for falsework. Special provisions such as protection from water, ice and debris at stream crossings.
- (12) Form coatings and release agents.
- (13) Means of obtaining specified concrete.
- (14) Location of box outs, pipes, ducts, conduits and miscellaneous inserts in the concrete attached to or penetrating the forms.
- (15) Location and spacing of rubber pads where shutter vibrators are used.

6.21 Form Work

6.21.1 General : Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as consented by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support. The design, erection and removal of formwork shall conform to IRC:87 "Guidelines for Design and Erection of Falsework for Road Bridges" and these specifications. All form work, staging scheme etc. as designed by the Contractor shall be subject to consent of the Engineer.

6.21.2 Material : All materials shall comply with the requirements of IRC87. Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk.

The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Materials and component used for the formwork shall be examined for damage or deterioration before use / re-use. In case of timber formwork, the inspection shall also cover signs of attacks by decay, rot or insect attack or development of splits

6.21.3 Design of Formwork :

- (1) The formwork must be designed keeping in view all loads and forces. The Contractor shall furnish the design and drawing of complete formwork including staging scheme for consent of the Engineer before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information to the Engineer as required by him. Notwithstanding any consent to the design & drawings by the Engineer, the Contractor shall be entirely responsible for the adequacy and safety for formwork.
- (2) The design of the formwork shall conform to provisions of IRC:87. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection. In the case of prestressed concrete superstructure, careful consideration shall be given to redistribution of loads on props due to prestressing.

6.21.4 Workmanship :

- (1) Formwork shall be so constructed and supported as to remain sufficiently rigid during the placement and compaction of the concrete and shall be sufficiently watertight to prevent loss of water or mortar from concrete.
- (2) Forms for finished surfaces should be smooth and mortar tight. If wood forms are used, the boards must be uniform in the thickness, tongued and grooved, smoothly finished on the surface next to the concrete, evenly matched and tightly placed, except where the desired surface or appearance requires special treatment. The use of forms of ply-wood/steel/similar product is also permitted.
- (3) Moulds for pretension works shall be sufficiently strong and rigid to withstand, without distortion, the effects of placing and compacting concrete as well as those prestressing in case of manufacture by the individual mould process where the prestressing tendon is supported by the mould before transfer.
- (4) The number of joints in the formwork shall be kept to a minimum by using large size panels. Design shall provide for proper soldiers to facilitate alignment. All joints shall be leak proof and must be properly sealed. Use of PVC joint sealing tapes, foam rubber or PVC T-section is essential to prevent leakage.
- (5) As far as possible, clamps shall be used to hold the forms together. Where use of nails is unavoidable, minimum number of nails shall be used and these shall be

left projecting so that they can be easily withdrawn. Use of double headed nails shall be preferred.

- (6) Use of ties shall be restricted as far as practicable. Wherever ties are used they shall be used with HDPE sheathing so that the ties can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.
- (7) Unless otherwise specified, Chamfers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, bevelled edges and mouldings shall be made in the formwork itself.
- (8) Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning.
- (9) The formwork shall be constructed with precamber to the soffit to allow for deflection of the formwork. It shall take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures having regard to the deformation of the false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting the prestressed structures.
- (10) Where centering trusses or launching trusses are adopted for casting of superstructures, their joints should be thoroughly checked periodically. Also various members of centering truss should be periodically examined for proper alignment and unintended deformation & deterioration due to corrosion before proceeding with concreting.
- (11) Formwork shall be so made so as to produce a finished concrete true to shape, line and levels and dimensions as shown in the drawings subject to tolerances as specified in these specifications.
- (12) Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.
- (13) Screw jacks or hard wedges where required shall be provided to make up any settlement before or during placing of concrete.
- (14) Special measures in the design of formwork shall be taken to ensure that it does not hinder the shrinkage of concrete. Soffit of the formwork shall be so designed as to ensure that the formwork does not restrain the shortening and / hogging of beams during prestressing.
- (15) Any cut-out or openings provided in any structural member to facilitate erection of formwork shall be closed with the same grade of concrete as the

adjoining structure immediately after removal of the formwork ensuring watertight joints.

- (16) Provision shall be made for safe access on, to and about the formwork at the levels as required.
- (17) Water used for curing should not be allowed to stagnate near the base plates supporting the staging and should be properly drained.
- (18) The formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating (machine oils) shall be prohibited for use as coating. Release agent shall be applied strictly in accordance with the manufacturer's instructions. Same type & make of release agent shall be used throughout the similar formwork material and different types should not be mixed.
- (19) Release agent shall not come in contact with reinforcement
- (20) For steel props, the maximum deviation from straightness is 1/600 of length
- (21) All formwork shall be thoroughly cleaned immediately before concreting and shall be subject to consent of the Engineer

6.21.5 Formed Surface and Finish

The formwork shall be lined with the material consented by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall have no stain on the concrete and so fixed to its backing as not to impart any blemishes. Internal ties and embedded metal parts shall be carefully detailed and their use shall be subject to consent by the Engineer.

6.21.6 Finishing :

No surface finishing will normally be provided. If minor defects are noticed, the surface should be rendered. The required finish shall be obtained by use of properly designed formwork of closely jointed boards. The surface may be improved by carefully removing all fins and other projections, thoroughly washing down and then filling the most noticeable surface blemished with a cement and fine aggregate paste. For major defects, if noticed any repairs should be carried out with prior consent of the Engineer.

- 6.21.7 Cleaning and Treatment of Form : All rubbish particularly chippings, shavings and sawdust shall be removed from the interior of the forms before the concrete is placed and the formwork in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved release agent. Care shall be taken that such approved release agent is kept out of contact with the reinforcement.

6.21.8 Stripping Time :

- (1) The scheme for removal of the formwork (i.e de-shuttering and de-centering) shall be planned in advance and shall be subject to consent of the Engineer. Formwork shall be so removed as not to cause any damage to concrete.
- (2) Forms shall not be struck until the concrete has reached a strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work. Where possible, the formwork shall be left longer as it would assist the curing.
- (3) In normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the periods as specified in Table 6.13 below

Table 6.13 : Stripping Time of Forms

Sl. No.	Member	Minimum Time for Stripping of the Form
1	Walls, Columns & Vertical faces of all structural members	24 to 48 hours as may be consented by the Engineer
2	Slabs (props left under)	3 days
3	Beam soffits (props left under)	7 days
4	Removal of props under slabs (i) Spanning upto 4.5m (ii) Spanning over 4.5m	7 days
5	Removal of props under beams (i) Spanning upto 6m (ii) Spanning over 6m	14 days

For other cements, the stripping time recommended for ordinary Portland cement may be suitably modified with the consent of the Engineer.

- (4) The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab or beam as the case may be together with any live load likely to occur during curing or further construction.

- (5) Where the shape of the element is such that the formwork has reentrants angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.
- (6) The forms should be so constructed as to be removable in the sections without marring or damaging the surface of the concrete. Forms should be removed as soon as possible in order to make necessary repairs and finish the surface. As soon as forms are removed, list of major/minor defects noticed in concrete should be prepared. Repairing methodology should be approved by the Engineer. After making necessary repairs, the surface should be finished with wood float so as to free from streaks, discolorations or other imperfections. Plastering should not be permitted and a steel trowel should not be used to finish surfaces.

6.22 Steel Reinforcement

6.22.1 Material

All the materials for steel reinforcement shall confirm to the requirements as specified in Chapter 4: Materials for Structures of these Specifications.

6.22.2 Protection of Reinforcement

Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paint. This may be ensured either by using reinforcement fresh from factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sand blasting, mechanical wire brushing subject to consent of the Engineer.

Portion of uncoated reinforcing steel and dowels projecting from concrete shall be protected within one week after initial placing of concrete with neat cement mixed with water to a consistency of thick paint. This coating shall be removed not more than one week before placing of the adjacent pour of concrete. If the coating on the bars is damaged during transportation or handling and cannot be repaired shall be rejected.

6.22.3 Bending of Reinforcement

Bar bending schedule shall be furnished by the Contractor subject to consent of the Engineer. Reinforcing steel shall conform to the dimensions and shape as per the bar bending schedules consented by the Engineer. Bars shall be bent cold Bars shall not be bent or straightened in a manner that will damage the parent material or the coating. Bars shall not be heated to facilitate straightening

Any reinforcement, which is bent, should not be rebent at the location of the original bend. Where the temperature of steel is below 5°C, special precautions may be necessary such as reducing the speed of bending or with the Engineer's approval, increasing the radius of bending. Reinforcement shall be bent and fixed in accordance with the procedures specified in IS: 2502 and shall not be straightened that will injure the material.

6.22.4 Placing of Reinforcement

- (1) All reinforcement shall be placed and maintained in the position as shown in the drawings
- (2) Cover and spacing of steel shall be uniform and as specified in the Specifications and as shown in the drawings
- (3) Reinforcement steel shall be adequately secured and bound together at all intersections with 1.6mm dia mild steel wire in accordance with IS:280 or approved reinforcement clips so that it maintains its position during casting and vibration of concrete. Free ends of the binding wires used to tie bars shall be bent into the member. For aggressive environment, galvanized binding wire shall be used.
- (4) Crossing bars should not be tack welded for assembly of reinforcement unless permitted by the Engineer.
- (5) All steel fabrics shall be lapped two meshes unless otherwise shown on the drawing and securely bound to the supporting bars with 1.6mm dia mild steel wire (IS:280) or approved reinforcement clips.
- (6) Sufficient spacers shall be provided as shall, in the opinion of the Engineer, be necessary to maintain specified concrete cover to the reinforcement and preventing displacement before and during the placement of the concrete. Spacers should be of such material and design as will be durable, will not lead to the corrosion of reinforcement and will not cause spalling of concrete cover. Spacer block made from cement, sand and small aggregates should match the mix proportion of concrete as far as is practicable with a view to being comparable in strength, durability and appearance. Use of wood, tile or porous material will not be allowed for this purpose. Concrete cover blocks shall contain the binding wire to secure it to the reinforcement.
- (7) Subject to the reduction in bond stress, bars may be arranged as pairs in contact or in groups of three or four bars bundled in contact. Bundled bars shall be tied together to ensure the bars remaining together. Bars larger than 32 mm diameter shall not be bundled except in columns. Bars shall not be used in a member without stirrups. Bars in a bundle should terminate at different parts spaced at least 40 times the bars size apart except for bundles stopping at support
- (8) Layers of reinforcements shall be separated by spacer bars at approximately one meter intervals. The minimum diameter of spacer bars shall be 12 mm or equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater.
- (9) Reinforcement bars shall be adequately secured by chairs / ties / hangers so that it will maintain its position during casting and vibrating the concrete.
- (10) The coated reinforcing steel shall be held in place by

(11) No concreting shall be done until the reinforcement has been inspected by the Engineer.

6.22.5 Bar Splices

(1) Lapping :

(i) All reinforcement shall be furnished in full length as indicated in drawings.

No splicing of bars, except where shown on the drawings will be permitted without consent of the Engineer. Lengths of splice, wherever required, shall be as indicated on drawings and consented by Engineer. Lapped splices shall be staggered & located at points along the span where stresses are low.

(ii) Lap Length : Lap splices shall not be used for bars larger than 32 mm. When bars are lapped, the length of the lap shall at least equal the anchorage length required to develop the stress in smaller of the two bars lapped. Length of lap provided, however shall neither be less than 25 times the smaller bar size plus 150mm in tension reinforcement nor be less than 20 times the smaller bar size plus 150mm in compression reinforcement.

(iii) The lap length calculated in the preceding paragraph shall be increased by a factor of 1.4 if any of the following conditions apply:

- a) the nominal cover to the lapped bars from the top of the section as intended to be cast is less than twice the bar size;
- b) the clear distance between the lap and another pair of lapped bars is less than 150 mm ;
- c) a corner bar is being lapped and the nominal cover to either face is less than twice the bar size Where conditions (a) and (b) or conditions (a) and (c) apply the lap length shall be increased by a factor of 2.0.

(iv) Lap splices are considered to be staggered if the centre to centre distance of the splices is not less than 1.3 times the lap length

(v) In case of bundled bars, lapped splices of bundled bars shall be made by splicing one bar at a time; such individual splices within a bundle shall be so staggered that in any cross section there are not more than four bars in a bundle.

(2) Welding Joints or Mechanical Connections :

(i) Welded joints or mechanical connections in reinforcement may be used with the approval of the Engineer but in the case of important connections, test shall be made to prove that the joints are of the full strength of bars connected. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS: 2751 and inspection of welds shall conform to IS: 822

(ii) Welded joints may be permitted in cold worked bars conforming to IS: 1786 provided that the carbon equivalent calculated from the chemical composition of the bar is 0.4% or less. Welding of the cold worked bars may be done in accordance with the recommendations of IS: 9417. When cold- worked bars are welded, the stress at the weld should be limited to the strength of mild steel bars without cold-working.

(iii) Welded joints should not be located near the bends in the reinforcement. Wherever possible, joints in the parallel bars of principal tensile reinforcement should be staggered. The welded joints may preferably, be placed in regions of low stresses.

(iv) Bars may be joined with mechanical devices e.g. by special grade steel swaged on to bars in end to end contact or by screwed couplers or using bottle nuts, if consented by the Engineer. Patented systems with approved use shall only be permitted to be used on production of test results to the satisfaction of the Engineer. The effectiveness for such joints shall invariably be proved by static and fatigue strength tests. Such joints should preferably be located at sections where the bending moment is not more than 50 percent of the moment of resistance and such joints should be so disposed that at any section not more than 50% of the bars are connected by mechanical devices, bottle nuts or couplings.

7 Miscellaneous Works

7.1 Stone Pitching / Revetment on Slopes

7.1.1 Scope

The work shall consist of covering the slopes of banks with stone, boulders, cement concrete blocks over a layer of granular material called filter

7.1.2 Pitching

The pitching shall be provided as indicated in the drawings and consented by the Engineer. The shape of stone pitching shall be as per the approved drawings. The stones shall be sound, hard, durable and fairly regular in shape. Quarry stones shall be used for this purpose. Round boulders shall not be allowed. Stone subject to marked deterioration by water or weather shall not be accepted. The size and weight of stone shall conform to clause 5.3.5.1 of IRC: 89. No stone, weighing less than 40 Kg shall, however, be used. The sizes of spalls be a minimum of 25mm and shall be suitable to fill the voids in the pitching. Where the required sizes of boulders are not available economically, cement concrete boulders of equivalent weight shall be used. The grade of concrete shall be M-15 grade. Cement concrete blocks will be preferred wherever practicable.

7.1.3 Filter Media

The material for the filter media shall consist of sand, gravel, stone or coarse sand. To prevent escape of the embankment material through the voids of the stone pitching / cement concrete blocks as well as to allow free movement of water without creating any uplift head on the pitching, one or more layers of graded materials, commonly known as a filter medium, shall be provided underneath the pitching. Alternatively

the Contractor may suggest any other filter media subject to the approval by the Engineer.

7.2 Boulder Aprons, Sausages

7.2.1 Scope

This work shall consist of laying boulders on the bed of rivers for protection against scour.

7.2.2 Material

The stones used in Apron shall be sound, hard, durable and fairly regular in shape. Stone subject to marked deterioration by water or weather shall not be used. Quarry stones are preferable to round boulders as the later roll off easily. Angular stones fit into each other better and have good interlocking characteristics. The size of stone should conform to clause 5.3.7.2 of IRC: 89. The size of stone shall be as large as possible. In no case any fragment shall weigh not less than 40 Kg. The specific gravity of stones shall be as high as possible and it shall be not be less than 2.65.

Where the required sizes of boulders are not available economically, cement concrete boulders of equivalent weight shall be used. The grade of concrete shall be M-15. Cement concrete blocks shall be preferred where practicable.

7.2.3 Boulder Apron

To ensure regular and orderly disposition of the full intended quantity of stone in the apron, template cross walls in dry masonry shall be built about a meter thick and to the full height of the specified thickness of the apron at the intervals of 30 meters all along the length and width of the apron. Within these walls, the stones then shall behind packed.

The surface on which the apron is to be laid shall be leveled and prepared for the length and width as shown on the drawings. In case the surface on which apron is to be laid is below the low water level, the ground level may be raised up to low water level by dumping earth and the apron laid thereon. The quantity of stone required in the apron shall be re-worked out by taking the toe of pitching at higher level.

7.3 Other Public Utilities Existing Within Right of Way and Requiring Extension / Temporary Diversion / Handling / Support / Protection During Construction. All the Other public utilities (other than overhead power line 33KV & above) including under track crossing that could be identified and presently existing within Right of Way (ROW) are in the scope of works of contractor .Some of the said utilities, presently existing within the ROW, shall require extension up to the ROW boundary whereas some of them shall require casing to undertake the construction activities. All the other utilities shall require protection / support / temporary diversion during construction and as required by the respective utility owning agencies. The utilities requiring temporary diversion shall have to be restored back to their original position as required by the respective utility owning agency. In addition to the

above, during construction the Contractor shall also protect the public utilities which are being extended / diverted by the Employer.

Any damage caused to the utilities by the actions of the Contractor during construction shall have to be made good by the Contractor at his own cost and to the entire satisfaction of the respective utility owning agency.

SEVOK-RANGPO RAIL LINE PROJECT

TECHNICAL SPECIFICATIONS

CONSTRUCTION OF MELLI YARD

Bridge Super Structure

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1 General

These specifications for certain items contained herein are the Employer's minimum and specific requirements. These specifications are based on the provisions of various Codes and Employer's Requirements for the Works required to be undertaken by the Contractor under this Contract and for better understanding of the Contractor. However for details, the respective Codes shall be referred to. The order of precedence for various Codes has been specified in Clause 2.2 of these specifications.

Any modification / change in arriving at Specifications from the minimum specifications defined in this document shall not constitute a Variation

The Contractor shall also develop Method Statements and Test Procedures / Work Procedures / Plans and Manuals / Construction Drawings / Sketches etc. for all the items of Work, based on the Specifications, applicable Codes & Standards, best Engineering practices etc. and shall submit to the Engineer for his consent.

2 Standards

2.1 Introduction

The Materials and workmanship specification as follows has been based on Indian Standards and International Standards as scheduled below. Apart from the basic data, specifications etc. all items of works shall be governed by the Codes & Specifications as detailed hereunder and as revised / corrected / amended up to 28 days before the due date of submission of the Bid Proposal.

The Contractor will be responsible for detailing in his specification of the standards on which his materials and workmanship will be based, and these will be of similar or higher standard than those listed below.

The Contractor shall also be responsible for getting the approval from Engineer for the International Standards which are not specifically included herein below and the Contractor intends to apply the same for the detailing of his specification, additionally.

The Contractor is required to review in the first instance the relevant Indian Standards and other Standards / Codes as mentioned. The specifications will be primarily based on the said standards to the extent that they are applicable. However in case the Contractor intends to use any other International Standards, he should indicate the same in his proposal for consideration of the Employer. Usage of the same shall be subject to approval of the Engineer.

2.2 Relevant Standards

Apart from the basic data, Specifications and specific requirements listed in the Bid document, all items of works shall be governed by the latest versions of the following Codes, Specifications as revised/corrected/amended (with latest correction slip) up to the time of bidding. In case of any contradiction in various codal provisions, the order of precedence shall be as follows

- a) Technical Specifications (Bid Documents)

- b) IRS Codal provisions
- c) IRC Codal Provisions
- d) IS Codal Provisions
- e) Provisions in other International Codes

Notwithstanding the precedence specified above, the Contractor shall always seek advice from the Engineer and Employer in the event of any conflict, immediately for a final decision. Relevant standards are scheduled as below:

2.2.1 Indian Railway Standard Codes and Specifications (IRS)

- (1) Indian Railway Bridges Rules, specifying the loads for Design of Superstructure and Substructure of Bridges (with up to date correction slip) including Chapter – VII for the rule for the opening of Railway adopted in 1941 – Revised – August 1982.
- (2) Loading Standards as given in Design Criteria
- (3) Indian Railway Schedule of Dimensions for Board Gauge
- (4) Indian Railway Code for Practice of Plain/Reinforced and Pre-stressed concrete for general / bridge construction (Concreted Bridge Code) Second Revision 1997 with correction slip up- to-date.
- (5) IRS Specifications for Steel Bridges Code
- (6) IRS : Welded Bridge Code for steel bridge girders
- (7) Indian Railway Bridge Manual 1998 with correction slip up-to-date
- (8) Indian Railways Permanent Way Manual.
- (9) Indian Railways Works Manual.
- (10) IRS Standard Code of Practice for design of Sub-structure & Foundation.
- (11) IRS: Manual on the design and construction of well and pile foundation.
- (12) Guidelines for Earthwork in Railway Projects: Guideline No. GE: G-1, July, 2003.
- (13) Guidelines on Erosion Control and drainage of Railway Formation - Guideline No. GE: G-4
- (14) Report No. RDSO/2007/GE: 0011: Guidelines for blanket layer provision on track formation with emphasis on heavy axle load train operation.
- (15) Guidelines and Specifications for Design of Formation for Heavy Axle Load – Report No. RDSO / 2007 / GE : 14
- (16) Report No. GE:R-50: Transitional System on approaches of bridges issued by RDSO.
- (17) RDSO Specification No. GE: IRS-2 (Final): Specification for mechanically produced blanketing material for railway formation including guidelines for laying.
- (18) Indian Railway – Engineering Code.

- (19) Indian Railway Manual for Long Welded Rails
- (20) IR Manual for Flash Butt Welding of Rails
- (21) IR Standard Specification for Fusion of Welding of Rails by Alumino Thermit Welding Process 2006
- (22) IRS T 29-2000 Cast Manganese Steel Crossings
- (23) IRS T 39-1985 Prestressed Concrete Sleepers
- (24) IRS GE: 1 June 2004 Ballast specification.
- (25) IRS T 1966 Fish Plates and Fish Bolts
- (26) IRS Fabrication and Erection of Steel Girder Bridges & Locomotive Turn Tables(BI-1979)
- (27) RDSO/M&C/RP-194/94 – Wiper seal & dust seal.
- (28) IRS: T-12 2009 Rail Specifications
- (29) Indian Railways Manual for Ultrasonic Testing of Rails and Welds – 2006 (with latest Correction Slips)

2.2.2 Indian Road Congress (IRC) Codes and Specifications

- (1) IRC: 5 Standard Specifications and Codes of Practice for Road Bridges Section – I – General features of design.
- (2) IRC: 6 Standard Specifications and Codes of Practice for Road Bridges – Section – II – Loads and Stresses – Seismic provisions of this standard are to be adopted for the bridge design.
- (3) IRC:18 Design Criteria for Pre-stress Concrete Road Bridges (Post-tensioned concrete).
- (4) IRC : 21 Standard Specifications and Codes of Practice for Road Bridges – Section – III – Cement concrete (Plain & reinforced)
- (5) IRC : 22 Standard Specifications and Codes of Practice for Road Bridges – Section – VI – Composite Construction.
- (6) IRC:24 Standard Specifications and Codes of Practice for Road Bridges – Section V, Steel Road Bridges
- (7) IRC : 54 – 1974 – Lateral and Vertical Clearances for Vehicular Traffic
- (8) IRC : 83 (Part – III) - Standard Specifications and Codes of Practice for Road Bridges – Section – IX – Bearings Part –III, Pot, POT cum PTFE Pin and Metallic Guide Bearings
- (9) IRC-78:Sub-structure for Road Bridges.
- (10) IRC-87:Design and erection of false work for road bridges.

- (11) Specifications for Road and Bridge Works issued by Ministry of Road Transport & Highways. (MORTH).
- (12) SP 6, 7, 16, 21, 22, 23, 24, 34, 36, 52, 60, 70.

2.2.3 Indian Standard Specifications

- (1) IS : 975 (all 5 parts) – Design loads (other than earthquakes) for buildings and structures.
- (2) IS : 456 Plain and reinforced concrete.
- (3) IS: 269 Indian Standard Specifications for Ordinary & Low Heat Portland Cement.
- (4) IS : 8112 43 Grade OPC.
- (5) IS : 383 Coarse and fine aggregate from natural sources for concrete.
- (6) IS : 2386 (all 8 parts) – Tests for aggregates for concrete
- (7) IS : 3025 (all 49 parts) – Methods of sampling and test for water and waste water.
- (8) IS : 3085 Method of test for permeability of cement mortar and concrete.
- (9) IS:1199 Indian Standard Specifications for Method of Sampling and analysis of concrete.
- (10) IS :7320 Concrete slump test apparatus.
- (11) IS : 5515 Compaction factor apparatus.
- (12) IS : 1791 Batch type concrete mixers.
- (13) IS : 4634 Methods of testing performance of batch type concrete mixers.
- (14) IS: 2722 Indian Standard Specifications for Portable Swing Weight batches for concrete (Single and Double Bucket type)
- (15) IS : 6925 Methods of test for determination of water soluble chlorides in concrete admixtures.
- (16) IS : 9103 Admixtures for concrete.
- (17) IS : 516 Method of test for strength of concrete.
- (18) IS : 4031 (all 15 parts) – Physical tests for hydraulic cement.
- (19) IS : 5513 Vicat apparatus.
- (20) IS : 10080 Vibration machine for casting standard cement mortar cubes.
- (21) IS : 10262 Concrete mix design.
- (22) IS: 4926 Indian Standard Specifications for Ready Mixed Concrete.
- (23) IS : 1892 Subsurface investigations.
- (24) IS : 2720 (all 41 parts) – method of tests for soil.
- (25) IS : 2132 Thin walled tube sampling of soils.
- (26) IS : 2131 Standard penetration test for soils.

- (27) IS : 2911 (Part I to IV) - Code of practice for design and construction of pile Foundations
- (28) IS: 1893-2002 Criteria for Earthquake Resistance Design of Structures
- (29) IS: 4326 Earthquake Resistance Design and Construction of Buliding – Code of Practice
- (30) IS : 13920 Ductile detailing of reinforced concrete structures subjected to seismic forces.
- (31) IS : 5624 Foundation bolts.
- (32) IS : 3955 Design and construction of well foundations.
- (33) IS: 875 (Part 3) – 1987 – Code of Practice for Design Loads (Other than Earthquakes) for Buildings and Structures – Wind Loads (Second Revision)
- (34) IS: 1786-1985-High Strength Deformed Steel Bars & Wires for Concrete Reinforcement (Third Revision).
- (35) IS: 432 (Part-I & Part-I) – 1982 – Mild Steel, Medium Tensile Steel Bars and Hard Drawn.
- (36) IS: 280 Mild steel wire for general purposes.
- (37) IS: 2502 Code of practice for bending and fixing of Bars for concrete reinforcement.
- (38) IS: 1343 Prestressed concrete.
- (39) IS: 14268 Prestressing Strands.
- (40) IS: 4082 Recommendations of stacking and storage of construction materials at site.
- (41) IS: 800 General construction in steel.
- (42) IS: 2062-1992-Steel for General Structural Purposes – Specifications (Fourth Revision)
- (43) IS: 1261 – 1959 – Seam Welding in Mild Steel (Reaffirmed 1998)
- (44) IS: 1367 – Technical Supply conditions for Threaded steel fasteners.
- (45) IS: 3502:1994-Steel Chequered Plates – Specifications (Second Revision).
- (46) IS: 7215 – 1974 – Tolerances for Fabrication of Steel Structures (Reaffirmed 1995, Sixth Reprint July, 1997)
- (47) IS: 816 Metal arc welding for general construction in mild steel.
- (48) IS: 819 Resistance spot welding for light assemblies in mild steel.
- (49) IS: 814-1991-Covered Electrodes for Manual Metal Arc Welding (Fifth Revision)
- (50) IS: 1323 – 1982-Oxy-acctylene Welding for Structural Work in Mild Steel (Second Revision)

- (51) IS: 1161 – 1998 – Steel Tubes for Structural Purposes – Specifications (Fourth Revisions)
- (52) IS: 8629 (Parts I to III) – 1977 – Protection of Iron and Steel Structures from Atmospheric Corrosion (Reaffirmed 2002).
- (53) IS: 3757 – 1985 – High Strength Bolts.
- (54) IS: 6623 – 1985 - High Strength Nuts.
- (55) IS: 6911 – Stainless Steel.
- (56) IS: 1363 (all 3 parts) – Hexagon head bolts, screws and nuts of product grade C.
- (57) IS: 6639 Hexagonal bolts for steel structures.
- (58) IS: 102 Ready mixed paints, brushing, red lead, non-settling priming.
- (59) IS: 123 Ready mixed paints, brushing, finishing, semi-gloss, for general purposes to Indian
- (60) IS: 104 Ready mixed paint, brushing, zinc chrome, priming.
- (61) IS: 2074 Ready mixed paint, air drying, red oxide-zinc chrome.
- (62) IS: 34 White lead for paints.
- (63) IS: 2339 Aluminum paints for general purposes, in dual container.
- (64) IS: 2751 Code of Practice for Welding of Mild Steel Bars used for reinforced concrete construction.
- (65) IS: 3400 (all 22 parts) – Methods of tests for vulcanized rubbers.
- (66) SP 70: 2001 Handbook on construction safety practices.
- (67) IS: 3764 Safety code for excavation work.
- (68) IS: 4081 Safety code for blasting and related drilling operations.
- (69) IS: 7293 Safety code for working with construction machinery.
- (70) IS: 7205-1974-Safety Code for erection of Structural Steel Work (Fifth Reprint July, 2001).
- (71) SP 22 (S&T): 1992 Explanatory Hand Book on codes for Earth Quake Engineering.
- (72) IS: 3696:1987 (Part – I & Part-II)) Safety code for scaffolds and Ladders.
- (73) IS: 3016 :1965 Code of practice for Fire precaution in welding and cutting operations.
- (74) IS: 14881:2001Method for Blast Vibration Monitoring – Guidelines.
- (75) IS: 1852 Rolling and cutting tolerances for hot rolled steel products.
- (76) IS: 817 Training and testing of metal arc welders.

- (77) IS: 1270 Metric steel tape measure.
- (78) IS: 1200 (all relevant parts) – Method of measurement of building and civil Engineering works.
- (79) IS: 786 Conversion factors and conversion tables.
- (80) IS: 8500-1991 Structural steel – Micro alloyed (Medium and high strength qualities – specification (first Revision)
- (81) I S: 1024-1999 Use of Welding in Bridges and Structures subject to Dynamic Loading – code of Practice – Second Revision (Reaffirmed 1998)
- (82) IS: 9595-1996 Metal Arc welding of Carbon and Carbon Manganese Steels – Recommendations (First Revision)
- (83) IS: 1148-1982 Specification for hot rolled rivet bars (upto 40mm dia) for structural purposes (third revisions)
- (84) IS: 1149-1982 High tensile steel rivet bars for structural purposes (third revision)
- (85) IS: 1030 Grade 280-520W- Cast Steel
- (86) IS: 1929 Hot forged steel rivets for hot closing (12 to 36 mm dia)
- (87) IS: 57 Red lead for paints and other purposes
- (88) IS: 75 Linseed oil, raw and refined
- (89) IS: 77 Linseed oil, boiled for paints
- (90) IS: 1182 Radiographic examination of butt joints in steel plates
- (91) IS: 2595 Radiographic testing
- (92) IS: 487 Brush, paint and varnish
- (93) IS: 1915 Steel bridge code
- (94) IS: 6586 Metal spraying for protection of iron steel
- (95) IS: 5666 Etch primer
- (96) IS: 887 Animal tallow
- (97) IS: 816 Metal arc welding for general construction in mild steel
- (98) IS: 1024 Welding in bridges and structures subject to dynamic loading
- (99) IS: 1493 Design of Bored and Cast in Situ Piles Founded in Rock.- Guide lines
- (100) IS: 1785 Part 1 High Tensile Steel Wire
- (101) IS: 1080-1985 Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
- (102) IS: 1498-1970 Classification and identification of soils for general engineering purposes

- (103) IS: 1725-1982 Specification for soil based blocks used in general building construction
- (104) IS: 1888-1982 Method of Load Test on Soils
- (105) IS: 1904-1986 Code of practice for design and construction of foundations in soils: General Requirements
- (106) IS: 2809-1972 Glossary of Terms and Symbols Relating to Soil Engineering
- (107) IS: 2810-1979 Glossary of terms relating to soil dynamics
- (108) IS: 2974-1982 Part I : Code of Practice for Design and Construction of Machine Foundations- Part I : Foundation for Reciprocating Type Machines
- (109) IS: 4091-1979 Code of Practice for Design and Construction of Foundations for
Transmission Line Towers and Poles

2.2.4 Other International Codes

- (1) En 1990-2002 (Eurocode – Basis of Structural Design) – (For Safety, comfort deformation including twist and deflection)
- (2) EN 1991-2-2003 (Eurocode 1 – Action on Structures, part 2 – Traffic Loads on Bridges)- (Natural frequency range and Loading for fatigue estimation)
- (3) EN 1992 – 1:2004 (Eurocode 2 – Design of Concrete Structures, Part – 1 – General Rules and Rules for Buildings)
- (4) EN 1992 – 1-1:2004 (Eurocode 3 – Design of Steel Structures, Part 1 – 1 -1 General Rules) – (Classification of cross sections).
- (5) EN 1993 – 1-8:2002 (Eurocode 3 – Design of Steel Structures, Part 1 – 8 Design of Joints) – (Classification of HSFG Bolts).
- (6) EN 1993 – 1-9:2002 (Eurocode 3 – Design of Steel Structures, Part 1 – 9 Fatigue Strength of Steel Structures).
- (7) EN 1993 – 2:2004 (Eurocode 3 – Design of Steel Structures, Part 2 – Steel Bridges) - (Requirements for fatigue assessment, Road and Rail Bridges).
- (8) EN 1994 – 2:2003 (Eurocode 4 – Design of Composite Steel & Concrete Structures, Part 2 – Rules for Bridges) – (Width of effective flange, shear connectors).

2.2.5 UIC Codes

- (1) UIC 774 – 3R –Track Bridge interaction Recommendation for calculation (for Forces due to LWR).
- (2) UIC 772R: Bearings of rail bridges
- (3) UIC 774-3R Track/Bridge interaction

2.2.6 BS Codes

- (1) BS – 3784 Grade “A” Specifications for Polytetrafluoroethylene
- (2) BS-5350: Standard Method of test of adhesives, Part C9, Floating roller peel test.
- (3) BS-5400 : Part – 1 General Statement.
- (4) BS-5400 : Part – 2 Specifications for loads.
- (5) BS-5400: Part – 3 Code of Practice for Steel Bridges.
- (6) BS-5400: Part – 5 Code of Practice for composite Bridges.
- (7) BS-5400 : Part- 9 Bridge Bearings.
- (8) BS-5400: Part-10 Code of Practice for Fatigue.
- (9) BS-1449, 3484, 1134, 5296.

3 Material for Structures

3.1 General

Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these Specifications.

If any material, not covered in these Specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements consented by the Engineer.

3.2 Sources of Material

Approval of all sources of material for the Work shall be obtained from the Engineer before their use on the Project.

The Contractor shall notify the Engineer of his proposed sources of materials prior to delivery. If it is found after trial that proposed or previously approved sources of supply do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from the other acceptable sources at his own expense.

3.3 Bricks

Burnt clay bricks shall conform to the requirements of IS: 1077, except that the minimum compressive strength when tested flat shall not be less than 8.4 MPa for individual bricks and 10.5 MPa for average of 5 specimens. They shall be free from cracks and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp corners and emit a clear ringing sound when struck. The size may be according to local practice with a tolerance of ± 5 per cent.

3.4 Stones

Stones shall be of the type specified and consented by Engineer. It shall be hard, sound, free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stone with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water by more than 5 per cent of their dry weight when tested in accordance with IS: 1124.

The length of stones shall not exceed 3 times its height nor shall they be less than twice its height plus one joint. No stone shall be less in width than the height and width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

3.5 Cast Iron

Cast iron shall conform to IS: 210. The grade number of the material shall not be less than 14.

3.6 Cement

3.6.1 Cement to be used in the works shall be any of the following types and with the prior consent of the Engineer :

- (1) Ordinary Portland Cement, 33 Grade, conforming to IS:269.
- (2) Rapid Hardening Portland Cement, conforming to IS:8041.
- (3) Ordinary Portland Cement, 43 Grade, conforming to IS:8112.
- (4) Ordinary Portland Cement, 53 Grade, conforming to IS:12269.
- (5) Sulphate Resistant Portland Cement, conforming to IS:12330.

3.6.2 Cement conforming to IS:269 shall be used only after ensuring that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 500 kg/cum of concrete.

3.6.3 Cement conforming to IS: 8112 and IS: 12269 may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, these cements shall be used with a certain caution as high early strengths of cement in the 1 to 28-day range can be achieved by finer grinding and higher constituent ratio of Tricalcium Silicate and Dicalcium Silicate. In such cements, the further growth of strength beyond say 4 weeks may be much lower than that traditionally expected. Therefore, further strength tests shall be carried out for 56 and 90 days to fine tune the mix design from strength considerations.

3.6.4 Cement conforming to IS: 12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. It shall not be used under such conditions where concrete is exposed to risk of excessive chlorides and sulphates attack both. The recommended threshold values as per IS: 456 are sulphate concentration in excess of 0.2 per cent in soil substrata or 300 ppm (0.03per cent) in ground water. Tests to confirm actual values of sulphate concentration are essential when the structure is located near the sea coast, chemical factories, agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS:12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength can be

achieved without exceeding the maximum permissible cement content of 500 kg/cum of concrete,

- 3.6.5 Cement conforming to IS: 8041 shall be used only for precast concrete products with prior consent of the Engineer.
- 3.6.6 Ordinary Portland Cement, not less than 53 Grade, conforming to IS:12269 / IRS T 40 shall be used for pre-stressed concrete works
- 3.6.7 Total chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total sulphur content calculated as sulphuric anhydride (SO₃) shall in no case exceed 2.5 per cent and 3.0 percent when tri-calcium aluminate per cent by mass is up to 5 or greater than 5 respectively.
- 3.6.8 Use of Fly Ash as shall not be permitted

3.7 Coarse Aggregates

- 3.7.1 For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel etc.. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials beyond the tolerance limits specified in the relevant IS Codes. Coarse aggregate having positive alkali-silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, Parts I to VIII.
- 3.7.2 Marine aggregates shall not be used.
- 3.7.3 The Contractor shall submit for the consent of the Engineer, the entire information indicated in Appendix A of IS:383.
- 3.7.4 Maximum nominal size of coarse aggregate for various structural components in PCC, RCC or PSC, shall conform to Clause 4.8 of these Specifications.

Table 3.1: Requirements of Coarse Aggregates

Sl. No.	IS Sieve Size	Percent by Weight Passing the Sieve		
		40mm	20mm	12.5mm
1	63mm	100	-	-
2	40mm	95-100	100	-
3	20mm	30-	95-100	100
4	12.5mm	-	-	90-100
5	10mm	10-	25-	40-
6	4.75mm	0-5	0-	0-

3.8 Sand / Fine Aggregates

- 3.8.1 For masonry work, sand shall conform to the requirements of IS: 2116.
- 3.8.2 For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or

other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorised sand washing machines / screw type mechanical washers should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383 for his consent. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

3.8.3 Creek /Marine sand shall not be used in permanent works

3.9 Steel

3.9.1 Cast Steel

The use of cast steel shall be limited to bearings and other similar parts. Steel for castings shall conform to Grade 280-520N of IS: 1030. In case where subsequent welding is unavoidable in the relevant cast steel components, the letter N at the end of the grade designation of the steel casting shall be replaced by letter W. 0.3 per cent to 0.5 per cent copper may be added to increase the corrosion resistance properties.

3.9.2 Steel for Pre-stressing

The pre-stressing steel shall conform to either of the following :

- (1) Plain hard drawn steel wire conforming to IS: 1785 (Part I).
- (2) High tensile steel bar conforming to IS: 2090
- (3) Uncoated stress relieved strands conforming to IS: 6006.
- (4) Uncoated Stress relieved low relaxation strands conforming to IS; 1426

All pre-stressing steel shall be free from splits, harmful scratches, surface flaws, rough, jagged and imperfect edges and other defects likely to impair its use in pre-stressed concrete.

The value of modulus of elasticity of steel used for design of pre-stressed concrete members shall preferably be determined by tests on samples of steel to be used for construction. For the purpose of this, the value given by the manufacturer of the pre-stressing steel shall be considered as fulfilling the necessary requirements. Where it is not possible to ascertain the modulus of elasticity by test or from the manufacturer of the steel, the values as specified in Table 3.2 below maybe adopted

Table 3.2 : Modulus of Elasticity for Pre-stressing Steel

Sl. No	Type of Steel	Modulus of Elasticity Es kN/mm ²
1	Plain cold drawn wires conforming to IS: 1785 (Part-I)	210
2	High tensile alloy steel bars conforming to IS: 2090	200

3	Strands conforming to IS: 6006	195
4	Strands conforming to IS: 14268	195

Coupling units and other similar fixtures used in conjunction with the wires or bars shall have an ultimate tensile strength of not less than the individual strength of the wires or bars being joined

3.9.3 Reinforcement / Untensioned Steel

For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, the reinforcement / untensioned steel as the case may be shall consist of the following grades of reinforcing bars as specified in Table 3.3 below.

Table 3.3: Requirements of Reinforcement / Untensioned Steel

Sl. No	Grade Designation	Bar Type confirming to governing IS Specifications	Characteristic Strength f_y MPa	Elastic Modulus GPa
1	S 240	Grade 1 Mild Steel & Medium Tensile Steel bars conforming to IS: 432 Part I Mild Steel Bar	240	200
2	S 415	Cold twisted bars conforming to IS: 1786 High Yield Strength Deformed Bars (HYSD) / TMT bars	415 / 500	200

Other grades of bars conforming to IS:432 and IS:1786 shall not be permitted. All the steel shall be procured only from the primary steel producers and having BIS license. Primary steel producers are those steel (crude and / finished steel) producers using iron ore as the basic raw material / input. It therefore, includes in-house iron making followed by production of liquid steel & crude steel with / without in-house rolling. So all Integrated Steel Plants adopting BF-BOF route and major producers adopting Corex-BOF or DRI-EAF or MBF-EOF technology would fall under this category.

The Contractor shall notify the name of such primary steel producers to the Engineer, from whom he intends to procure the steel, along with copy of primary steel producer certificate and BIS license. All reinforcing steel shall be free from loose small scales, rust and coats of paint, oil mud etc. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

3.9.4 Structural Steel

- (1) All structural steel shall before fabrication comply with the requirements of the following Indian Standards:
 - (i) IS:226 : Structural Steel (Standard Quality)

- (ii) IS:961 : Structural Steel (High Tensile)
- (iii) IS:2062 : Weldable Structural Steel
- (iv) IS:8500 : Weldable Structural Steel (medium & high strength qualities)
- (v) IS:1148 : Hot rolled rivet bars (upto 40mm dia) for structural purposes
- (vi) IS:1149 : High tensile rivet bars for structural purposes
- (vii) IS:1161 : Steel tubes for structural purposes
- (viii) IS:4923 : Hollow Steel sections for structural use
- (ix) IS:11587 : Structural weather resistant steel
- (x) IS:808 : Specifications for Rolled Steel Beam, Channel and Angle Sections
- (xi) IS:1239 : Mild Steel Tubes
- (xii) IS:1730 : Dimension for Steel Plate, sheet and strip for structural and general engineering purposes
- (xiii) IS: 1731 : Dimension for Steel flats for structural and general engineering purposes
- (xiv) IS:1732 : Dimension for round and square steel bars for structural and general engineering purposes
- (xv) IS:1852 : Rolling and cutting tolerances for hot rolled steel products

The use of structural steel not covered by the above standards maybe used with the specific consent of the Engineer. Engineer shall seek the approval of Employer before communicating his consent to the Contractor in this regard.

- (2) Structural Steel for Railway Bridges shall also conform to the special requirements as specified below:
- (i) IS: 2062, Quality “A” Grade Designation E250 (Fe 410W) as rolled semi-killed or killed shall be used for foot-over bridges and other structures subjected to non- critical loading
 - (ii) IS: 2062, Quality “B” Grade Designation E250 (Fe 410W) fully killed and normalized / controlled cooled, where service temperature does not fall below 0°C, shall be used for welded / riveted girders subjected to Railway loading. Plates less than 12mm thick need not be normalized / controlled-cooled.
 - (iii) IS: 2062-2006 Grade designation E 410 (Fe 540) or E 450 (Fe 570) Quality D (both copper bearing quality) according to the welded or riveted work specifically for High Tensile Steel.
 - (iv) For superior and enhanced corrosion resistance for sections, plates and bars for welded, riveted or bolted construction, the material shall

comply with the requirement of IRS: M-42, Gr. I or Gr. II for riveted / bolted or welded work respectively.

- (v) Steel, which is to be cold pressed, shall comply with the requirements of IS: 2002.
- (vi) Steel for bolts shall conform to property class 4.6 or 6.6 as specified in IS: 1367 accordingly, as the structural steel specification is for mild steel or high tensile steel.
- (vii) Steel for drifts shall be in accordance with IS: 1875 for forged quality steel or IS: 7283 for hot rolled bars.
- (viii) Steel for rivets shall comply with the requirement of IS: 1148 for hot rolled rivet bars for general structural purposes and IS: 1149 for high tensile steel rivet bars for high strength structural purposes. For high strength low alloy structural steel rivet bars with enhanced corrosion resistance for use in bridges, steel shall comply with the requirement of IRS: M-43.
- (ix) The dimensions of all rolled sections must agree with the drawings or as consented by the Engineer.
- (x) The rolling and cutting tolerances shall be in accordance with IS: 1852 or as consented by the Engineer. If closer tolerances are desired they shall be shown in the drawing.
- (xi) All the steel sections used in the fabrication must have mill test certificate clearly indicating the specification to which the steel conforms and whether steel is killed and normalized. All the cast mark numbers/ heat mark numbers, shall be recorded along-with the number of plates in a register as soon as the plates are received in the workshop. Whenever the steel is received without any test certificate, a sample test piece from plate of each cast mark number is to be cut and sent for testing. Only when it is established that the plates are of required specification, these shall be processed for cutting.
- (xii) Use of steel of any quality other than those mentioned above would require the prior consent of the Engineer.
- (xiii) Welding Consumables :
 - a) Parent metal shall be of fusion welding quality conforming to IS: 2062.
 - b) Electrodes shall conform to IRS Specification M-28. The filler wire and flux combinations for submerged arc welding shall conform to IRS

Specification M-39. Wire for CO2 welding shall conform to RDSO/M&C/Specification.

- c) All consumables shall be stored and handled with care and in accordance with the manufacturers recommendations. This shall be governed as per relevant para of IS: 9595.

- (3) All structural steel shall be procured only from the primary steel producers (as defined above) and having BIS license

3.10 Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. As a guide, the following concentrations represent the maximum permissible values :

(1) To neutralize 200 ml sample of water. using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.

(2) To neutralize 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCl.

(3) The permissible limits for solids shall be as follows when tested in accordance with IS:3025 : Permissible Limits (Max.)

- (i) Organic : 200 mg/lit.
- (ii) Inorganic : 3000 mg/lit
- (iii) Sulphates (SO₄) : 500 mg/lit
- (iv) Chlorides (Cl) : 2000 mg/lit for plain concrete works, 1000mg/lit for reinforced concrete works and 500mg/lit for Prestressed concrete works
- (v) Suspended matter : 2000 mg/lit

All samples of water (including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements stated herein.

(4) The pH value shall not be less than 6.

(5) In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time tests as specified below.

- (i) The sample of water taken for testing shall represent the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.
- (ii) Average 28 days compressive strength of at least three 15cm concrete cubes prepared with water proposed to be used shall not be less than 90 percent of the average of strength of three similar concrete cubes prepared

with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS:516.

(iii) The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by+ 30 minutes from the initial setting time of control test block prepared and tested in accordance with the requirements of IS:4031.

(iv) Water found satisfactory for mixing is also suitable for curing concrete. However, water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds is objectionable.

3.11 Concrete Admixtures

3.11.1 General

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state. Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers duly approved by the Engineer having proven track record, quality assurance and full-fledged laboratory facilities for the manufacture and testing of concrete. The Contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

- (i) Normal dosage and detrimental effects, if any, of under dosage and over dosage.
- (ii) The chemical names of the main ingredients in the admixtures.
- (iii) The chloride content, if any, expressed as a percentage by the weight of the admixture.
- (iv) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.
- (v) Whether or not the admixture leads to the entertainment of air when used as per the manufacturer's recommended dosage, and if so to what extent
- (vi) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.
- (vii) There would be no increase in risk of corrosion of the reinforcement or other embedments as a result of using the admixture
- (viii) Retardation achieved in initial setting time

3.11.2 Physical and Chemical Requirements

All the materials for Structural Steel Works shall confirm to the requirements as specified in Chapter 3 [Materials for Structures] of these Specifications.

- (i) "Plasticisers" and "Super-Plasticisers" shall meet the requirements indicated for "Water reducing Admixture".
- (ii) Except where resistance to freezing and thawing and to disruptive action of deicing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS: 1199 shall not be more than 1percent higher than that of the corresponding control mix
- (iii) Calcium chloride or admixtures containing calcium chloride shall not be used in structural concrete containing reinforcement, prestressing tendons or the embedded metal.
- (iv) Admixtures containing Cl, SO₃ ions, nitrates and admixtures based on thiocyanate shall not be used.
- (v) Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

The tests that shall be performed along with permissible variations in the same are indicated below:

- a) Dry Material Content: to be within 3 per cent and 5 per cent of liquid and solid admixtures respectively of the value stated by the manufacturer.
- b) Ash content : to be within 1 per cent of the value stated by the manufacturer.
- c) Relative Density (for liquid admixtures): to be within 2 per cent of the value stated by the manufacturer.
- (vi) Use of such admixtures does not have adverse effect on the properties of concrete or mortar particularly with respect to strength, volume change durability and has no deleterious effect on reinforcement.
- (vii) All tests relating to the concretes admixtures shall be conducted periodically at an independent laboratory having NABL certification and compared with the data given by the manufacturer.
- (viii) While qualifying the admixture, the infra-red spectrograph plot should be given. Each batch of supply should be tested for infra-red Spectrograph and prove the consistency of supply.
- (ix) When an expanding agent is used, the total unrestrained expansion shall preferably be between 4% to 6%. Aluminum powder as an expanding agent shall not be permitted.

3.12 Handling & Storage of Materials

- a) All materials shall be stored as per IS: 4082.
- b) Cement : Cement of different specifications shall be stacked separately and quality of stored cement actually used in any member or part of the structure shall fulfill the design and construction requirement of the same.

Cement shall be stored at work site in such a manner as to prevent deterioration either through moisture or intrusion of foreign matter. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirement at site and should be cleaned at least every 3 months. Cement older than 3 months should not be used.

- c) Aggregates : Coarse Aggregates supplied in different sizes shall be stacked in separate stockpiles and shall be mixed only after the quantity required for each size has been separately weighed or measured. The quantity of coarse aggregates, thus recombined shall be that required for a single batch of concrete.
- d) Steel : The storage of all reinforcing steel shall be done in such a manner as will assure that no deterioration in its quality takes place. The coil of HTS wires & strands shall be given anti-corrosive treatment such as water soluble oil coating before wrapping it in hessian cloth or other suitable packing. During transportation, it shall be ensured that no damage is done to coils while loading and unloading. Care shall be taken to avoid mechanically damaging, work hardening or heating prestressing tendons while handling.
- e) Any material, which has deteriorated or has been damaged, corroded or contaminated, shall not be used for concrete work.

The procedures to be adopted for transportation & storage of the materials shall be subject to the consent of the Engineer. All the materials even though stored in approved godowns / places must be subjected to acceptance test prior to their immediate use

3.13 Tests and Standards of Acceptance

- a) Cement: A sample shall be tested from every batch of cement delivered on site or once for every 1000 bags whichever is more frequent. Tests shall be carried out for fineness, initial and final setting time and compressive strength (IS: 4031) and results approved by Engineer before use. The methods and procedures for sampling shall be in accordance with IS: 3535. Engineer may require any other form of sampling and tests including chemical analysis (IS: 4032) in case the cement supplied is of doubtful quality.
- b) Steel : Physical tests as per IS: 2062 and IS: 1786. Various physical tests shall be carried out as per IS: 226, IS: 1608, IS: 1599 and IS: 1387
- c) All materials shall be subjected to an acceptance test prior to their immediate use.
- d) The Contractor shall furnish test certificates from the manufacturer/supplier of materials along with each batch of material(s) delivered to site.
- e) The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction.

- f) The testing of all the materials shall be carried out by the Contractor at the field laboratory or from the laboratory approved by the Engineer and in the presence of the Engineer. The Contractor shall make all the necessary arrangements and bear the entire cost.
- g) Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's cost at any recognised laboratory / testing establishments having NABL certification and duly approved by the Engineer.
- h) If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall be borne by the Contractor.

4 Concrete Works

4.1 General

This section refers to the construction of concrete superstructure including concrete mix design, trial mix, testing and workmanship for concreting. The work shall consist of furnishing and placing structural concrete and incidental construction in accordance with these Specifications and in conformity with the lines, grades and dimensions, as shown on the approved drawings.

4.2 Codes and Specifications to cover

The provisions in codes listed in these specifications and specifications accompanying the contract documents so far as they are applicable to superstructure shall be strictly followed.

Contractor shall study the general arrangement drawings (GADs) and other detailed drawings accompanying contract documents and point out any discrepancies, short comings and contradictions and shall have them clarified and reconciled before start of the work. Any delay caused due to contractor seeking such clarification during progress of work will be considered to contractor's account.

Contractor will be responsible for preparation of further detailing and preparation of bar bending schedules

4.3 Materials

All the materials shall conform to the requirements as specified in Chapter 3: Materials for Structures of these Specifications

4.4 Grades of Concrete

- 4.4.1 The grades of concrete shall be designated by the characteristic strength as given in Table 4.1 below, where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Table 4.1 : Grades of Concrete

Sl. No	Grade Designation	Specified Characteristic Compressive Strength of 150mm cubes at 28 days in MPa
1	M 10	10
2	M 15	15
3	M 20	20
4	M 25	25
5	M30	30
6	M 35	35
7	M 40	40
8	M 45	45
9	M 50	50
10	M 55	55
11	M 60	60

4.4.2 Durability :The durability of concrete depends on its resistance to deterioration and the environment in which it is placed. The resistance of concrete to weathering, chemical attack, abrasion, frost and fire depends largely upon its quality and constituents materials. Susceptibility to corrosion of the steel is governed by the cover provided and the permeability of concrete. The cube crushing strength alone is not a reliable guide to the quality and durability of concrete; it must also have an adequate cement content and a low water-cement ratio. The general environment to which the concrete will be exposed during its working life is classified in three levels of severity that is moderate, severe and extreme, as described in Table 4.2 below

Table 4.2 : Environmental Exposure Conditions of Concrete

1	Moderate	Concrete surface protected against weather or aggressive conditions. Concrete surface sheltered from severe rain or freezing whilst wet. Concrete exposed to condensation. Concrete structure continuously under water. Concrete in contact with non-aggressive soil/ground water.
2	Severe	Concrete surface exposed to severe rain, alternate wetting and drying or occasional freezing or severe condensation. Concrete exposed to aggressive sub-soil/ground water or coastal environment.

3	Extreme	Concrete surface exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. Concrete structure surfaces exposed to abrasive action, surfaces of members in tidal zone. All other exposure conditions which are adverse to exposure conditions covered above
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4.4.3 The lowest grades of concrete in structures and corresponding minimum cementitious material contents and water-cement ratios shall be maintained as indicated in Tables 4.3, 4.4, and 4.5 below based on the environmental exposure conditions

Table 4.3 : Minimum Grade of Concrete for Bridges

Sl. No	Structural Member	Moderate Exposure	Severe Exposur	Extreme Exposure
1	PCC Member	M 25	M 30	M 35
2	RCC Member	M 30	M 35	M 40
3	PSC Member	M 35	M 40	M 45

Table 4.4 : Minimum Cement Concrete and Water-Cement Ratio

Type of Work	Minimum Cement	Exposure Condition W/c Ratio	
	kg/cum	Normal	Severe
Major Works			
PCC members	360	0.45	0.45
RCC members	400	0.45	0.40
PSC members	400	0.45	0.40

Note :- 1. Maximum cementitious material content shall be limited to 500kg/m³

4.4.4 Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e. "Design Mix". For all items of concrete, only "Design Mix" shall be used,

4.5 Permeability

One of the main characteristics influencing the durability of any concrete is its permeability. Therefore, tests for permeability shall be carried out for concrete bridges as recommended herein.

- a) Permeability test shall be mandatory for all RCC/PSC bridges under severe and extreme environment.
- b) Under moderate environment, permeability test shall be mandatory for all major bridges
- c) For other bridges permeability test is desirable to the extent possible.

With Strong, dense aggregates, a suitably low permeability is achieved by having a sufficiently low water-cement ratio, by ensuring as thorough compaction of the concrete as possible and by ensuring sufficient hydration of cement through proper curing methods. Therefore, for given aggregates, the cement content should be sufficient to provide adequate workability with a low water-cement ratio so that concrete can be completely compacted by vibration. Test procedure for penetration measuring permeability has been given in Appendix-G of IRS Concrete Bridge Code-1997. The depth of penetration of moisture shall not exceed 25mm.

4.6 Proportioning of Concrete

4.6.1 Prior to the start of construction, the Contractor shall design the mix and submit to the Engineer for approval, the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticisers or super-plasticisers) may be used at the Contractor's option, subject to the approval of the Engineer. Other types of admixtures shall be prohibited, unless specifically permitted by the Engineer.

4.6.2 Requirements of Consistency

The mix shall have the consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency.

The optimum consistency for various types of structures shall be as indicated in Table 4.6 below or as consented by the Engineer. The slump of concrete shall be checked as per IS:516.

Table 4.6: Optimum Consistency Requirements

Sl. No.	Type of Structure	Slump (mm)
1	Structures with exposed inclined surface requiring lowslump concrete to allow proper compaction	25
2	Plain cement concrete	25
3	RCC structures with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40-50
4	RCC structures with fair degree of congestion of reinforcement e.g. pier and abutment caps, box culverts well curb, well cap, walls with thickness greater than 300 mm	50-75
5	RCC and PSC structures with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300 mm	75-125

4.6.3 Requirements for Designed Mixes

(1) Target Mean Strength

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the "current margin".

- (i) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.65 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.
- (ii) Concrete of each grade shall be analysed separately to determine its standard deviation. The standard deviation of concrete of a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified in the “Tests and Standards of Acceptance” of this section.

$$\text{Estimated standard deviation } S_d = \sqrt{\Sigma \Delta^2 / (n - 1)}$$

Where, Δ is the deviation of the individual test strength from the average strength of n samples and n is the number of sample test results.

When significant changes are made in the production of concrete batches (for example changes in the materials used, mix design, equipment or technical control), the standard deviation value shall be separately calculated for such batches of concrete and current margin as well as target mean strength shall be worked out again.

- (iv) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table 4.7 below

Table 4.7: Current Margin for Initial Mix Design

Sl. No.	Concrete Grade	Current Margin (MPa)	Target Mean
1	M 15	10	25
2	M 20	10	30
3	M 25	11	36
4	M 30	12	42
5	M 35	12	47
6	M 40	12	52
7	M 45	13	58
8	M 50	13	63
9	M 55	14	69

The initial current margin given in the Table 4.7 shall be used till sufficient data is available to determine the current margin as per sub-clause (i) above.

- (iv) The concrete mixes shall be designed to produce the grade of concrete having the required workability, durability and characteristic strength.
- (2) Trial Mixes

The Contractor shall give notice to enable the Engineer to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor

shall prepare trial mixes, using samples of approved materials typical of those he proposes to use in the works, for all grades prior to commencement of concreting. The initial trial mixes shall generally be carried out in an established laboratory approved by the Engineer. In all cases complete testing

of materials forming the constituents of proposed Design Mix shall have been carried out prior to making trial mixes and consented by Engineer. When the site laboratory is utilised for preparing initial mix design, the concreting plant and means of transport employed to make the trial mixes shall be similar to that proposed to be used in the works. Test cubes shall be taken from trial mixes as follows. For each mix, set of six cubes shall be made from each of three consecutive batches. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Engineer. The cubes shall be made, cured, stored, transported and tested in accordance with these specifications. The average strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa.

(3) Control of Strength of Design Mixes

(i) Adjustment to Mix Proportion

Adjustments to mix proportions arrived at in the trial mixes shall be made subject to the approval of Engineer, in order to minimise the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

(ii) Change of Current Margin

When required by the Engineer, the Contractor shall recalculate the current margin in accordance with procedure specified above. The recalculated value shall be adopted as consented by the Engineer, and it shall become the current margin for concrete produced subsequently,

(iii) Additional Trial Mixes

During production, the Contractor shall carry out trial mixes and tests, if required by the Engineer, before substantial changes are made in the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with sub-clause (i) above

4.6.4 Additional Requirements

Additional requirements shall also consist of the following overall limits of deleterious substances in concrete :

(1) The total chloride content of all constituents of concrete as a percentage of mass of cement in mix shall be limited to values given below :

(i) For Pre-stressed Concrete : 0.10%

(ii) For Reinforced Concrete works exposed to chloride in service : 0.20%

(iii) Other reinforced concrete construction : 0.30%

(2) The total sulphuric anhydride (SO₃) content of all the constituents of concrete as a percentage of mass of cement in the mix shall be limited to 4%

4.6.5 Suitability of Proposed Mix Proportions

The Contractor shall submit the following information for the approval of Engineer :

- (i) Nature and source of each material
- (ii) Quantities of each material per cubic meter of fully compacted concrete
- (iii) Either of the following :
 - a) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement(s) as specified.
 - b) Full details of tests on trial mixes.
- (iv) Statement giving the proposed mix proportions for nominal mix concrete.

Whenever there is a significant change in the quality of any of the ingredients for the concrete, the Engineer may order the carrying out fresh trial mixes at no extra cost.

Any change in the source of material or in the mix proportions shall be subject to the prior approval of Engineer

4.7 Admixtures

Use of admixtures such as superplasticisers for concrete may be made with the approval of the Engineer. As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of his products only after obtaining complete knowledge of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the project.

Manufacturer should provide satisfactory evidence that such admixtures do not have adverse affect the properties of concrete or mortar particularly with respect to strength, volume change, durability and has no deleterious effect on the reinforcement. Admixtures used should conform to provisions of IS: 9103.

Calcium chloride or admixtures containing calcium chloride shall not be used in structural concrete containing reinforcement, prestressing tendon or other embedded metal. Also admixtures containing Cl and SO₃ ions or nitrates shall not be used . Admixtures based on thiocyanate can promote corrosion and hence are prohibited.

4.8 Size of Coarse Aggregates

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be as specified in Table 4.8

Table 4.8: Maximum Size of Coarse Aggregate

Sl. No.	Component	Maximum Nominal Size of Coarse Aggregate (MM)
1	Reinforcement Cement Concrete (RCC) work in girder, slabs, wearing coat, kerb, approach slab. Any PSC work	20

The proportions of the various individual size of aggregates shall be so adjusted that the grading produces densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

4.9 Equipment

The type, numbers, capacity, their location & mobilization & de-mobilisation schedule of the equipment for production, transportation and compaction of concrete including the measuring devices and their accuracy, to be used for the project shall be subject to the consent of the Engineer.

4.10 Batching & Mixing

4.10.1 In proportioning concrete, the quantity of cement, aggregate and water should be determined by weigh batching. Any solid admixture that may be added, may be measured by weight, liquid and paste admixtures by volume or weight. Batching plant should conform to IS: 4925. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy periodically checked, Coarse and fine aggregates shall be batched separately. The grading of the aggregates should be controlled by blending the different sizes of aggregates in right proportion. The amount of added water shall be adjusted to compensate moisture contents in aggregates.

4.10.2 Concrete shall be mixed in a batching and mixing plant. Hand mixing shall not be permitted.

The plant shall be at a location consented by Engineer considering the properties of the mixes and the transportation arrangements available with the Contractor. Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

4.11 Transporting, Placing and Compaction of Concrete

4.11.1 The method of transporting and placing concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position without re-handling, so that no contamination, segregation or loss of its constituent

~~materials takes place. Concrete shall not be freely dropped into place from a height exceeding 1.5 meters.~~

4.11.2 Ready Mixed Concrete:

- (1) Ready Mixed Concrete may be used subject to prior consent of the Engineer. It shall conform to the specifications of concrete as specified herein and IS: 4926.
- (2) The quality of admixtures like water reducing agent, retarders, super plasticisers cum retarders etc. should meet the requirements of Clause 3: Materials for Structures of these Specifications and its suitability tested as per IS: 9103 at the time of finalizing the mix design.
- (3) Under any circumstances, re tempering of concrete shall not be allowed.
- (4) Ready mixed concrete shall be transported in transit agitators confirming to IS: 5892. Agitating speed of the agitators during transit shall not be less than 2 revolutions per minute and not more than 6 revolutions per minute.
- (5) The concrete shall be delivered completely to the site of work within 1½ hours (when the atmospheric temperature is above 20°C) and within 2 hours (when the atmospheric temperature is at or below 20°C) of adding the mixing water to the dry mix of cement and aggregate or adding the cement to the aggregate, whichever is earlier. Time of such introduction shall be recorded on the delivery note together with the weight of constituents of each mix. In case, location of site of construction is such that this time period is considered inadequate, increased time period may be specified provided that properties of concrete have been tested after lapse of the proposed delivery period at the time of finalising mix design.

4.11.3 In case of pumped concrete conveyed by pressure through rigid pipe or flexible hose and discharged directly in to the desired area, the pumping rate should be 10 to 70m³ per hour. Effective pumping range is 300m horizontally and 90m vertically.

4.11.4 All formwork and reinforcement contained in it shall be cleaned and made free from standing water & dust.

4.11.5 All corners of concrete shall have chamfers of 25mm

4.11.6 No concrete shall be placed in any part of the structure until the consent of the Engineer has been obtained.

4.11.7 If concreting is not started within 24 hours of the consent being given, it shall have to be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.

4.11.8 Except where otherwise consented to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal

vibrators are used. Concrete cover blocks of the same strength and density as parent concrete shall be used.

- 4.11.9 Concrete when deposited shall have a temperature of not less than 5 degrees Celsius, and not more than 40 degrees Celsius, It shall be compacted in its final position within 30 minutes of its discharge from the mixer or agitator (in case of Ready Mixed Concrete) as the case may be. It may be necessary to add retarding

Admixtures to concrete if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

- 4.11.10 No concrete shall be allowed without vibration except under water concreting or tremie concreting.
- 4.11.11 Concrete shall be thoroughly compacted by vibration during placing and worked around the reinforcement, tendons or ductformers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. To achieve proper compaction mechanical vibrators shall be used. The vibrators can be internal or external type and depending on the shape and size of the member, both the types may be used in combination. When internal vibrators are used, they shall be used vertically to the full depth of the layer being placed and shall penetrate into the layer below while it is still plastic to the extent of 100mm. The vibrator shall be kept in place until air bubbles cease to escape from the surface and then withdrawn slowly to ensure that no hole is left in concrete, care being taken to see that it remains in continued operation while being withdrawn. Vibrators should not be used to move the concrete as it can cause honeycombing.
- 4.11.12 Internal vibrators shall be inserted in an orderly manner and distance between insertions should be about 1.5 times the radius of the area visibly affected by vibration. For horizontal and vertical operations of the vibrators, the spacing of points of vibration shall be such that the zone of influence overlap
- 4.11.13 Form vibrators shall be used in addition to internal vibrators in case of pre-stressed concrete girders / slabs etc.
- 4.11.14 The use of vibrators complying IS: 2502, IS:2505, IS; 2514 and IS: 4656 for compacting the concrete is recommended. Over-vibration and under vibration of concrete should be avoided.
- 4.11.15 Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns.
- 4.11.16 Concrete should be compacted before setting commences and should not be subsequently disturbed
- 4.11.17 Bearing areas for members shall be finished to true plane so as to give uniform bearing on the entire area. Bearing plane shall be horizontal even for the bridges on grade.

4.12 Clear Cover to Reinforcement

- (1) Clear cover shall not be less than the size of the bar or the maximum aggregate size plus 5mm. In case of a bundle of bars, it should be equal to or greater than the size of single bar of equivalent area plus 5 mm.
- (2) From durability consideration, minimum clear cover shall be as per Table 4.9 below

Table 4.9: Minimum Clear Cover to Reinforcement

Sl. No	Type of Structure	Clear Cover (in mm) for Environmental Conditions		
		Extreme	Severe	Moderate
1	Slab	50	35	25
2	Beam / Girder	60	50	35
3	Column	75	75	50
4	Well, Pile & Footing	75	75	50

- (3) Clear cover shall not exceed 75mm in any type of structure
- (4) For pre-stressing wires and strands, a minimum cover of 50mm shall be provided for all types of environment conditions
- (5) The cover to any pre-stressing duct shall not be less than 75mm
- (6) Clear cover shall be uniform and as per the drawings

4.13 Construction Joints

- 4.13.1 Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings, except with prior consent of the Engineer in case of emergencies. The joints shall be provided in a direction perpendicular to the member axis. Cold joints should be totally eliminated. The location of the construction joint, procedure for surface preparation of construction joint and sequence of concreting shall be subject to consent of the Engineer
- 4.13.2 Concreting shall be carried out continuously up to the construction joints, the position and arrangement of which shall be predetermined by the designer.
- 4.13.3 The use of construction joints in pre-stressed concrete work should be avoided. However, if found unavoidable, they shall be provided by adopting proper construction techniques.
- 4.13.4 Properly designed reinforcement shall be provided for transfer of full tensile stress across the joints prior to casting of the next lift.
- 4.13.5 Position of Construction Joints:

- (1) Construction joints should be positioned to minimise the effect of the discontinuity on the durability, structural integrity and appearance of the structure.
- (2) As far as possible, joints should be positioned in non-aggressive zones, but if aggressive zones cannot be avoided, joints should be sealed.
- (3) Joints should be positioned where they are readily accessible for preparation and concreting, the preparation of the joints is more likely to be

satisfactory where the cross section is relatively small and where reinforcement is not congested.

- (4) As far as possible, joints for fair faced concrete should be located where they conform with the architectural features of the construction. Unless they are masked in this way, the position of the joints are always obvious, even when the concrete is given a textured finish.
- (5) If substantial changes in the cross section of a member are necessary, the joints should be formed where they minimise stresses caused by temperature gradients and shrinkage.
- (6) Joints should be located away from regions of maximum stress caused by loading, particularly where shear and bond stress are high. Construction joints between slabs and ribs in composite beam should be avoided. As a general rule, joints in column are made as near as possible to the beam hunching, joints in beams and slabs should normally be made at the centre or within the middle third of the span.

4.13.6 Preparing the surface of the Joint

- (1) The minimum number of joints should be used and their construction should be simple. They should be either horizontal or vertical, because concreting sloping surfaces are usually unsatisfactory.
- (2) Where concrete is placed in vertical members e.g. walls, columns and the like, the lift of concrete shall finish level or at right angles to the axis of the member, the joint line matching the features of the finished work. Concreting shall be carried out continuously upto the construction joint.
- (3) Laitance, both on the horizontal and vertical surfaces of the concrete, should be removed before fresh concrete is cast. The surface should be roughened to promote good adhesion. Various methods for removal can be used but they should not dislodge the coarse aggregate particles. Concrete may be brushed with a stiff brush soon after casting while the concrete is still fresh, and while it has only slightly stiffened.
- (4) If the concrete has partially hardened, it may be treated by wire brushing or with a high pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed.

- (5) Fully hardened concrete should be treated with mechanical hand tools or grill blasting, taking care not to split or crack aggregate particles.
- (6) The best time for treating the joint is a matter of judgment because it depends on the rate of setting and hardening (which is itself dependent on the temperature of the concrete). Before further concrete is cast, the surface should be thoroughly cleaned to remove debris and accumulated rubbish, one effective method, being air jet.
- (7) Where there is likely to be a delay before placing the next concrete lift, protruding reinforcement should be protected. Before the next lift is placed, rust, loose mortar or other contamination should be removed from the bars and where conditions are particularly aggressive and there has been a substantial delay between lifts, the concrete should be cut back to expose the bars for a length of about 50mm to ensure that contaminated concrete is removed.
- (8) In all cases, when construction joints are made, to essential it is ensure that the joint surface is not contaminated with release agents, dust or curing membrane, and that the reinforcement is fixed firmly in position at the correct cover.

4.13.7 Concreting at Construction Joints

- (1) When the form work is fixed for the next lift, it should be inspected to ensure that no leakage can occur from the fresh concrete. It is a good practice to fix a6mm thick sponge which seals the gap completely.
- (2) The practice of first placing a layer of mortar or grout is not recommended. The old surface should be soaked with water without leaving puddles, immediately before starting concreting, then the new concrete should be thoroughly compacted against it. When fresh concrete is cast against existing mature concrete or masonry, the older surfaces should be thoroughly cleaned and soaked to prevent the absorption of water from the new concrete. Standing water should be removed shortly before the new concrete is placed and the new concrete should be thoroughly vibrated in the region of the joint.

4.14 Protection and Curing

4.14.1 Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor. Curing and protection of concrete shall start immediately after compaction of the concrete to protect it from :

- a) Premature drying out particularly by solar radiation and wind
- b) High internal thermal gradients
- c) Leaching out by rain and flowing water
- d) Rapid cooling during the first few days after placing
- e) Low temperature or frost

f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement. Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

4.14.2 Hot Weather Concreting

When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 40 degrees Celsius while placing. This shall be achieved by stacking aggregate under the shade and keeping them moist using cold water, reducing the time between mixing and placing to the minimum, cooling form work by sprinkling water, starting curing before concrete dries out and restricting concreting as far as possible to early mornings and late evenings. When ice is used to cool mixing water, it will be considered a part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted. The Contractor will be required to state his methodology for the Engineer's approval when temperatures of concrete are likely to exceed 40 degrees Celsius during the work.

4.14.3 Moist Curing

The concrete should be kept constantly wet for a minimum period of 14 (fourteen) days. Water should be applied on unformed surfaces as soon as it can be done without marring the surface and on formed surfaces immediately after the forms are stripped. The concrete shall be kept constantly wet by ponding or covered with a layer of sacking, canvas, hessian or a similar absorbent material. When air temperature is expected to drop below 5°C during the curing period, additional covering of cotton/gunny bags, straw or other suitable blanketing material shall be provided so that concrete temperature at surface does not fall below 10°C.

4.14.4 Curing Compound

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer. Such compounds shall be applied to all exposed surfaces of the concrete along with stripping of form work. Tests shall be done to ascertain :

- a) Loss of moisture in concrete with and without curing compound.
- b) Cube strength of concrete with moist curing and curing compound.
- c) Permeability of concrete.

Curing compound shall not be used on any surface requiring further finishing to be applied. All construction joints shall be moist, cured and no curing compound will be permitted in locations where concrete surfaces are required to be bonded together.

Curing compounds shall be continuously agitated during use. Concrete to be cured by this methods shall receive two applications of curing compound.

4.14.5 Steam Curing

Steam curing can be advantageously used to save time of curing of concrete for transfer of pre- stress

Where steam curing is adopted, it shall be ensured that it is done in a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.

Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.

The steam shall be at 100 per cent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete and the ambient air temperature shall increase at a rate not exceeding 5 degrees Celsius per hour until a maximum temperature of 6 degrees Celsius to 70 degrees Celsius is reached. The maximum temperature shall be maintained until the Concrete has reached the desired strength.

When steam curing is discontinued, the ambient air temperature shall not drop at a rate exceeding 5 degrees Celsius per hour until a temperature of about 10 degrees Celsius above the temperature of the air to which the concrete will be exposed, has been reached. The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

4.15 Finishing

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with suitable cement mortar.

All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Adequate pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing or by the Engineer.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good.

The work that has sagged or contains honeycombing to an extent detrimental to structural

safety or architectural appearance shall be rejected.

4.16 Setting out for Bridges

4.16.1 Alignment for Bridges: In order to facilitate the setting out of the work, the centre line of the bridges must be accurately established by the Contractor and shall be consented by the Engineer

4.17 Superstructure

4.17.1 Reinforced Concrete Construction :

- (1) Solid Slabs : The whole of the slab shall be cast with reinforcement embedded for the kerb and railing (wherever required). No other construction joint shall be allowed. Where wearing coat is required to be provided, after the deck slab has been cast, the surface of the slab shall be finished rough but true to the lines and levels as shown on the drawings. Where the slab is resting on bearings, the same shall be placed in position before casting of deck slab

4.17.2 Pre-stressed Concrete Construction

- (1) PSC Girder and Composite RCC Slab :PSC Girder may be precast or cast- in-situ as consented by the Engineer. Girders shall be cast in single pour and may be post- tensioned or pre-tensioned. Where precast construction is required to be adopted, selection of casting yard and details of methodology and of equipment for shifting and launching of girders shall be subject to consent of the Engineer. In case of cast- in-situ construction, the sequence of construction including side shifting of girders, if applicable, and placing on bearings shall be subject to the consent of the Engineer. The PSC girder constituting the top flange, web and the bottom flange shall be concreted in a single operation without any construction joint. The portions of deck slab near expansion joints shall be cast along with reinforcements and embedments for expansion joints. For this purpose, the portion of deck slab near expansion joints may be cast in a subsequent stage, if consented, by the Engineer.
- (2) Other Requirements
 - a) During concreting, care shall be taken to ensure that sheathing is not damaged and clogged. It shall be ensured that the cable move freely inside the sheath before, during and after concreting.
 - b) HTS strands should be moved in both directions during the concreting operations. This can easily be done by light hammering the ends of the wires / strands during concreting. It is also advisable that 3 to 4 hours after concreting, the cable should be moved both ways through a distance of about 20 cms. With such movement, any leakage of the mortar which has taken place in spite of all precautions, loses bond with the cables, thus reducing the chance of blockage. This operation can also be done by fixing pre-stressing jacks at one

end, pulling the entire cable and then repeating the operation by fixing the jack at the other end. Compressed air should also be pumped to clear leaked mortar. However the methodology of moving the cable during and after concreting shall be subject to consent of the Engineer.

- c) All precast slabs / parapet blocks used in gang paths etc. are to be table vibrated
- d) Permeability testing shall be as per Clause 4.5 of these Specifications.
- e) Additional testing (in addition to the testing as specified herein), if considered necessary by the Engineer, shall also be carried out by the Contractor at no extra cost to the Employer.

4.17.3 Drainage outlets

The drainage outlets shall be in conformity to the requirements and code of practice. The spacing of the drainage outlets shall be as per approved drawing or as directed by the Engineer. The down spouts shall be adequately fixed to the deck and shall be of rigid corrosion resistant materials not less than 100 mm dia in the least dimension and shall be provided with suitable clean out fixtures. These outlets shall be so provided that the discharge of the rain water drained by them is not directed towards any part of the super-structure or substructure component.

4.17.4 Installation of Bearings

Care shall be taken during installation of the bearings to permit their correct functioning in accordance with the design scheme. It will be desirable that the representatives of the manufacturer be present at the time of installation of bearings at least for first few girders.

The suppliers of the bearings shall dispatch the bearings in its true shape / position from the workshop with the top & bottom plates suitably clamped. Dismantling of the bearings at site shall not be permitted under normal circumstances.

The load shall be transferred on to the bearing only when the bedding materials has developed sufficient strength.

In case of cast in situ construction, the bearings shall be carefully protected during concreting operations. Any mortar contaminating the bearings shall be completely removed before it sets.

Details of seating of the bearings shall be strictly as per the manufacturer's recommendations,

4.18 Load Testing

4.18.1 Non-destructive Tests (NDT)

Additional nondestructive tests on the hardened concrete in the structure as a whole or any finished part of the structure where necessary may be carried out to ascertain its integrity of strength. Details of few non-destructive techniques are given in Appendix-F of the Code of Practice for Plain, Reinforced and Pre-

stressed Concrete for General Bridge Construction (Bridge Code) of Indian Railway.

4.19 Tolerances

Tolerances for the finished concrete bridge structures shall be as specified in Table 4.10 below.

Table 4.10: Tolerances for Finished Concrete Bridge Structures

Sl. No.	Description	Tolerances
1	Shift from Alignment	+ 25 mm
2	Deviation from plumb or specified batter for face of exposed piers	1 in 250, subjected to a maximum value of 0.5 times the least lateral dimension of pier
3	Deviation from plumb or specified batter for face of back filled abutments	1 in 125
4	Cross Sectional dimensions of piers, abutments and girders.	- 5 mm
5	Thickness of deck slab of bridges	+ 6 mm
6	Size and location of openings	+ 12 mm
7	Plan dimensions of footings(formed)	+ 50 mm
8	Plan dimensions of footings(unformed excavation)	+ 75 mm
9	Thickness of footings	+ No limit

Sl. No.	Description	Tolerances
		- 5%
10	Footing eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
11	Reduced level of top of footing / pier	± 5 mm
12	Centre to centre distance of pier and	± 30 mm
13	Centre to Centre distance of bearings	± 5 mm
14	Centre to centre distance of pier bearings across	± 5 mm

4.20 Tests and Standards of Acceptance of Concrete

4.20.1 Concrete shall conform to the surface finish and tolerance as prescribed in these specifications for respective components

- 4.20.2 Random sampling and lot by lot of acceptance inspection shall be made for the 28 days cour strength of concrete.
- 4.20.3 Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following :
- a) No individual lot shall be more than 30 cu.m. in volume
 - b) At least one cube forming an item of the sample representing the lot shall be taken from concrete of the same grade and mix proportions cast on any day.
 - c) Different grades of mixes of concrete shall be divided into separate lots
 - d) Concrete of a lot, shall be used in the same identifiable component of the bridge
- 4.20.4 Sampling and Testing
- Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure hid down in IS: 1199. A random sampling procedure to ensure that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes shall be adopted.150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS:516. The 28-day test strength result for each cube shall form an item of the sample.
- 4.20.5 Test specimen and sample strength: Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS: 9013. The specimen shall be tested as described in IS: 516 The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than ± 15 percent of the average.
- 4.20.6 Frequency : The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 4.11 below

Table 4.11: Minimum Frequency of Sampling of Concrete

Sl. No.	Quantity of Concrete in Work (m ³)	No. of Samples
1	1-5	1
2	6-15	2
3	16-30	3
4	31-50	4

5	51 and above	4 plus one additional sample for each additional 50 m ³ or part thereof
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4.20.7 Acceptance Criteria

- (1) Compressive Strength : When both the following conditions are met, the concrete complies with the specified compressive strength:
 - (i) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in Column A of Table 4.12 below;
 - (ii) Any individual test results complies with the appropriate limits in Column B of Table 4.12 below.
- (2) Flexural strength: When both the following conditions are met, the concrete complies with the specified flexural strength:
 - (i) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm²
 - (ii) The strength determine from any test result is not less than the specified characteristic strength less 0.3 N/mm².

Table 4.12:

Characteristic Compressive Strength Compliance Requirements

Sl. No	Specified Grade	Group of Test Results	A	B
			The mean of the group of test result exceeds the specified characteristic compressive strength by at	Any individual test result is not less than the characteristic compressive strength less:
1	M 20 & above	Any consecutiv	3 N/mm ²	3 N/mm ²

- (3) Quantity of Concrete Represented by Strength Test Results:
 - (i) The quantity of concrete represented by a group of 4 consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.
 - (ii) For the individual test result requirements given in Column B of Table 4.12 above or in item (ii) of para (2) above only the particular batch from which the sample was taken shall be at risk.

- (iii) Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60m^3 .
- (4) If the concrete is deemed not to comply pursuant to the Flexural Strength Criteria, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.
- (5) Concrete of each grade shall be assessed separately.
- (6) Concrete shall be assessed daily for compliance.
- (7) Concrete is liable to be rejected if:
 - (i) it is porous or honey combed;
 - (ii) its placing has been interrupted without providing a proper construction joint
 - (iii) the reinforcement has been displaced beyond the tolerances specified; or
 - (iv) construction tolerances have not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer.

4.21 False Work

4.21.1 Falsework shall be designed to meet the requirements of the permanent structure, taking into account the actual conditions of materials, environment and site conditions. Careful attention shall be paid to the detailing of connections and function with a view to avoiding gross errors leading to significant damage or failure. All false work as designed by the Contractor shall be subject to the consent of the Engineer before starting of the work

4.21.2 Falsework shall be designed to cater for following loads:

- a) Dead load of wet concrete and reinforcement;
- b) Weight of form work;
- c) Plant and equipment including impact;
- d) Impact due to deposition of concrete;
- e) Construction personnel;
- f) Pre-stressing loads;
- g) Lateral loads;
- h) Wind loads; and Force due to water current, if any.

4.21.3 Materials: All the materials shall conform to the specified quality consistent with the intended purpose and actual site condition as applicable.

4.21.4 Falsework Plans: Falsework plans shall include the following information:

- (1) Design Assumptions – All major design values and loading conditions shall be shown on these drawings. They include assumed values of superimposed load, rate of placement, mass of moving equipment which may be operated on formwork, foundation pressures, camber diagram and other pertinent information, if applicable.
- (2) Types of materials, sizes, lengths and connection details.
- (3) Sequence of removal of forms and shores.
- (4) Anchors, form ties, shores and braces
- (5) Field adjustment of the form during placing of concrete.
- (6) Working scaffolds and gangways.
- (7) Weep holes, vibrator holes or access doors for inspection and placing of concrete.
- (8) Construction joints, expansion joints.
- (9) Sequence of concrete placements and minimum/maximum elapsed time between adjacent placements.
- (10) Chamfer strips or grade strips for exposed corners and construction joints.
- (11) Foundation details for falsework. Special provisions such as protection from water, ice and debris at stream crossings.
- (12) Form coatings and release agents.
- (13) Means of obtaining specified concrete.
- (14) Location of box outs, pipes, ducts, conduits and miscellaneous inserts in the concrete attached to or penetrating the forms.
- (15) Location and spacing of rubber pads where shutter vibrators are used.

4.22 Form Work

- 4.22.1 General : Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as consented by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support. The design, erection and removal of formwork shall conform to IRC:87 "Guidelines for Design and Erection of Falsework for Road Bridges" and these specifications. All form work, staging scheme etc. as designed by the Contractor shall be subject to consent of the Engineer.
- 4.22.2 Material : All materials shall comply with the requirements of IRC87. Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Materials and component used for the formwork shall be

examined for damage or deterioration before use / re-use. In case of timber formwork, the inspection shall also cover signs of attacks by decay, rot or insect attack or development of splits

4.22.3 Design of Formwork :

- (1) The formwork must be designed keeping in view all loads and forces. The Contractor shall furnish the design and drawing of complete formwork including staging scheme for consent of the Engineer before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information to the Engineer as required by him. Notwithstanding any consent to the design & drawings by the Engineer, the Contractor shall be entirely responsible for the adequacy and safety for formwork.
- (2) The design of the formwork shall conform to provisions of IRC:87. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection. In the case of prestressed concrete superstructure, careful consideration shall be given to redistribution of loads on props due to prestressing.

4.22.4 Workmanship :

- (1) Formwork shall be so constructed and supported as to remain sufficiently rigid during the placement and compaction of the concrete and shall be sufficiently watertight to prevent loss of water or mortar from concrete.
- (2) Forms for finished surfaces should be smooth and mortar tight. If wood forms are used, the boards must be uniform in the thickness, tongued and grooved, smoothly finished on the surface next to the concrete, evenly matched and tightly placed, except where the desired surface or appearance requires special treatment. The use of forms of ply- wood/steel/similar product is also permitted.
- (3) Forms shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up for any settlement in the form work either before or during the placing of concrete.
- (4) The number of joints in the formwork shall be kept to a minimum by using large size panels. Design shall provide for proper soldiers to facilitate alignment. All joints shall be leak proof and must be properly sealed. Use of PVC joint sealing tapes, foam rubber or PVC T-section is essential to prevent leakage
- (5) As far as possible, clamps shall be used to hold the forms together. Where use of nails is unavoidable, minimum number of nails shall be used and these shall be left projecting so that they can be easily withdrawn. Use of double headed nails shall be preferred.

- (6) Use of ties shall be restricted as far as practicable. Wherever ties are used they shall be used with HDPE sheathing so that the ties can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.
- (7) Unless otherwise specified, Chamfers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, bevelled edges and mouldings shall be made in the formwork itself.
- (8) Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning
- (9) The formwork shall be constructed with precamber to the soffit to allow for deflection of the formwork. It shall take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures having regard to the deformation of the false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting the prestressed structures.
- (10) Where centering trusses or launching trusses are adopted for casting of superstructures, their joints should be thoroughly checked periodically. Also various members of centering truss should be periodically examined for proper alignment and unintended deformation & deterioration due to corrosion before proceeding with concreting
- (11) Formwork shall be so made so as to produce a finished concrete true to shape, line and levels and dimensions as shown in the drawings subject to tolerances as specified in these specifications.
- (12) Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.
- (13) Screw jacks or hard wedges where required shall be provided to make up any settlement before or during placing of concrete.
- (14) Special measures in the design of formwork shall be taken to ensure that it does not hinder the shrinkage of concrete. Soffit of the formwork shall be so designed as to ensure that the formwork does not restrain the shortening and / hogging of beams during prestressing.
- (15) Any cut-out or openings provided in any structural member to facilitate erection of formwork shall be closed with the same grade of concrete as the adjoining structure immediately after removal of the formwork ensuring watertight joints.
- (16) Provision shall be made for safe access on, to and about the formwork at the levels as required

- (17) Water used for curing should not be allowed to stagnate near the base plates supporting the staging and should be properly drained
- (18) The formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating (machine oils) shall be prohibited for use as coating. Release agent shall be applied strictly in accordance with the manufacturer's instructions. Same type & make of release agent shall be used throughout the similar formwork material and different types should not be mixed.
- (19) Release agent shall not come in contact with reinforcement
- (20) For steel props, the maximum deviation from straightness is 1/600 of length
- (21) All formwork shall be thoroughly cleaned immediately before concreting and shall be subject to consent of the Engineer

4.22.5 Formed Surface and Finish

The formwork shall be lined with the material consented by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall have no stain on the concrete and so fixed to its backing as not to impart any blemishes. Internal ties and embedded metal parts shall be carefully detailed and their use shall be subject to consent by the Engineer.

4.22.6 Finishing : No surface finishing will normally be provided. If minor defects are noticed, the surface should be rendered. The required finish shall be obtained by use of properly designed formwork of closely jointed boards. The surface may be improved by carefully removing all fins and other projections, thoroughly washing down and then filling the most noticeable surface blemished with a cement and fine aggregate paste. For major defects, if noticed any repairs should be carried out with prior consent of the Engineer.

4.22.7 Cleaning and Treatment of Form : All rubbish particularly chippings, shavings and sawdust shall be removed from the interior of the forms before the concrete is placed and the formwork in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved release agent. Care shall be taken that such approved release agent is kept out of contact with the reinforcement.

4.22.8 Stripping Time :

- (1) The scheme for removal of the formwork (i.e de-shuttering and de-centering) shall be planned in advance and shall be subject to consent of the Engineer. Formwork shall be so removed as not to cause any damage to concrete. .
- (2) Forms shall not be struck until the concrete has reached a strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions and cured under conditions

of temperature and moisture similar to those existing on the work. Where possible, the formwork shall be left longer as it would assist the curing.

- (3) In normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the periods as specified in Table 4.13 below

Table 4.13 : Stripping Time of Forms

Sl. No	Member	Minimum Time for Stripping of the Form
1	Walls, Columns & Vertical faces of all structural members	24 to 48 hours as may be consented by the Engineer
	Slabs (props left under)	3 days
	Beam soffits (props left under)	7 days
4	Removal of props under slabs (i) Spanning upto 4.5m (ii) Spanning over 4.5m	7 days
5	Removal of props under beams (i) Spanning upto 6m (ii) Spanning over 6m	14 days

For other cements, the stripping time recommended for ordinary Portland cement may be suitably modified with the consent of the Engineer.

- (4) The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab or beam as the case may be together with any live load likely to occur during curing or further construction.
- (5) Where the shape of the element is such that the formwork has reentrants angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.
- (6) The forms should be so constructed as to be removable in the sections without marring or damaging the surface of the concrete. Forms should be removed as soon as possible in order to make necessary repairs and finish the surface. As soon as forms are removed, list of major/minor defects noticed in concrete should be prepared. Repairing methodology should be approved by the Engineer. After making necessary repairs, the surface should be finished with wood float so as to free from streaks, discolorations or other imperfections. Plastering should not be permitted and a steel trowel should not be used to finish surfaces.

4.22.9 Slip form Shutter:

Slip Form Shuttering: Hydraulic slip form shuttering shall be used for the construction of bridge piers.

Complete slip form consisting of hydraulic jacks, yokes, shuttering plates hydraulic hoses, jack rods, working platform, hanging scaffolds along with fittings and fixtures and necessary spares shall be supplied by the contractor assembled in the proper places and in the proper manner maintained and kept operational till the completion of the job. The design of the slip form shuttering shall be such as to prevent the tendency of the pier/abutment shaft to rotate about its vertical axis or to drift laterally in any direction. Sufficient capacity of jacks shall be provided to achieve uniform raising of the entire forms. The contractor shall also mention the number and diameter of jack rods he intends to use for each pier/abutment. Jack rods may be removed either during the work or after completion of the work. The shuttering plate thickness shall not be less than 5 mm.

The contractor shall also show in the drawing the method of lifting and distributing concrete into form and get it approved by the Engineer. Sufficient number of lifts will be provided to keep pace with the slip forming.

Slip-form operation shall generally be executed in a continuous, round the clock manner resulting in monolithic structure without horizontal joints. However,

should there be stoppage of slipping operation due to any reason the construction joint so created shall be treated in a manner similar to those for fixed form joints. The cycle of operation commencing from the stage when the forms are filled with concrete after erection of the slip form in proper position and proper manner, is to raise the form with the help of jacks until the belt of form work has been evenly raised to about 250 mm or so. The horizontal reinforcement for this height shall be placed in position and concrete deposited and vibrated almost to the top of the form work. The hydraulic jacking system shall provide for the simultaneous movement of all the jacks in small pre-calculated increments of 25 mm in 10 to 15 minutes giving a sliding rate of 100 to 150 mm per hour average of continuous slip forming.

Precision instrument to check eccentricity of pier on either direction is to be used at every 3m interval of height or every set of concreting whichever is less. The contractor shall render all assistance to the Engineer for checking level of the working platform involving verticality of the structure and in adjusting the form that is out of plumb as directed.

The contractor shall provide adequate no. of proper access tower with mechanized passenger hoist arrangement of approved design for the access of personnel to the working decks. The erection and dismantling of the access tower shall also be done by the contractor. The contractor shall also provide for adequate lighting arrangement for night working. The rate quoted by the contractor for continuous

4.23 Steel Reinforcement

4.23.1 Material

All the materials for steel reinforcement shall confirm to the requirements as specified in Chapter 3: Materials for Structures of these Specifications.

4.23.2 Protection of Reinforcement

Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paint. This may be ensured either by using reinforcement fresh from factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sand blasting, mechanical wire brushing subject to consent of the Engineer.

Portion of uncoated reinforcing steel and dowels projecting from concrete shall be protected within one week after initial placing of concrete with neat cement mixed with water to a consistency of thick paint. This coating shall be removed not more than one week before placing of the adjacent pour of concrete. If the coating on the bars is damaged during transportation or handling and cannot be repaired shall be rejected.

4.23.3 Bending of Reinforcement

Bar bending schedule shall be furnished by the Contractor subject to consent of the Engineer. Reinforcing steel shall conform to the dimensions and shape as per the bar bending schedules consented by the Engineer. Bars shall be bent cold. Bars shall not be bent or straightened in a manner that will damage the parent material or the coating. Bars shall not be heated to facilitate straightening. Any reinforcement, which is bent, should not be rebent at the location of the original bend. Where the temperature of steel is below 5°C, special precautions may be necessary such as reducing the speed of bending or with the Engineer's approval, increasing the radius of bending. Reinforcement shall be bent and fixed in accordance with the procedures specified in IS: 2502 and shall not be straightened that will injure the material.

4.23.4 Placing of Reinforcement

- (1) All reinforcement shall be placed and maintained in the position as shown in the drawings
- (2) Cover and spacing of steel shall be uniform and as specified in the Specifications and as shown in the drawings
- (3) Reinforcement steel shall be adequately secured and bound together at all intersections with 1.6mm dia mild steel wire in accordance with IS:280 or approved reinforcement clips so that it maintains its position during casting and vibration of concrete. Free ends of the binding wires used to tie bars shall be bent into the member. For aggressive environment, galvanized binding wire shall be used.
- (4) Crossing bars should not be tack welded for assembly of reinforcement unless permitted by the Engineer...
- (5) All steel fabrics shall be lapped two meshes unless otherwise shown on the drawing and securely bound to the supporting bars with 1.6mm dia mild steel wire (IS:280) or approved reinforcement clips.

- (6) Sufficient spacers shall be provided as shall, in the opinion of the Engineer, be necessary to maintain specified concrete cover to the reinforcement and preventing displacement before and during the placement of the concrete. Spacers should be of such material and design as will be durable, will not lead to the corrosion of reinforcement and will not cause spalling of concrete cover. Spacer block made from cement, sand and small aggregates should match the mix proportion of concrete as far as is practicable with a view to being comparable in strength, durability and appearance. Use of wood, tile or porous material will not be allowed for this purpose. Concrete cover blocks shall contain the binding wire to secure it to the reinforcement.
- (7) Subject to the reduction in bond stress, bars may be arranged as pairs in contact or in groups of three or four bars bundled in contact. Bundled bars shall be tied together to ensure the bars remaining together. Bars larger than 32mm diameter shall not be bundled except in columns. Bars shall not be used in a member without stirrups. Bars in a bundle should terminate at different parts spaced at least 40 times the bars size apart except for bundles stopping at support
- (8) Layers of reinforcements shall be separated by spacer bars at approximately one meter intervals. The minimum diameter of spacer bars shall be 12 mm or equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater.
- (9) Reinforcement bars shall be adequately secured by chairs / ties / hangers so that it will maintain its position during casting and vibrating the concrete.
- (10) The coated reinforcing steel shall be held in place by use of plastic coated binding wires especially manufactured for the purpose.
- (11) No concreting shall be done until the reinforcement has been inspected by the Engineer.

4.23.5 Bar Splices

- (1) Lapping :
 - (i) All reinforcement shall be furnished in full length as indicated in drawings. No splicing of bars, except where shown on the drawings will be permitted without consent of the Engineer. Lengths of splice, wherever required, shall be as indicated on drawings and consented by Engineer. Lapped splices shall be staggered & located at points along the span where stresses are low.
 - (ii) Lap Length : Lap splices shall not be used for bars larger than 32 mm. When bars are lapped, the length of the lap shall at least equal the anchorage length required to develop the stress in smaller of the two bars lapped. Length of lap provided, however shall neither be less than 25 times the smaller bar size plus 150mm in tension reinforcement nor be less than 20 times the smaller bar size plus 150mm in compression reinforcement.

- (iii) The lap length calculated in the preceding paragraph shall be increased by a factor of 1.4 if any of the following conditions apply:
- a) the nominal cover to the lapped bars from the top of this section as intended to be cast is less than twice the bar size;
 - b) the clear distance between the lap and another pair of lapped bars is less than 150 mm ; and
 - c) a corner bar is being lapped and the nominal cover to either face is less than twice the bar size.

Where conditions (a) and (b) or conditions (a) and (c) apply the lap length shall be increased by a factor of 2.0.

- (iv) Lap splices are considered to be staggered if the centre to centre distance of the splices is not less than 1.3 times the lap length
- (v) In case of bundled bars, lapped splices of bundled bars shall be made by splicing one bar at a time; such individual splices within a bundle shall be so staggered that in any cross section there are not more than four bars in a bundle.

(2) Welding Joints or Mechanical Connections :

- (i) Welded joints or mechanical connections in reinforcement may be used with the approval of the Engineer but in the case of important connections, test shall be made to prove that the joints are of the full strength of bars connected. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS: 2751 and inspection of welds shall conform to IS: 822
- (ii) Welded joints may be permitted in cold worked bars conforming to IS: 1786 provided that the carbon equivalent calculated from the chemical composition of the bar is 0.4% or less. Welding of the cold worked bars may be done in accordance with the recommendations of IS: 9417. When cold-worked bars are welded, the stress at the weld should be limited to the strength of mild steel bars without cold-working.
- (iii) Welded joints should not be located near the bends in the reinforcement. Wherever possible, joints in the parallel bars of principal tensile reinforcement should be staggered. The welded joints may preferably, be placed in regions of low stresses.
- (iv) Bars may be joined with mechanical devices e.g. by special grade steel swaged on to bars in end to end contact or by screwed couplers or using bottle nuts, if consented by the Engineer. Patented systems with approved use shall only be permitted to be used on production of test results to the satisfaction of the Engineer. The effectiveness for such joints shall invariably be proved by static and fatigue strength tests. Such joints should preferably be located at sections where the bending moment is not more than 50 percent of the moment of resistance and

such joints should be so disposed that at any section not more than 50% of the bars are connected by mechanical devices, bottle nuts or couplings.

5 Structural Steel Works for Railway Bridges

5.1 General

(1) The work shall include furnishing, fabricating, transporting, assembling, erecting and painting of structural steel and other incidental metal construction for railway bridges of the kind, size and quantity in conformity with the drawings and these specifications or as desired by the Engineer.

(2) All steel work, whether in fabrication or in erection, shall be done in accordance with the relevant Codes of Practice and Standard Specifications, subject to any further provisions contained in this chapter. These specifications are equally applicable to steel structures in buildings and sheds except where specified otherwise. In the event of any of these provisions being at variance

with the standard IRS specifications, the latter shall prevail unless otherwise specified by the Engineer or in Drawings.

5.2 Materials

5.2.1 General

All the materials for Structural Steel Works shall conform to the requirements as specified in Chapter 3 [Materials for Structures] of these Specifications.

General requirements relating to the supply of material shall conform to the IS Code IS:1387, for the purpose of which the supplier shall be the Contractor and the purchaser shall be the Engineer. Mild steel shall be to IS:226 and /or IS 2062 and HTS to IS 561 unless otherwise specified. In case of imported material, Steel work Specifications of the country of origin or equivalent IS Specifications will be as indicated in the Contract or by the Engineer.

Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges and other defects. It shall have a smooth and uniform finish, and shall be straightened in the mill before shipment. They shall also be free from loose mill scale, rust, pitting or other defects affecting its strength and durability.

The acceptance of any material on inspection at the mill i.e. rolling mills, foundry or fabricating plant where material for the work is manufactured, shall not be a bar to its subsequent rejection, if found defective. Unless specified otherwise, high tensile steel rivet conforming to IS:1149 shall be used for members of high tensile steel conforming to IS:961 and shall not be used for mild steel members. Unless specified otherwise, bolted connection of structural joints using high tensile friction grip bolts shall comply with requirements of IS:4000. Cast iron shall not be used in any portion of the bridge structure, except where it is subject to direct compression and as shown in the drawings Special requirements are given below:

(1) Structural Steel

Structural steel conforming to IS: 2062 (20116) – Hot Rolled Low, Medium & High Tensile Structural Steel- shall be used for all members of truss structure.

(2) Bolts and Nuts

For splicing of any structural member wherever required HSFG bolts and nuts of property class-8.8 conforming to IS: 3757 and IS: 6623 (1985) respectively shall be used. Unless specified otherwise, the bolts shall be hexagonal. All anchor bolts shall be of property class of 8.8 and nuts shall conform to IS: 1363 (1992), IS: 1364 (1992) and IS: 1367, as applicable, and unless specified otherwise, shall be hexagonal. All nuts shall conform to property class compatible with the property class of the bolt used.

(3) Washers

For HSFG bolts, washer shall be conforming to IS: 6649 (1985). Plain washers shall be conforming to IS: 5369 (1975), unless otherwise specified. One washer shall be supplied with each bolt and, in case of special types of bolts, more than one washer as needed for the purpose shall be supplied. An additional double coil helical spring washer, conforming to IS: 6755 (1980), shall be provided for bolts carrying dynamic or fluctuating loads and those in direct tension.

(4) Stud Shear Connectors

The stud shear connectors shall be high tensile steel as per IS: 3935 and the testing procedure shall be as per BS: 5400-6.

5.2.2 Standards Applicable

All materials shall conform to requirements of respective IS Codes and IRS. Specifications listed below. Special requirements are given below

Mild steel for bolts and nuts shall conform to IS:226 and IS: 1148 but have a minimum tensile strength of 44 kg/sq.mm and minimum percentage elongation of 14. High tensile steel for bolts and nuts shall conform to IS:961 and IS:1149 but with a minimum tensile strength of 58 kg/sq.mm. High strength friction grip bolts shall be permitted for use only on satisfactory evidence of performance to the requirements specified by the Engineer.

For cast steel, the yield stress shall be determined and shall not be less than 50 per cent of the minimum tensile strength.

Plain washers shall be of steel. Tapered or other specially shaped washers shall be of steel or malleable cast iron.

Materials for castings and forgings, fasteners and welding consumables shall be as per relevant IS code.

Parallel barrel drifts shall have a tensile strength not less than 55 kg/sq.mm With elongation of not less than 20 per cent measured on a gauge length of 4 So (So = cross sectional area in sqmm).

Use of Corrosion Resistant steel

In aggressive environment, corrosion resistant steel can be used. These are low-alloy steels containing a total of 1 per cent to 2 per cent alloys, in particular, copper, chromium, nickel and phosphorous

5.2.3 Methodology Statement

Contractor will submit a „methodology statement“ if not already included in the bid offer at tendering stage itself and have it approved by the Engineer at start of work. This statement shall include:

- i. Sequencing of work, vis-à-vis the complete scheme of superstructure works
- ii. PERT chart to fit in with overall duration within targeted completion date
- iii. Requirement and arrangements proposed in base depot / fabrication yard and other details.
- iv. Scheme for transport of fabricated steel girder.
- v. Girder launching and erection scheme including crane operations.
- vi. Scheme for providing accessories / appurtenances.

Before commencement of work, Contractors will discuss with Engineer and finalise the details listed above. If any changes in the scheme are called for, the Contractor will promptly bring such necessity to notice of Engineers and give his proposals in writing. They will be discussed and finalised in a workmanlike manner. Any delay and cost involved will be to contractor's account unless such change has been called for due to any major change in design or scope of the work or change of policy of Government. Nothing extra is payable for preparation and finalisation of the Methodology / Methods Statement.

5.3 Fabrication of Steel Work

5.3.1 Codes of Specifications

The work shall be done in accordance with the following codes and specifications and any other requirements that may be prescribed in special cases.

- i. IRS Steel Bridge Code
- ii. IRS Specification No.B-1-2001 for Steel Girder Bridges
- iii. IRS Specification No. M 3-Class I, II, III and IV Steel forgings, blooms for forgings and billets for re-rolling
- iv. IRS Specification No. M-28 Classification, testing and approval of metal arc welding electrodes for use – Indian Railways.
- v. IRS Specification No. M-29 Classification, testing and approval of submerged arc welding with flame combination.

- vi. IRS Specification No M-41 Corrosion resistance steel
- vii. IRS Specification No M-42 High strength low alloy structural steel with enhanced corrosion resistance.
- viii. IRS Specification No M-49 High strength excavating structural steel rivet bars with enhanced corrosion resistance.
- ix. IRS Specification No P-31 Zinc Chromate red oxide primer.

The fabrication and erection of the steel work shall be in accordance with IRS: B1-2001 supplemented by relevant provisions of this Specifications

5.3.2 Qualities of Steel

The steel used for fabrication work shall conform to the appropriate quality as specified below, unless the use of any other quality of steel is specially approved.

- i. IS 226:1962 (Standard quality): For non-welded structures subjected to dynamic loading and for welded non-dynamically loaded structures, if the thickness of material welded does not exceed 20mm.
- ii. IS:2062-1962 (Fusion welding quality) - For all welded structures for which IS:226 is not suitable.
- iii. IS:1977-1962 (Ordinary quality):-
 - a) Grade ST 44-0: For non-welded structures not subjected to dynamic loading other than wind (e.g. sheds, buildings, foot over bridges) except structures designed according to plastic theory.
 - b) Grade ST-32-0: For general purposes where the load carried is not the main consideration (e.g. grills, railings)

5.3.3 Straightening of Members

All members used shall be straight except those meant to be curved and any straightening necessary shall be carried out before the material is worked upon. The straightening shall be done by pressure and no heating resorted to except with the prior approval of the Engineer and with such safeguards as considered by him to be necessary.

5.3.4 Cutting of Steel

Cutting of steel for fabrication may be done by shearing, sawing or by gas. For less important works the Engineer may permit the use of chisels and jim crows also. Gas cutting for important works shall preferably be done by mechanically controlled torches. Cut edges shall be machined where so specified. If machining is not specified, hand flame cut, chisel cut and jim crowed edges shall be ground smooth where so directed by the Engineer. Para 17 of B1-2001 may also be referred to in this connection.

5.3.5 Making of Holes

- (a) In all important works and in splices, the holes for rivets or bolts shall either be drilled to the correct sizes or sub-punched initially to a diameter 6mm less than the finished diameter and reamed subsequently to the correct sizes as indicated in Para 18 of B1-2001. Sub-punching is, however, not permissible in the main truss members of open-web bridge girders.
- (b) Forming of holes by gas-cutting is strictly forbidden.
- (c) Holes for rivets and black- bolts shall be 1.5mm (1/16 inch) larger in diameter than the rivet bar or the bolt, and care shall be taken not to exceed this limit. In the case of turned bolts the holes shall be drilled to such tolerances as laid down in Cl. 29.5 of I.R.S. B.I.-2001 Specification for Steel girder Bridges and Locomotive turn-tables.
- (d) Marking and drilling of holes in members, especially for the end connections, shall preferably be done with the use of templates. Holes in rolled sections shall follow the standard gauge lines unless otherwise indicated in the drawings.

5.4 Welding

(1) General

Only Automatic submerged arc welding will be used for fabrication. The welding and the welded work shall conform to I.R.S. welded bridge code, IS: 816 (1969) and IS: 9595 (1980), unless otherwise specified. As much work as possible shall be welded in shops and the layout and sequence of operations shall be so arranged as to eliminate distortion and shrinkage stresses.

- (a) In the case of welded fabrication, the following directions shall be observed in addition to the provisions of the IRS welded Bridge Code
 - i) Shop welding shall be adopted wherever possible in fabricating components and sub members for welding shall be done by submerged and welding.
 - ii) Suitable jigs and fixtures shall be used, both in the field and in the shop, to avoid distortion during welding, and in the case of plated construction, to control distortions within the same limits as applicable to corresponding rolled sections.
 - iii) Components which are mass fabricated in the shops should be proved in master templates.
- (b) Unless specified otherwise, the lowest classes of electrodes to be used for different types of welding work shall be as given in following Table under, based on IRS Specification No.M.28-66 for the classification.

Table 01 Testing and Approval of Metal Arc Welding Electrodes

Class of Electrode as per IRS	Type of work to be welded	I.S. Specification	Code (as per IS:815-66)
Class A	Mild steel work where the strength of weld is of no importance e.g. filling of holes, dents etc	814-63	M.100 to M.999
Class B (Normal ductility)	For general welding work on steel – M.S. to IS:226-1962 and cast steel to IS:1030 Grade 3 and IRS M3 Grade 2, for service conditions where the weld is	Do	M 110 to M 997-H, J, K or P.
Class B2 (Moderately high ductility)	For welding of mild steel to IS:2062-1962 (Fusion welding quality) or equivalent, for service conditions where the weldment is rigid and subjected to relatively high dynamic stresses	D o	Do

The classification of the various makes and brands of electrodes in the market, as assessed from time to time will have to be referred to before its use on the work. Lists shall be made out by the M.&C Wing of RDSO and maintained in the Headquarters Works Branch and CAO's Offices. Any electrode to be used shall be verified from these lists to see if it is of the appropriate class.

- (c) The maximum size of electrodes for welding any work and the size of run to be obtained from each shall be based on the following Tables 02 and 03 except for close butt welds or other cases where any special technique is approved.

Table 02 Size of Electrodes

Average thickness of plate or	Maximum size of electrode to be used
Less than 5mm	10 S.W.G. (or 3.2mm)
5mm and above but less than 8mm	8 S.W.G. (or 4mm)
8mm and above, but less than 10mm	6 S.W.G. (or 5mm)
10mm and above, but less than 16mm	4 S.W.G. (or 6mm)
16 mm and above, but less than 25mm	5/16" (or 8mm)
25 mm and above	3/8" (or 9mm dia)

Table 03 Size of Weld Runs

Gauge of Electrode	Sectional area of		Approximate size of run in cm per electrode 42.5 cm long	
	Maximum	Minimum	Maximum	Minimum
12 S.W.G.	18.00	12.30	10.0	15.0
10 S.W.G.	22.60	12.30	12.7	22.8
8 S.W.G.	25.20	14.20	17.7	30.5

6 S.W.G.	27.10	16.80	22.8	38.0
4 S.W.G.	32.90	19.35	27.9	48.2
2 S.W.G.	36.80	23.25	35.5	55.9
0 S.W.G. (or 5/16")	41.30	27.0	43.2	66.9

Note : In any strength weld, the first run shall not ordinarily be deposited with an electrode of gauge larger than 8 S.W.G. For subsequent runs the electrode shall not be increased by more than two sizes between consecutive runs.

5.5 Workmanship

5.5.1 General

Fabrication Such work shall be performed only within the plants and by fabricators who have at the tendering stage established, to the satisfaction of the Engineer / Railway, that they have the experience, knowledge, trained man power, quality controls, equipment and other facilities required to produce the steel work to desired quality. Prequalification of the plant and fabricator will be established either by the submission of detailed written proof or through in plant inspection by the Engineer

5.5.2 Templates

The templates for the work shall be steel bushed in cases where the Engineer may consider necessary. Where actual materials from the work have been used as templates for drilling similar pieces, the Engineer will decide whether they are fit for use as part of the finished structure.

5.5.3 Rolling Margin

The rolling margin in plates, sections and bars shall be in accordance with the relevant Indian Standard and all materials outside these limits shall be liable to rejection.

5.5.4 Interchangeability of Parts

The Contractor shall arrange for corresponding parts of each unit manufactured from the same drawing to be interchangeable as far as economic manufacturing conditions permit and shall advise the Engineer of the precise arrangements made in this respect. There should be level, finished concrete floor of sufficient dimensions in the fabrication yard, on which the fabricator will precisely set out the outline of the structure (to full scale) as per drawings for the purpose of preparing templates. Only steel tapes shall be used for all measurements and they will be held tight and level on the floor while measuring or marking.

5.5.5 Steel Tapes

Steel tapes used for marking out the work shall be calibrated at a temperature of 20⁰ C.

5.5.6 Universal Plates and Flats

Where universal plates or flats are used as part of a built up section and with their edges exposed, such edges shall be true or planed true.

5.5.7 Drilling

i. Rivet and Bolt Holes

No holes shall be punched full size without the permission of Engineer.

ii. Reamer Holes

All holes for turned bolts shall be reamed in the manufacturer's works.

iii. Holes in welded Members

All bolt and rivet holes in members built up by welding shall be drilled after welding has been completed.

iv. Removal of Burrs

Holes which are drilled through two or more separable parts shall have all burrs removed after separating the parts

v. Holes for Countersunk H.S.F.G. Bolts

Holes for countersunk H.S.F.G. bolts shall conform to the proportions for Flat countersunk heads with 80° included angle and head diameter approximately twice the diameter of the bolt. The counter sunk shall be truly concentric with the shank holes. Bolt heads shall be dressed flush where necessary for proper construction

5.5.8 Closed Butted Joints

i. Where close butted joints are required they will be indicated on the Drawings and the butting ends of the parts shall be machined to ensure close contact when the joint is made.

ii. Close contact shall be deemed to have been achieved when atleast 90% of the area is in close contact and the remaining 10% or so also has clearance not exceeding 0.2mm

5.5.9 Shearing of Plates

Shearing and grinding of steel plates shall not be carried out without the permission of the Engineer.

5.10 Notches

The roots of all notches shall be smoothed

5.5.11 Procedure Trials for Welding and Cutting Where required by the Engineer, welding and flame cutting trials shall be carried out and completed before fabrication on representative samples of materials to be used in the work, as follows:-

a. The samples of materials shall be selected and marked by the Engineer when the materials for the work are inspected at the mills.

b. Trials on material 19mm thick may be taken to include all material under 19mm thick and on material 38mm thick to include material between 19mm and 38mm thick. Over 38mm thickness material shall be tested for every thickness increment of 6mm. The trials of flame cutting shall be carried out on material representative of all thicknesses to be used in the work

c. The welding and flame cutting trials shall demonstrate workmanship / quality to the satisfaction of the Engineer. The procedures to be adopted shall include

Welding procedure in accordance with IRS welded Bridge Code supplemented by IS:813 and IS:1980. The heat control techniques required to ensure that the flame cut surfaces of any imported steel like steel to B.S. 4360 Grade WR 50,50B, WR 50B, 50C and WR 50C are suitable for inclusion in welds

d. The trials shall include specimen weld details from the actual construction which shall be welded in a manner simulating the most unfavourable instances of fit up and preparation which it is expected will occur in the particular fabrication. After welding, the specimens shall be held as long as possible at room temperature, but in any case not less than 72 hours, and shall then be sectioned and examined for cracking.

e. Procedure Trials: Testing shall be to relevant IS Code or if approved to B.S. 709. The following groups of tests, shall be carried out in accordance with the type of welds

i. Butt welds:- Transverse tensile test. Transverse and longitudinal bend test with the root of the weld in tension and compression respectively and Charpy V notch impact test.

ii. Filletwelds: Fillet weld fracture test

iii. Tackwelds: Inspection for cracking

iv. All welds: Macro examination specimen for each type of weld. Additional tests not included in (i) and (ii) above will be specified by the Engineer as required. Shop welded joints will be radiographically examined for 100%

5.5.12 Welding Requirements

a) Qualification and Testing of Welders

Only qualified welders will be engaged in the work and they also will be tested for their skill in welding to full satisfaction of the Engineer as directed below

i. No welding operator shall be employed on the work until he has, in the presence of the Engineer, passed the appropriate tests laid down in relevant codes

ii. Where plates of 12mm thick and over are to be butt welded the tests. Engineer may specify other tests to be conducted.

iii. Routine re-testing of welding operators may be required every six months if considered necessary by Engineer.

iv. The Engineer can also require any welding operator to be retested at any time during the Contract.

b) Supervision of Welding

- i) The Contractor shall appoint welding supervisors whose competence and qualifications shall be subject to approval of the Engineer and all welds shall be carried out under their direction.
- ii) Except where agreed by the Engineer, a record shall be kept to enable butt welds to be identified with the welders responsible for the work but material shall not be marked by hard stamping for this purpose.

c) Welding Plant

The welding plant shall be capable of maintaining at the weld, the voltage and current specified by the manufacturer of the electrodes used. The Contractor shall supply instruments for verifying voltage and current as and when required by the Engineer.

d) Welding

Metal Arc welding shall be carried out in accordance with IRS Welded Bridge Code (and if so required with B.S. 5135) and the following additional requirements.

- i. The general welding programme for shop and site welds, including particulars of the preparation of fusion faces, pre-heating where required and methods of making welds shall be submitted in writing to the Engineer for approval before the work is put in hand. No departure from the welding programme or from the details shown on the Drawings shall be made without the prior approval of the Engineer.
- ii. Approval of the welding procedure shall not relieve the Contractor of his responsibility for correct welding and for minimising of distortion in the finished structure.
- iii. The procedures for welding and flame cutting established by the procedure trials under Para 21.4.11 shall be strictly followed.
- iv. All main butt welds shall have complete penetration and shall comply with the requirements of IRS Welded Bridge Code. They shall be made between prepared fusion faces. Where possible they shall be welded from both sides. The ends of the welds shall have full throat thickness. This shall be obtained on all main welds by the use of extension pieces adequately secured on either side of the main plates. Additional metal remaining after the removal of the extension pieces shall be removed by machining, or by other approved means and the ends and surfaces of the welds shall be smoothly finished.
- v. In the fabrication of built-up assemblies all butt welds in the component part's shall be complete before the final assembly
- vi. Pre-heating and temperature conditions, electrodes, and size of single runs shall be as follows.

- a. Grades 43A and 43C steel – no welding of these and similar mild steels shall be undertaken where the ambient or plate temperature is 0^o C or below.
 - b. Grades WR 50B and WR 50C Steel - for all welding of steel to Grades 50B and 50 C and similar carbon manganese steels the temperature shall be not less than 10^o C when welding is commenced.
- vii) Controlled hydrogen electrodes shall be dried out and used in strict accordance with the manufacturer's instructions.
- viii) Loose flux used for automatic and semi-automatic welding shall be kept free from contamination and used in accordance with the manufacturer's instruction.
- ix) All tack welds shall be of the same quality and size as the first run of the main weld. The main weld shall fuse completely with the ends of the tack welds to form a regular profile. Where preheat is required for the main welds the tack welds shall be made under the same heat conditions. The length of the tack welds shall not be less than four times the thickness of the thicker part or 50mm whichever is the smaller.
- x) The position of welds required for temporary attachments shall be approved by the Engineer before the work starts.
- xi) Temporary attachments shall be removed without damage to the parent metal, which shall be finished smooth by grinding in the direction of the applied stress in the finished structure.
- xii) All cracked welds shall be cut out to the satisfaction of the Engineer before re- welding
- xiii) Where automatic or semi-automatic welding processes are used, back gouging will not be required when it is demonstrated to the Engineer that satisfactory welds are produce
- xiv) Where butt welds are to be ground flush, there shall be no loss of parent metal. The final grinding shall be in the direction of the applied stress.
- xv) Run – off plates and run-on plates.
- a) One pair of “run-on” plates and one pair of “run-off” plates all prepared to the same thickness and profile as the parent metal shall be attached by clamps to the start and finish respectively of all butt welds so that the direction of rolling of the added plates is parallel to that of the parent metal.
 - b) Except as directed by the Engineer the plates in approximately 1 in 5 pairs of run-off plates shall each be 150mm wide by 200mm long,

the length being measured in the rolling direction of the metal and at right angles to the weld.

- c) The welds shall run the full length of the joint and extend at full section for a minimum distance of 25mm into the run-off plates.
- d) On completion of the welds the 150mm x 200mm run-off plates shall not be removed until they have been marked by the Engineer to identify them with the joints to which they are attached.
- e) When removing the run-off and run-on plates by flame cutting the cuts shall not be nearer than 6mm to the sides of the parent metal and remaining metal shall be removed by grinding in the direction of the applied stress or by other method approved by the Engineer.
- f) Specimens for test shall be selected from the run-off plates as required by the Engineer.

5.5.13 Welding Inspection

The Engineer will require radiographic or other non-destructive examinations to be carried out on all main welds carrying tension and on other welds to his satisfaction. If required, samples of the welds in permanent or temporary works shall be cut out for examination by the Engineer

5.5.14 Stress Relieving

If required by the Engineer or specified elsewhere herein or specified on the Drawings, welds shall be stress relieved and special units may require to be normalized.

5.5.15 Flame Cutting

Where the flame cut surface is not subsequently incorporated in a weld, machine flame cutting may be used subject to the following requirements

- i) Grades 43A and 43C steel. All irregularities in the cut face, edges and corners shall be removed by grinding in the direction of the main stress to be carried by the material.
- ii) Grades WR 50, 50B, WR 50B, 50C and WR 50C steel:- The heat input and cooling condition shall be in accordance with the procedures specified in Clause 13 of B.S. 5135, unless otherwise specified

5.5.16 Welding of stud shear connectors

The stud shear connectors shall be welded in accordance with the manufacturer's instructions including preheating.

The stud and the surface to which studs are welded shall be free from scale, moisture, rust and other foreign material. The stud base shall not be painted, galvanised or

cadmium plated prior to welding. Welding shall not be carried out when temperature is below 10 degrees Celsius or surface is wet or during periods of strong winds unless the work and the welder are adequately protected. The welds shall be visually free from cracks and shall be capable of developing at least the nominal ultimate strength of studs. The procedural trial for welding the stud shall be carried out when specified by the Engineer.

5.6 Bolting and Drilling etc

5.6.1 Drilling

- (1) Holes for bolts shall be drilled to conform to Clause 10 of IS: 7215-1974. Punching of holes shall not be permitted. All holes, except as stated hereunder, shall be drilled to the required size, 3mm less in diameter and reamed thereafter to the required size. All matching holes for bolts shall register with each other so that a gauge of 0.8mm less in diameter than the hole can pass freely through the members assembled for bolting, in the direction at tight angle to such members.
- (2) All drilling shall be freed of burrs.
- (3) No holes shall be made by gas cutting process.

5.6.2 Field Bolts

- (1) Requirements stipulated under bolting shall apply for field bolts. Field bolts, nuts and washers shall be furnished by the Contractor in excess of the nominal numbers required. He shall supply the full number of bolts, nuts and washers and other necessary fittings required for completing the work, together with the additional bolts, nuts and washers totaling to 10% of the requirement subject to minimum of 10 Nos. Only HSFG bolts of class 8.8 shall be used.
- (2) At the time of assembly, the surfaces in contact shall be free of paint or any other applied finish, oil, dirt, loose rust, loose scale, burrs and other defects which would prevent solid seating of the parts or would interfere with the development of friction between them.
- (3) If any other surface condition, including a machined surface, is specified, it shall be the responsibility of the Contractor to work within the slip factor specified for the particular case.
- (4) Each bolt and nut shall be assembled with washers of appropriate shape, quality and number in cases where plane parallel surfaces are involved. Such washers shall be placed under the bolt head or the nut, whichever is to be rotated during the tightening operation. The rotated nut or bolt head shall be tightened against a surface normal to the bolt axis, and the appropriate tapered washer shall be used when the surfaces are not parallel. The angle between the bolt axis and the surface under the non-rotating component (i.e. the bolt head or the nut) shall be $90 + 3$ degree. For angles outside these limits, a tapered washer shall be placed under the non-rotating component. Tapered washers shall be correctly positioned.

- (5) No gasket or other flexible material shall be placed between the holes. The holes in parts to be joined shall be sufficiently well aligned to permit bolts to be freely placed in position. Driving of bolts is not permitted. The nuts shall be placed so that the identification marks are clearly visible after tightening. Nut and bolts shall always be tightened in a staggered pattern and where there are more than four bolts in any one joint, they shall be tightened from the centre of the joint outwards.
- (6) If, after final tightening, a nut or bolt is slackened off for any reason, the bolt, nut and washer or washers shall be discarded and not used again.

5.7 Erection

5.7.1 General

(1) The erection of steel work for different types of structures shall be done in accordance with the respective Indian Railway standard specifications as listed below.

(a) Bridge work: IRS Specification No. B1-2001 for Erection and Riveting of Bridge Girders.

(b) General Structural Work: IRS Specification No.B2 for Steel Structures (other than Girder Bridges)- Part 3.

(c) IronandSteeltanksandstagings – IRS Specification No.B3- Part 4.

The important provisions of IRS Specification No.B1-2001 (Part 3) which is commonly required to be followed in the field for all steel girders are extracted and given below for ready reference, duly amplified where necessary.

5.7.2 Material Handling

- (a) The materials, on receipt, shall be carefully unloaded, examined for defects, checked, sorted and stacked securely on a level bed, out of danger from flood or tide and out of contact with water or ground moisture. They will be supported on timber or concrete plinths so that they do not touch the ground.
- (b) The materials shall be verified with the marking shown on the marking plan, if any, or with the detailed drawings issued for the work.
- (c) Any material found damaged or defective shall be stacked separately. The materials should, as far as possible, be inspected before unloading from trucks to ascertain if any damage has occurred in transit. The portions found damaged or defective shall be marked with paint of distinctive colour. Such materials shall be dealt with under orders of the Engineer and without delay. Slightly distorted parts may be straightened by gradual pressure without heating, whereas badly damaged portions may require to be replaced. In exceptional cases, where rectification of badly distorted or broken parts is allowed by the Engineer, it shall be done in such manner and with such safeguards as directed by him. Connection plates, if slightly bent or twisted shall be straightened cold. If bent so sharply as to require heating, the whole plate thus treated shall be annealed before use on work. Engineer at his discretion may

~~have such rectified component tested for its load carrying capacity before use on work.~~

5.7.3 Preliminary Requirements

- i. Before starting the work, the method of erection and the details of the erection equipment proposed to be used shall be got approved by the Engineer, but such approval shall not be considered as relieving the Contractor of his responsibility for safety or for carrying out the work in full accord with the drawings and specifications. All temporary works shall be properly designed and substantially constructed for the loads they would be called upon to sustain, including wind and lateral forces, etc according to the local conditions.
- ii. A careful inspection of plant and tackle shall be made to ensure that they are in good order and well upto the capacity required. When chains or ropes are used for lashing, care must be taken to protect them as well as the members lashed, to avoid damage to either.
- iii. Frame and steel skeleton structures shall be carried up true and plumb. Temporary bracings shall be provided, if required, to take care of stresses from erection equipment or other loads carried during erection and also to ensure lateral stability of structures during the process of erection.
- iv. All surfaces which shall be in permanent contact after assembly shall be thoroughly cleaned to remove all paint and mill scale and shall receive, immediately before being assembled one coat of approved primer like Zinc Chrome Red Oxide to IS 2074 or in accordance with relevant Para in Painting Iron Work, with the prescribed number of coats. Care shall be taken to see that any burr or other surface defects are removed before the parts are assembled. Field rivets, welds and bolted connections shall be protected by a coat of clean boiled linseed oil till the work is inspected and passed by the Engineer's representative. After passing, these shall be cleaned and painted with a coat of red lead paint or other approved primer, irrespective of whether the final painting of the finished structure is to be done by the Contractor or not.

5.7.4 Assembling Steel

- i. The parts shall be accurately assembled as shown on the drawings and match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged.
- ii. Hammering which will injure or distort the members shall not be done. Bearing surface or surfaces to be in permanent contact shall be cleaned, before the members are assembled. The truss spans shall be erected on blocking, so placed as to give the proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets in railings shall not be driven until the span has been swung.
- iii. All joint surfaces for bolted connections including bolts, nuts, washers shall be free from scale, dirt, burrs, other foreign materials and defects that

would prevent solid seatings of parts. The slope of surface of bolted parts in contact with bolt head and nut shall not exceed 1 in 20, to the plane normal to bolt axis, otherwise suitable tapered washer shall be used.

- iv. All fasteners shall have a washer under nut or bolt head whichever is turned in tightening. Any connection to be riveted or bolted shall be secured in close contact with service bolts or with a sufficient number of permanent bolts before the rivets are driven or before the connections are finally bolted. Joints shall normally be made by filling not less than 50 per cent of holes with service bolts and barrel drifts in the ratio

4:1. The service bolts are to be fully tightened up as soon as the joint is assembled.

Connections to be made by close tolerance or barrel bolts shall be completed as soon as practicable after assembly.

- v. Any connection to be site welded shall be securely held in position by approved methods to ensure accurate alignment, camber and elevation before welding is commenced.
- vi. The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting up of parts by moderate use of drifts or by a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Engineer and his approval of the method of correction obtained. The correction shall be made in the presence of the Engineer
- vii. The field riveting, and bolted and pin connection shall conform to the requirements of following Para as appropriate.

5.7.5 Bolted Connections

Permanent bolted connections shall be used only where shown on the drawings or where specially approved by the Engineer. In all such cases, washers not less than 6mm thick shall be used under the heads and nuts, and the nuts drawn tight and “checked” by burring over the threads with a chisel.

5.8 Painting

5.8.1 General

Unless otherwise specified all painting and protection coating work shall be done in accordance with Para 39 of IRS B1-2001 and IS:1477 (Part 1) supplemented by the specifications given below. In locations where girders are subjected to satisfy such as close vicinity of sea and or over creeks, metalising with sprayed aluminium as given in Appendix VIII to IRS B1-2001 will be done, followed by painting with one coat of etch primer to IS:5666 (ii) or the coat of

zinc chrome primer to IS:104 the zinc chrome to be used in the manufacturer conforming to type 2 of IS 51 and (iii) two coats of aluminium paint to IS 2339 by brushing or spraying as specified. One coat is to be applied in shop before despatch and second after erection after touching up the earlier coats if damaged in transit or during erection.

5.8.2 Surface Preparation

Steel surface to be painted either at the fabricating shop or at the site of work shall be prepared in a thorough manner with a view to ensuring complete removal of mill scale by one of the following processes as agreed to between the fabricator and the Engineer.

- a) Dry or wet grit / sand blasting
- b) Pickling which should be restricted to single plates, bars and sections
- c) Flame cleaning

Primary coat shall be applied as soon as practicable after cleaning and in case of flame cleaning, primary coat shall be applied while the metal is still warm. All slag from welds shall be removed before painting. Surfaces shall be maintained dry and free from dirt and oil. Work out of doors in frosty or humid weather shall be avoided.

5.8.3 Applicable Codes of Practice

The applicable specifications, standards and codes are including but not limited to the followings:-

(1) IS: 102 (1962) Ready Mixed Paint, Brushing, Red lead, Non Setting, Priming. (2) IS: 159 (1981) Ready Mixed Paint, Brushing, Acid Resisting for .Protecti against Acid Fumes, Colour as Required.

3) IS: 341 (1973) Black, Types A, B & C.

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- (4) IS: 384 (1979) Brushes, Paints and Varnishes, Flat.
 - (5) IS: 487 (1985) Brush, Paint and Varnish i) Oval Ferrule Bound ii) Round
 - (6) IS: 958 (1975) Temporary Corrosion Preventive Grease, Soft Film, Cold
 - (1) IS: 1153 (1975) Temporary Corrosion Preventive, Fluid, Hard Film, Solvent Deposited.
 - (2) IS: 1477 (1971) Code of Practice for Painting of Ferrous Metals in Building.
Part I – Pre-treatment
Part II - Painting
 - (3) IS: 1674 (1960) Temporary Corrosion Preventive Fluid, Soft Film, Solvent Deposited.

- (4) IS: 2074 (1992) Ready Mixed Paints, Red Oxide –Zinc Chrome, Priming.

5.8.4 Coatings

Prime coat to be used shall conform to the specification of primers specified hereinafter or in Drawings / Contract and should be approved by the Engineer. Metal coatings shall be regarded as priming coatings. Primer shall be applied to the blast cleaned surface before any deterioration of the surface is visible. In any case, the surface shall receive one coat of primer within 4 hours of abrasive blast cleaning.

All coats shall be compatible with each other. When metal coatings are used, the undercoat shall be compatible with the metal concerned. The undercoat and finishing coat shall preferably be from the same manufacturer. Successive coats of paints shall be of different shades or colours and each shall be allowed to dry thoroughly before the next is applied. Particular care shall be taken with the priming and painting of edges, corners, welds and rivets. Typical guidelines for epoxy based paints and the conventional painting system for bridge girders as given below may be complied with:

(a) Epoxy Based Painting

- i) Surface preparation: Remove oil / grease by use of petroleum hydrocarbon solution (IS:745) and Grit blasting to near white metal surface.
- ii) Paintsystem: 2 coats of epoxy zinc phosphate primer = (60 micron; Total 5 coats = 300 micron) to RDSO Specn. No.IC/PCN/103/86. Finished coats approved by --
- air less spray of coats of Epoxy zinc phosphate to RDSO Specifications No.M&C /PCN/102/86.

b) Conventional Painting System for areas where corrosion is not severe

Priming Coat:

One coat of ready mixed zinc chrome priming conforming to IS:104 followed by one coat of ready mixed red oxide zinc chrome primer conforming to IS:2074.Or

Two coats of zinc chromate red oxide primer conforming to IRS P-31.

Finishing Coats Two cover coats of red oxide paint conforming to IS:123 or any other approved paint shall be applied over the primer coat. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second coat shall be given after touching up the primer and the cover coats if damaged in transit.

c) Conventional Painting System for areas where corrosion is severe

Priming Coat:

One coat of ready mixed zinc chrome primer conforming to IS:104 followed by one coat of red oxide zinc chrome conforming to IS:2074.

Finishing Coats:

Two coats of aluminium paint conforming to IS:2339 shall be applied over the primer coat. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second coat shall be given after touching up the primer and the cover coats if damaged in transit.

5.8.5 Painting in the Shop

- a) All fabricated steel shall be painted in the shops after inspection and acceptance with at least one priming coat unless the exposed surfaces are subsequently to be cleaned at site or are metal coated. No primer shall be applied to galvanised surfaces.
- b) Shop contact surfaces, if specifically required to be painted, shall be brought together while the paint is still wet.
- c) Field contact surfaces and surfaces to be in contact with cement shall be painted with primer only. Paint shall be completely dried before loading and transporting to site.
- d) Surface not in contact but inaccessible after shop assembly shall receive the fully specified protective treatment before assembly
- e) Where surfaces are to be welded, the steel shall not be painted or metal coated within a suitable distance from any edges to be welded if the specified paint or metal coating would be harmful to welders or is expected to impair the quality of site welds.
- f) Exposed machined surfaces shall be adequately protected.

5.8.6 Painting at Site

- i) Surfaces which will be inaccessible after site assembly shall receive the full specified protective treatment before assembly.
- ii) Surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while the paint is still wet.
- iii) Damaged or deteriorated paint surfaces shall be first made good with the same type of coat as the shop coat.
- iv) Where steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds, bolts and site rivets.
- v) Specified protective treatment shall be completed after erection.

5.8.7 Methods of Application

The methods of application of all paint coatings shall be in accordance with the manufacturer's written recommendation and approved by the Engineer or as indicated in painting chapter to the extent they are applicable to major steel structures. Spray painting may be permitted provided it will not cause

inconvenience to the public and is appropriate to the type of structure being coated. Areas hard to gain access for painting and areas shaded for spray application shall be coated first by brushing.

Oil based red lead primers must be applied by brush only, taking care to work into all corners and crevices.

The primer, intermediate and finishing coats shall all be applied so as to provide smooth coatings of uniform thickness. Wrinkled or blistered coatings or coatings with pinholes, sags, lumps or other blemishes, shall not be accepted. Where the Engineer so directs the coating shall be removed by abrasive blast cleaning and replaced at the Contractor's expense

5.8.8 Guideline of Specifications for Protective Coating System in Different Environments Paint System.

- (1) Since the seriousness of the problem of corrosion depends upon atmospheric conditions and these vary enormously, there is no single protective system or method of application that is suitable for every situation.
- (2) However, as a guide to specifying authorities, broad recommendations in this respect are given in Table 21.3 for various types of coatings in various environmental conditions, extracted from MOST Specifications for Roads and Bridges. Approximate life to first maintenance is also indicated and can be used as a guide.

Table 04 RECOMMENDATIONS FOR TYPES OF PROTECTIVE COATINGS

Syste	Environment
i) Wire brush to remove all loose rust and scale; 2 coats drying oil type primer; 1 under coat alkyd type paint; 1 finishing coat alkyd type. Total dry film thickness = 150 um	Suitable for mild conditions where appearance is of some importance and where regular maintenance is intended. This system may deteriorate to a marked extent if it is exposed to moderate aggressive
ii) Wire brush to remove all loose rust and scale; 2 coats drying oil type primer; 2 under coats micaceous iron oxide (MXO) pigmented phenolic modified drying oil. Total dry film thickness = 170 m	Similar to (i) but where appearance is not very important provides longer life in mild condition. Will provide upto 5 years life to first maintenance in polluted inland environment
iii) Blast clean the surface: 2 coats of quick drying primer; undercoat alkyd type paint; 1 finishing coat alkyd type. Total dry film thickness: 130-150 m.	Compared to (i) this would provide a longer life in mild conditions and could be used in less mild situation e.g. inland polluted, where maintenance could easily be carried out at regular intervals

iv) Blast clean the surface; 2 coats of drying type oil primer; 1 undercoat micaceous iron oxide pigmented drying oil type paint. Total dry film thickness: 165-190 μm	Suitable for general structural steel work exposed to ordinary polluted inland environments where appearance is not of primary importance.
v) Blast clean the surface; 2 coats of metallic lead pigmented chlorinated rubber primer. 1 undercoat of high build chlorinated rubber, 1 finishing coat of chlorinated rubber. Total Dry film thickness: 200 μm	Suitable for structures in reasonably aggressive conditions e.g. near the coast. Will provide, long term protection than (iv) in non-coastal situations. Also suitable for aggressive interior situations such as industrial areas.
vi) Blast clean the surface: 350-450 μm thickness. Coal tar epoxy.	Suitable for sea water splash zones or for conditions of occurrence of frequent salt sprays
vii) Pickle: hot dip galvanised (Zinc) Total thickness: 85 μm	Suitable for steel work in reasonably mild conditions. Life of 15-20 years before first maintenance could be expected in many situation
viii) Grit blast, hot dip galvanised. (Zinc). Total thickness = 140 μm	Provides a longer life than (vii) because of thicker zinc coating
ix) Grit blast; 1 coat of sprayed zinc/ aluminium followed by suitable sealer Total Thickness = 150 μm	Expected to provide long term protection approx 15-20 years in aggressive atmosphere.

5.9 Tolerances

The Contractor shall through appropriate planning and continuous measurements in the workshop and the erection at site, ensure that the tolerances specified below are strictly adhered to.

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852. The acceptable limits of straightness for rolled or fabricated members as per IS: 7215. Tolerances for fabrication of steel structures shall be indicated in the fabrication drawings and shall be in accordance with IRS - Specification for fabrication and erection of steel girder & bridges & loco turn tables (B1-2001).

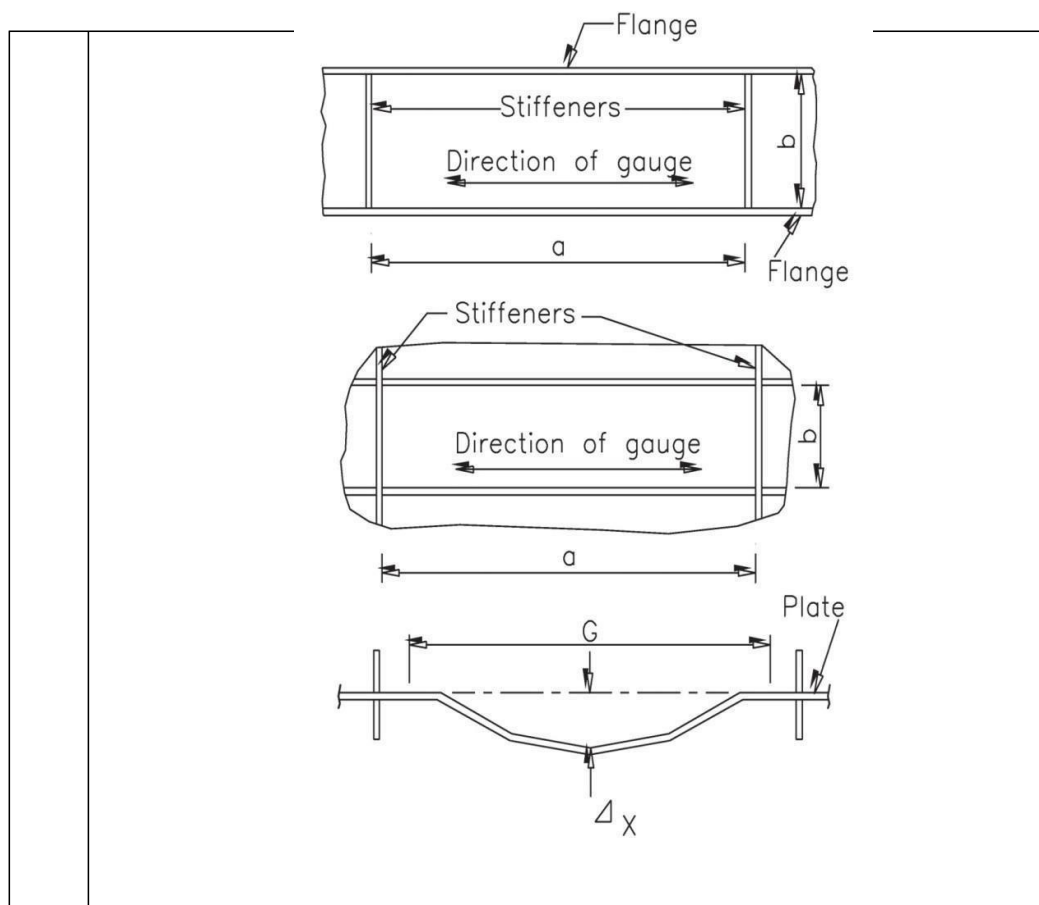
Below are, for reference, extracted from Appendix – II of this Specification (B1-2001) :-Manufacturing Tolerances.

1.	Plate Girders		
		(Description)	Tolerances in mm
			(plus) (minus)

	(a)	Overall length of the girder	6	3
	(b)	Distance between centres of bearings	1	1
	(c)	Depth over angles	3	1
	(d)	Corner of flange angle to edge of web at any place	0	2
	(e)	Diagonal at either end of the assembled span	3	3
	(f)	Centres of intersection of diagonals with girder flange measured along the girder flange	3	3
	(g)	Butting of compression ends:		
		(i) throughout	0	0.15

		(ii) locally	0	0.25
	(h)	Butting edge at web splices	0	1
	(i)	Straightness of girder bottom laid on the ground and checked with piano wire:		
		(i) Vertical plane		
		Convexity	0	3
		Concavity	0	0
		(ii) Horizontal plane	2	2
2.	Open Web Girders			
	(a)	Overall length of the girder	1	1
	(b)	Distance between centres of bearings	1	1
	(c)	Cross diagonals of assembled bays	1	1
	(d)	Centre to centre of cross girders	1	1
	(e)	Centre to centre of rail bearer	1	1
	(f)	Panel length in lateral bracing system	1	1
	(g)	Distance between inter section line	1	1
	(h)	Butting edge at compression members:		
		(i) throughout	0	0.15
		(ii) locally	0	0.25
	(i)	Twist in members	0	0
	(j)	Lateral distortion between points of	0.001 L	0.001 L
3.	Holes			
	(a)	Between any two holes in group	0.5	0.5

3	Displacement of vertical axis of the web with reference to flange	2
4	Box width of member	0 to +3
5	Verticality of stiffener or diaphragm out of plumb	2
6	Overall length of girder	+ 6 to -3
7	Depth of the girder at the centre of span	+ 3 to -1
8	Depth of the girder at the centre of span	+ 2 to -1
9	Distance between centre of bearings — —	+ 1 to -1
10	Diagonal at either end of assembled span	+ 3 to -3
11	An allowable limit for web buckling or undulation shall be flatness at right angles to plate surface measured parallel to longer side in either direction calculated from the formulae	
	$\Delta x = \frac{G}{165} \sigma_y$ or 4mm whichever is the lesser.	
	Where	
	Δx = Maximum deviation from straightness within a specific gauge length other values are constant	
	σ_y = Yield stress of steel in N/mm ²	
	G = length of measuring gauge in meter	
	(G = a where a < 2b and G = 2b where a > 2b)	



5.10 Quality Control & Testing Requirements

5.10.1 Quality Control

The steel shall comply in all respects with the requirements of approved drawings and relevant codes and specifications and shall be procured from approved manufacturers only. It may be noted that quality of raw steel used for fabrication shall be essence of the contract & shall be strictly conforming to specified standard. Steel sections to be supplied by the manufacturers shall be tested as per codal provisions at the manufacturer's premises before dispatch. The contractor on receipt of supply in his fabrication shop shall carry out necessary control tests including ultrasonic testing as per codal requirements and verify them with the list received from manufacturers. The rejected lot shall not be used and rejected lot shall be immediately removed from fabrication shop. Only steel passed in all tests shall be used for fabrication.

The Contractor shall supply information in the technical package regarding source / Manufacturers from where procurement of steel is roposed.

In order to exercise proper control of the quality of the welding, Contractor shall enforce methods of control as tabulated below:

Purpose	Control subjects	Methods of control
1	2	3
1. Control of welding materials and basic metal quality	Quality control of electrodes, welding wire, flux and protective gases. Checking of quality and weldability of the basic metal and welded members. Welding of specimens for quality determination. Control of assembly accuracy and technological welding process.	Weldability test to determine the technological properties of materials.
2. Checking of welders qualifications		Mechanical test of weld metal.
3. Control of welded joint quality		<p>Metallographical investigations of welds macro-structure and microstructure.</p> <p>Checking of weld metal resistance for intercrystalline corrosion. Study if weld metal solidity by physical control methods.</p> <p>Mechanical tests, metallographical investigation & checking of welded joints by physical control methods.</p> <p>Checking of assembly quality & centering of welded members.</p>

5.10.2 Tests & Testing Procedures

Fabricator agency shall have in house facilities for all testing of weld.

5.10.2.1 Visual Examination

The contractor shall conduct visual examination and measurement of the external dimensions of the weld for all joints. Before examining the welded joints, areas close to it on both sides of the weld for a width not less than 20 mm shall be cleaned of slag and other impurities. Examination shall be done by a magnifying glass which has a magnification power of ten (10) and measuring instrument which has an accuracy of + 0.1 mm or by weld gauges. Welded joints shall be examined from both sides. The contractor shall examine the following during the visual checks.

- i) Correctness and shape of the welded joints
- ii) Incomplete penetration of weld metal

- iii) Influx
- iv) Burns
- v) Unwelded craters
- vi) Undercuts
- vii) Cracks in welded spots and heat affected zones
- viii) Porosity in welds and spot welds
- ix) Compression in welded joints as a result of electrode impact while carrying out contact welding
- x) Displacement of welded element

The Contractor shall document all data as per sound practices.

5.10.2.2 Mechanical Test

The Contractor shall carry out various mechanical tests to determine weldability, metal alloyability, nature of break, correct size and type of electrodes, degree of pre-heat and post-heat treatment. The type, scope and sample of various mechanical tests shall be determined in agreement with the purchaser. The number of tests conducted shall depend on the result obtained to satisfy the Engineer that the correct type and size of electrode, degree of pre-heating and post-heating and weldability of metal are being followed.

5.10.2.3 Dye Penetration Test

All welds shall be tested by "Dye Penetration test" as per current practices.

5.10.2.4 Radiography Test

Radiography test shall be conducted by the contractor to determine gas inclusion (blow holes, hollows) slag inclusion, shallow welds and cracks for 100 % lengths all butt joints.

Before conducting the examination the welded joints shall be cleaned of slag and scales and visually examined. The welds shall be marked into separate portions depending on the length of photograph. The length of photograph shall be such as to ensure that there are no distortions and shall reveal the defect correctly. The length shall not be more than 0.75 of the focal distance and the width of the photograph would depend on the width of the welded joint plus 20 mm on either side of the weld. The cassette with film shall be protected by sheet of lead or equivalent of proper thickness against incidental, diffused and secondary radiation.

The direction of the ray with relation to the film shall be as specified hereunder.

Welds of butt joints without edge slopes with edge processing shall be examined by central ray directed at right angles to the weld.

In special cases examination of welds with inclined rays directed along edge slopes may be permitted by the Engineer.

Lap joints shall be examined by directing rays at 45 degree to the bottom plate. Welds in T- joints without any edge preparation shall be examined by rays directed at 45 degree to the weld. Angle welds in lap and tee-joints shall be examined by the rays in opposite direction i.e. the film will be on the side of the weld. Weld in angle joints shall be checked by directing ray along the bisector of the angle between the welded elements. Opposite direction of the ray and location of the film may also be permitted by the Employer.

5.10.2.5 Ultrasonic Test

Ultrasonic test shall be conducted by the contractor to detect gas inclusion (pores), slag inclusion, shallow welds, cracks, lamination and friability etc. Prior to starting of ultrasonic test the welded joint shall be thoroughly cleaned of slag and other material. Surface of the basic metal adjacent to welded joint on both sides shall be mechanically cleaned by the grinder or a metal brush to provide the contact of the whole ultrasonic probe surface with surface of basic metal. The width of the clean surface shall be as directed by the Engineer. The welded joint then shall be covered with a thin coat of transformer oil, turbine or machine oil to ensure acoustic contact. The joints so treated shall be marked and the marks shall be entered into the documentation, subsequent to this, ultrasonic test shall be carried out as directed by the Engineer. At least 50% of weld shall be tested by ultrasonic testing.

5.10.2.6 Testing of Bolted Connections:

- (i) Bolts and bolted connection joints with high strength friction grip bolts shall be inspected and tested according to IS: 4000
- (ii) Rivets and riveted connections, alignment of plates at all bolted & welded joints shall be inspected and tested for compliance to Codal requirements
- (iii) The firmness of joint shall be checked by 0.2mm filler gauge, which shall not go inside under the rivet head by more than 3mm.
- (iv) Hardness testing shall be carried out on six specimens

5.10.3 Load Test on Steel Truss Span:

The steel open web girder spans shall be load tested to prove the proper camber provided while fabrication, as under

- (1) In Un-pre-stressed open web girders spans, the camber of the main girders and the corresponding variations in length of members shall be such that when the girders are loaded with full dead load plus 75% of the live load without impact producing maximum bending moment, they shall take up the true geometrical shape assumed in their design.
- (2) Where girders are pre-stressed the stress camber change should be based on full dead load and live load including impact.

6. Miscellaneous Works

6.1 Expansion Joints

6.1.1 Scope

This work shall consist of fabrication and placing of expansion joints as indicated on the drawing and conforming to these specifications or as directed by the Engineer.

6.1.2 General Requirements

- a) The expansion joints shall be designed by the Contractor and duly got approved by the Engineer.
- b) It shall cater for expected movement and rotation of the structure at the joints.
- c) It shall also be easy for inspection, maintenance and replacement
- d) Expansion joints shall be robust, durable, water tight and replaceable. Site fabricated expansion joints shall be prohibited. Expansion joints shall be procured from approved manufacturers and be of proven type.
- e) Proprietary type deck joints offered by the Contractor shall comply in all respects with the manufacturer's specifications and meet the required range of movements and rotations and be fit for the purpose of ensuring satisfactory long term performance in the bridge subject to approval of the Engineer.

6.1.3 Performance Requirement with Respect to Bridges

The expansion joint shall :

- a. Withstand the imposed load including the impact load from live load and other sources.
- b. Allow expansion and contraction movement due to temperature, creep, shrinkage, pre- stressing and structural deformations.
- c. Permit relative rotation in elevation and plan due to the causes as noted above,
- d. Be waterproof
- e. Ensure sealing
- f. Ensure long life by being resistant to corrosion,
- g. Be easy to install,
- h. Be easy to maintain. Replaceability of expansion joint shall be one of the basic criteria for selection of type of expansion joint,
- i. Be resistant to the materials likely to collect/spill over the deck in its normal service.

6.1.4 Performance Requirement for Transition Zone

It is the zone of connection of joint assembly and the adjoining deck. The expansion joint shall :

- a) Permit transfer of generated forces without distress, i.e. without getting uprooted.
- b) The purpose will not be served if the bonding is with the wearing coat only. Anchorage must be provided with the deck structural element.

- c) Ensure that surface in the transition zone stays undisturbed during long term service

6.1.5 Expansion Joints for Railway Bridges

Expansion joints / gaps between the two RCC deck slabs / girders / boxes shall be properly designed by the Contractor and get it approved from Engineer. In addition to the performance requirements as specified above, the following requirements shall also be considered while designing the expansion joints / gaps

- a) To permit independent movement the RCC deck slabs / girders / boxes b)
To resist fall of ballast

6.1.6 Installation of Expansion Joints

Care shall be taken during installation of the expansion joints to permit their correct functioning in accordance with the design scheme. It will be desirable that the representative of the manufacturer be present at the time of installation of expansion joints at least for the first few joints.

6.2 Wearing Coat

6.2.1 Scope

The work shall consist of laying a wearing coat layer of required thickness as indicated on the drawings. It shall not be laid monolithic with the slab.

6.2.2 Material

All materials shall conform to the requirements as specified in Clause 3: Material for Structures in these Specifications.

6.2.3 Construction Operations

- (1) It shall have uniform thickness as specified in the drawings.
- (2) It shall have the grade not less than M25.
- (3) For Weather and seasonal limitations shall be as per IRC Standards.
- (4) The surface to receive the wearing coat shall be thoroughly swept and scraped clean and made free of dust and other foreign matter. It shall be conditioned to the specified levels and grade as directed by Engineer.
- (5) Construction operations such as preparation of mix, laying shall conform to respective specifications as included in these Specifications

7. Bridge Bearings

7.1 Scope

This work shall consist of furnishing and fixing bearings in position in accordance with the details shown on the drawings, to the requirements of these specifications and as consented by the Engineer.

7.1.2 General Requirements

- (1) Bearing plates assemblies and other expansion or fixed devices shall be constructed in accordance with the details shown on the drawings and as consented by the Engineer.

- (2) The bearings may either be supplied directly to the Engineer by the manufacturer to be installed by the Contractor or the Contractor is to supply and install the bearings as part of the contract. In the former case, the manufacturer shall be associated with the installation of the bearings to the full satisfaction of the Engineer, whereas in the latter case, the Contractor shall be solely responsible for the satisfactory supply and installation of the bearing. In the detailed description of the specification, a general reference shall be made to the Contractor or manufacturer and the interpretation shall be as per terms of contract.
- (3) The Contractor shall be solely responsible for the satisfactory supply and installation of the bearing.
- (4) The Contractor shall exercise the utmost care in setting and fixing all bearings in their correct positions and ensuring that uniformity is obtained on all bearing surfaces,
- (5) Bearings shall be handled with care and stored under cover.
- (6) When bearing assemblies or plates are shown on the drawings to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above (not exceeding 12 mm) and shall be finished by grinding.
- (7) It shall be ensured that the bearings are set truly level and in exact position as indicated on the drawings so as to have full and even bearing on the seats. Thin mortar pads (not exceeding 12 mm) may even be made to meet with this requirement.
- (8) It shall be ensured that the bottoms of girders to be received on the bearings are plane at the locations of these bearings and care shall be taken that the bearings are not displaced while placing the girders.
- (9) For bridges with skew angle less than 20°, the bearings shall be placed at right angle to the longitudinal axis of the bridge. For bridges with skew angle greater than 20°, very wide bridges and curved bridges, the location of the bearing shall be ensured as shown in the drawings.

7.2 Bearings

Railway bridge bearings are required to transfer heavy vertical longitudinal and transverse loads from the superstructure to sub-structure and finally to the foundation. The bearings also are required to accommodate large deflections/ rotations not only due to above stated dead loads, superimposed dead loads, live loads, dynamic augment, derailment loads, temperature loads, LWR loads, wind, Seismic loads and others as defined in IRS 'Bridge Rules' and codes listed elsewhere in this specification.

Under dead loads alone the span may be deflecting up wards (camber) and under live loads it shall be deflecting downward. The bearings on one end of the span shall only allow rotation both in longitudinal and transverse planes but not permit any translation, however on the other end both translation and rotation shall be allowed. The bearings should be easy to install, easy to inspect and practically maintenance

free diving the life of the bearing, giving a cost-effective arrangement. They should also be designed to be quickly and easily replaced. The expected life of the bearing should be 35 years. R.D.S.O. (Research Design and Standard Organization) of Indian Railway has issued guidelines on spherical bearings vide their no. CBS/Bearing dt. 22.06.2011, which may be adopted for design and provision of the bridge bearings. It is however, to be clearly understood that nearly complying the provisions of guidelines/ codes will not relieve the Contractor of his responsibility for the soundness and performance of the bearings.

7.2.1 Acceptance, Certification and Marking

Stipulations of this clause regarding the Acceptance Testing, Certification and Marking shall be strictly adhered which forming the basis of Product conformance and acceptance for the Spherical & Cylindrical Bearings.

1. System of attestation and conformity

Following will form the basis of acceptance of the Spherical & Cylindrical Bearings:

(a) Task of manufacturer:

- (i) Raw Material Acceptance/ Testing
- (ii) Factory production control/ in-process testing
- (iii) In-house Test on Finished Bearing

(b) Tasks of the Engineer/ inspection authority

- (i) Initial inspection of factory and of factory production control
- (ii) Continuous surveillance on process of production and conformance test on raw material & production in-process
- (iii) Witness of final acceptance testing of finished product

2. Manufacturer Internal Testing

Apart from the raw material and in-process inspection to be carried out & documented for all Bearings and their components. The Bearings thus manufactured shall be subjected to rigorous in house testing by the manufacturer prior to offering for the acceptance testing. Following in-house / internal testing on the finished Bearings shall be performed by the manufacturer:

- i) All Bearings shall be checked for surface finish or any other discernible superficial defects.
- ii) All the bearings shall be checked for overall dimensions as per the manufacturing tolerances specified in this guideline and the relevant contract specifications.
- iii) All Bearings of the entire production quantity to be offered for acceptance shall be load tested to 1.10 times the maximum design vertical load in serviceability condition as shown in the drawings.

- iii) From the entire production quantity to be offered for acceptance, One Bearing each selected at random shall be tested for Rotation (design rotation or 0.015 radians whichever higher), Co-efficient of Friction (at permanent and maximum Vertical Loads separately) and Combined Vertical & Horizontal Load test (at 1.10 times the maximum serviceability design loads), as the case applicable.

NOTE:-

- For tests specified under iii) & iv) of this clause (2) except for co-efficient of Friction test, the Bearings shall be held under Test Load for a period of 30 minutes.
- All testing shall be done for SLS Loading.

3. Acceptance Test by Inspecting Authority

Bearings passing the in house test requirements are then offered to the accepting / inspection authority for Acceptance Testing. Following Acceptance tests in presence of the Inspection authority shall be performed on the components of the bearings or the bearing as a whole, as applicable.

a) Tests for conformance of raw materials & its processing

- i. In addition to the certificates of Raw materials from the supplier manufacturer forming the initial basis of acceptance. Random sampling & testing at Independent NABL accredited lab for the material used in the production of the Bearings like steel, sliding surface, stainless steel, Bolts etc. shall be done. The inspection / accepting authority at his discretion shall relax and not insist on conducting the above test subject to availability of the satisfactory test data for the similar test conducted on materials of bearings recently manufactured & supplied for other projects within a period of six months preceding the date of Testing.
- ii. Ultrasonic inspection of the steel components
- iii. Test on welding e.g. Dye Penetration Test
- iv. Test on hard chromium plating e.g. Ferroxy Test
- v. Hardness test for the Mating Surface
- vi. Surface finish of the stainless steel sheet
- vii. Thickness of the anti-corrosive treatment etc.

b) Acceptance Test on finished Bearings

- i. Bearings shall be randomly checked for surface finish or any other discernible superficial defects.
- ii. Bearings shall be randomly checked for overall dimensions as per the Manufacturing tolerances specified in this guideline and the relevant contract specifications.
- iii. One Bearing selected at random from the lot under acceptance shall be load tested to 1.25 times the maximum design vertical load in serviceability condition as shown in the drawings.
- iv. One Bearings selected at random from the lot under acceptance shall be tested for design rotation or 0.015 radians whichever is higher at corresponding Vertical Load of 0.75 times the maximum

design serviceability vertical load as shown in the drawings. Additional pre-fabricated taper plates inducing the desired rotation into the Bearing shall be used in the Test assembly for the above test.

- v. For movable Bearings (Free Float and Slide Guide Types), One Bearing selected at random per lot shall be tested in order to determine the coefficient of friction at permanent and maximum Vertical Loads in serviceability condition separately, the value of friction shall not exceed 0.03 under lubricated condition.
- vi. For Bearings required to resist horizontal forces (Fixed and Slide Guide Types), One Bearing selected at random from each lot shall be subjected to combined Vertical and Horizontal Load Test to 1.10 times of the respective maximum design loads and forces in serviceability condition.

NOTE

:-

- For tests specified under iii), iv) & vi) of this clause b), the Bearings shall be held under Load for a period of 30 minutes. All testing shall be done for SLS Loading. For the purpose of Lot classification, following definitions shall be applicable:
- A lot shall comprise of the total number of Bearings manufactured together, of the type & load capacity as defined below, and offered for the Inspection at a time to the Engineer
- Accepting authority. However, the maximum number of Bearings in one lot shall be limited to 24.
- Bearings in excess of 24 Nos. shall be treated as separate lot.
- The fixed & movable Bearings shall be classified as separate Lots. However, the movable bearings irrespective of uni-directional & bi-directional movement abilities shall be placed under the same lot.
- In terms of Load capacity, Bearings with max. design vertical load less than 500 MT shall be considered as one lot and Bearings with more than 500 MT vertical load capacity shall be considered as separate lot.

4. Observation

During the Testing, the Engineer / accepting authority shall examine the behavior of the Bearings for any signs of Deformation, Crack on the Sliding surface and / or mating surface, Separation / Lift off between the sliding interface or ceasing of the Bearing Components. After the above Tests are completed, the tested bearings shall be removed from the test machine, dismantled and the components shall be examined for any signs of distress, permanent deformation in the components especially the sliding surface, warping, scoring, cracks or other permanent defects which may affect the serviceability or durability of the bearing. The Engineer / acceptance authority apart from witnessing the above test on finished Bearings shall also inspect the documents and reports

submitted by the manufacturer about the internal factory production control i. e. raw material, in-process production and internal testing of finished product carried out by the manufacturer.

5. Inspection Certificate

The details of the tests & inspection carried out both in house and in the presence of the Witnessing authority shall be recorded in the standard testing formats along with their observations. These filled up formats along-with the raw material test certificates, reports of the tests done in- process e. g. welding (DPT), hard chromium plating (Ferroxyl Test), mating surface hardness test, ultrasonic test, S/S surface finish and Paint DFT etc. shall be compiled and submitted to the Engineer / Acceptance Authority as Test Reports.

6. Certification

The Engineer/accepting agency after getting satisfied with the Quality of the product manufactured shall issue Certificate of conformity of the product stating the conformity with the provisions of this Specification and clearance to the Manufacturer to effect the shipment of the Bearings to the Job Site.

7. Marking

All Bearings shall have suitable identification plates permanently affixed which shall be visible after installation, identifying the following information:

- Name of Manufacturer
- Month & Last two digits of the year in which the Bearing Manufactured (mm/yy)
- Serial Number of the Bearing
- Bearing Designation & Type
- Design Performance parameters viz. Load, Movement etc

Besides this, the Bearing Top Surface shall also be marked with the following information to facilitate their correct installation at site:

- Centerline Marking
- Bearing Designation & Type
- Orientation Marking to facilitate correct placement on the Pedestal
- Direction of Major and Minor movement, as appropriate
- Preset Marking, if applicable

7.2.3 Packaging, transport and storage

1. The bearing shall be labeled by the manufacturer with the marking requirement as stated in Clause 5.3.4 (7) [Marking]. The marking shall only be applied when the prerequisites, regarding manufacturing, testing

& acceptance in accordance with Clause 5.3.4 [Acceptance, Certification and Marking] are fulfilled in all respect.

2. Bearings being made up of several components, which are not rigidly fixed together, shall be temporarily clamped together at the place of manufacture. Such clamps shall be sufficiently strong to hold the various bearing components in their correct positions during handling & transportation. They shall be marked / painted with a clear distinguish colour from that of the Bearing paint for easy identification. The Transportation Bracket shall be easily removable after installation or designed to break once the bearing starts to function, without damaging the bearing.
3. All bearings that are too heavy to be handled manually shall have provision for the lifting devices.
4. Bearings shall be wrapped under heavy duty polythene sheets and secured on wooden pallets or inside Boxes strong enough to withstand the handling & transportation. Bearings shall then be transported to the Job site under secured & horizontal condition.
5. The Bearings at the Job site shall be placed horizontally above the Ground Level on wooden pallets under covered space to avoid spoilage by rain water & dust etc.

7.2.4 Aspects Related to Bearing Installation & performance

In order to ensure bearing alignment & placement in accordance with the Contract plan & specifications, a reference index marking shall be provided on the Bearings Bottom & Top Component.

The deviation in level & alignment both in plan & elevation, in installation of Bearings from the standard location, shall not exceed 3% of the Bearing shorter dimension in plan and of the Bearing Total height in elevation. The deviation in parallelism of the Sliding surface with respect to datum shall not exceed 1% of the Length in the direction of measurement.

Installation

Bearings are to be installed with due care to ensure their correct functioning in accordance with the design of the Structure. The primary factors to be considered during the Installation of the Bearings are:

Transportation & Site Handling Aspects

Transport Brackets are not to be relied for the Lifting of the Bearings. Upon receipt of the Bearings at Site, the contractor shall have a visual Examination of the Bearings to ensure that no damage or Displacement of the Bearing Components is taken place during the Transportation. Any rectification or re-assembly if required shall be done strictly in the presence of the Manufacturer's Representative.

Installation Aspects

- ▮ Bearings shall be installed truly horizontal with Top & Bottom Components of the Bearings perfectly parallel to each other, unless otherwise stated.
- ▮ For pre-cast construction, the positioning of the Bolts & Dowels embedded in the Substructure / Superstructure shall be made strictly as per the Shop Drawings.
- ▮ The Dowels / Distribution Plates shall be properly grouted with suitable grout material ensuring no voids, honeycombing underneath & above the Bearing bottom & top Plates respectively. In case of Movable Bearings, particular care shall be taken to ensure the correct Orientation of the Bearings.
- ▮ For In-situ type of Construction the Bearings shall be covered from all sides to avoid the ingress of cement slurry etc. inside the bearing Components.
- ▮ In case of Pre-cast Construction, extreme care is to be taken to avoid impact loading onto the Bearings while launching the Girders / Superstructure. Girders shall not be rested freely over the Bearings without any Support.
- ▮ Transport Brackets shall be removed at an appropriate time after the casting of the cross diaphragm and setting of the Superstructure Concrete.
- ▮ Bearings and its components shall be checked for any dust, dirt or Cement Slurry Deposit etc. and the surrounding area shall be cleaned thoroughly once the Process of bearing Installation is finished.

7.2.5 Pot Bearings

General

Pot type bearings shall consist of a metal piston supported by a disc or reinforced elastomer confined within a metal cylinder to take care of rotation. Horizontal movement, if required, shall with a system of sealing rings be provided by sliding surfaces of PTFE pads sliding against stainless steel mating surfaces. The pot bearings shall consist of cast steel assemblies or fabricated structural steel assemblies.

Provisions of IRC-83 (Part I) shall be applicable for all metallic elements. Provisions of IRC:83 (Part II) shall be applicable for all elastomer elements. When any item is not covered by IRC:83 (Parts I and II), the same shall be as per guidelines given hereunder and BS:5400 (Sections 9.1 and 9.2), except that no natural rubber shall be permitted. If there is any conflict between BS on the one hand and IRC on the other, the provisions of IRC will be guiding.

1. Fabrication

- i. The surface mating with the PTFE in the sliding pair shall be of corrosion resistant stainless steel. Normally, the stainless steel shall form the upper component. The stainless steel shall overlap the PTFE after full movement on all sides. If stainless steel sheet is used, it should be bonded by continuous welding along the edges. Adhesive or any other

- bonding can be approved by the Engineer. The surface shall be prepared by thorough cleaning to remove grease, dust or any other foreign substance.
- ii. PTFE modular sheets of the sliding pair shall be located by confinement assisted by bonding. Confined PTFE shall be recessed into the metal backing plate. The shoulders of the recess shall be sharp and square to restrict the flow of PTFE.
 - iv. The thickness of the PTFE shall not be less than 4.5mm with projection above the recess not exceeding 2.0mm. When the piston is subjected to tilting, the seal must slide along the wall and alter its shape according to the angle of tilt. At the same time, it must be sufficiently rigid to bridge the gap between the piston and the wall of the pot. However, the percentage of plan area of the lubrication cavities to the gross area shall not exceed 25 per cent. The depth of the cavity shall not exceed 2.0mm.
 - iv. The diameter to thickness ratio of the confined elastomer shall not exceed 15. The surface of the confined elastomer shall be smooth.
 - v. A seal shall be provided to prevent extrusion of the confined elastomer between the piston and the pot wall. The seal should stay functional under the loads and rotations acting on it. Additional seal shall be provided to prevent entry of dust into the pot. Sealing rings for pot bearing shall be fabricated from stainless steel. When the piston is subjected to tilting, the seal must slide along the wall and alter its shape according to the angle of tilt. At the same time, it must be sufficiently rigid to bridge the gap between the piston and the wall of the pot.
 - vi. The hardness of the piston and pot wall at their contact region shall be minimum 350BHN to reduce wear. The surface finish of the pot base in contact with the confined
 - vii. All bearings shall be installed with anchor and anchor screws or some similar device such that while replacing, the bearings can be removed with minimum lifting of the superstructure.
 - viii. The external surfaces of the assemblies shall be completely cleaned by sand blasting. After sand blasting, dust shall be removed from the surface using clean and dry compressed air or a clean brush after which suitable coating shall be applied.
 - ix. Pot bearings including all parts as shown on the drawings shall be fully shop assembled at the manufacturer's works to ensure proper fitting of all the parts
2. Materials for POT/ PTFE Bearings
 - a) Steel
 - i) Structural steel shall conform to IS:226 or IS:2062, as applicable.
 - ii) Cast steel shall conform to Gr.280-520W of IS:1030 with 0.3 to 0.5 per cent copper increase the corrosion resistance properties.

- iii) Stainless steel shall conform to AISI:304 or X04Cr 18 Nil) of IS:6911 for ordinary applications. For applications with adverse / corrosive environment, the stainless steel shall conform to AISI:316L or O2Cr17Ni12Mo2 of IS:6911

b) PTFE

PTFE (poly tetra fluoro ethylene) shall be of unfilled pure virgin quality. It shall be free sintered. The mechanical properties of unfilled PTFE shall comply with Grade A of BS:3784.

c) Elastomer

The confined elastomer inside pot will have the following properties:

Properties of Elastomer for Bearings

	Properties	Unit	Test Method (IS Reference)	Value of the characteristic specified
1	Physical properties			
1.1	Hardness	IRHD	IS:3400 (Part	50+5
1.2	Minimum Tensile Strength	Mpa	IS:3400 (Part	15.5
1.3	Minimum Elongation at	%	IS:3400 (Part	400
2	Maximum Compression Set	%	IS:3400 (Part	Temperature (deg X)
	CR		+0 to 24.2	100 ± 1
3	Accelerated Ageing		IS:3400 (Part IV)	Temperature (deg C)
3.1	Max. change in Hardness	IRHD		+15
3.2	Max. change in Tensile	%		-15
3.3	Max. change in Elongation	%		-40

7.2.6 Rocker Roller Bearings.

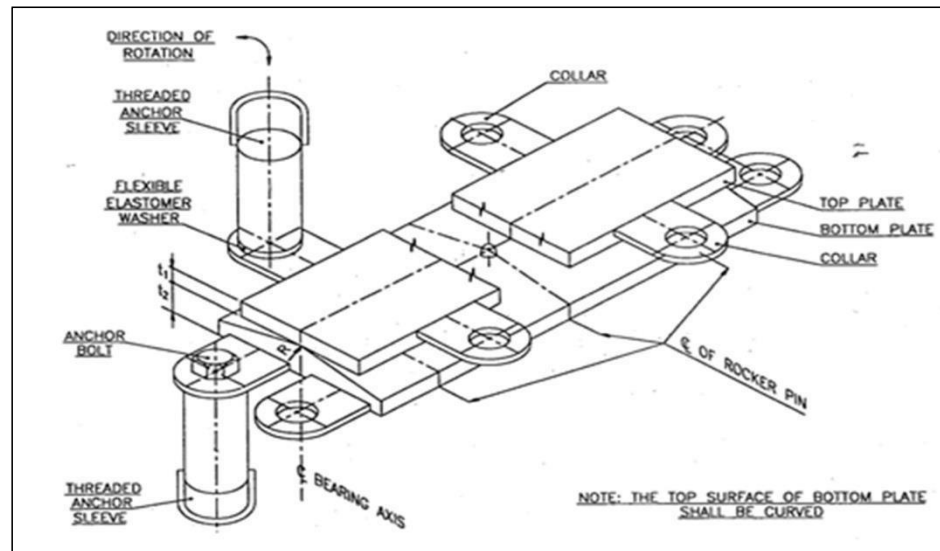
1. General: For railway bridges with spans in excess of 30.5m, where open web through girders are generally provided, the amount of movement needed and the vertical load transmitted through each bearing is too large to be catered by the sliding bearings. It is common, on Indian Railways, to provide rocker & roller bearings at the free end of open web through girders, and rocker bearings at the fixed end.
2. Materials: Only ferrous materials as specified in the following paragraphs shall be used in the manufacture of rollers, rocking devices and rocker/roller plates. Such devices shall be examined of cracks by ultrasonic methods in accordance with the requirements specified in level 3 of IS:9565 or by magnetic particle or dye penetration methods. Flaws in welds shall be detected as per IS:5334. No components with linear defects revealed by the procedures indicated are acceptable.
3. Mild Steel: Mild steel used for components of bearing shall conform to the requirements of IS:2062 E250 (Gr-B). The minimum yield strength shall be 240 N/mm² for any component. For sub-zero condition Grade A, C and D

of IS:2062 shall be used. Rollers are made of cast steel or forged steel, but not from mild steel.

4. Cast Steel: Cast steel shall be in accordance with 280-520 W or 340-570 W of IS: 1030. The castings shall be ultrasonically examined as per IS:7666 with acceptance standard as per IS:9565.
5. Forged Steel: Forged Steel can be used for the components of bearings. The raw material shall comply with Class 3, 3A or 4 of IS 1875 and the forged product shall comply with class 3, 3A or 4 of IS:2004 and normalized.
6. High Tensile Steel: High tensile Steel to be used for components of bearings shall comply with E350 (Fe490) of IS:2062.
7. Welds: Welds shall conform to IS:816, IS:1024 and IS:9595 as appropriate, using electrodes as per IS:814 and IS:1395.
8. Fasteners: Bolts, screws, nuts and lock nuts shall generally conform to IS:1363 (parts 1 to 3), IS:1364 (parts 1 to 3). High Strength structural bolts, nuts and hardened and tempered washers shall conform to IS:3757, IS:6623 and IS:6649 respectively.
9. Grease: The grease for bearings shall conform to the requirements of IS:503 (Grade 4). Silicon grease shall conform to IS:14383.

7.2.6.1 Components:

1. Rocker Bearing:



Typical Rocker Bearing

2. Roller Bearing: A bearing by an upper and lower plate separated generally by one or two rollers which permit longitudinal movement by rolling. A pendulum guide is used for single roller. Rollers can be in single number or in multiple numbers

Typical single roller Bearing

3. Knuckle Pin: A cylindrical pin provided between recesses of the top and bottom parts of a bearing for arresting relative sliding movement of the top and bottom parts without restricting rotational movement.
4. Rocker: A component with curved convex surface formed on one face. The curved surface can be a portion of a cylinder or sphere
5. Roller: A machined concentric cylindrical component of a roller bearing. It rolls between top and bottom plates or between top and saddle plates.
6. Bottom Plate: A bottom Plate is a metallic plate which rests on the supporting structure and transmits forces from a bearing to the substructure.
7. Saddle Plate: A plate which is positioned between the top plate and the roller(s).
8. Anchor bolt: An anchor bolt is an ordinary bolt anchoring the top and bottom plates to the structure. All the longitudinal forces from superstructure are transmitted to the supporting structure through the fixed end bearing. Any friction between the bed block and base plate/ saddle plate and bottom chord/ soffit is completely ignored and the entire horizontal forces are assumed to be transmitted by the connecting bolts.

7.2.6.2 Construction Operations:

All work shall conform strictly to the drawings and shall be in accordance with the provisions of this section. Care shall be taken to ensure that all parts of an assembly fit accurately together.

During erection the bearing shall be held in position securely by providing temporary connection between the top and bottom plates in case of fixed bearings and between top plate, bottom plate and saddle plate in case of sliding bearing or by any other suitable arrangement which prevents the relative displacement of the components.

7.2.6.3 Workmanship:

- a) Fabrication shall be carried out by an organisation experienced and qualified to undertake precision engineering of this type and be approved by the Engineer.
- b) Workmanship shall be of good quality, neatly finished and of good appearance. Castings shall be true to the forms and dimensions shown on the drawings and shall be free from pouring faults, sponginess, cracks, blow holes and other defects on position, affecting their appearance or strength. Warped or distorted castings will not be accepted. Exposed surfaces shall be smooth and dense.
- c) All castings shall be cleaned by sand or shot blasting to remove sand or scale and to present a clean uniform surface.

- d) All irregularities, fins or risers shall be ground off flush with the adjacent surface. Castings with visible cracks, blow holes or similar blemishes shall be rejected if the imperfections are located in bearing surfaces or cannot be remedied to the approval of the Engineer.
- e) Imperfections which are not located in bearing surfaces shall be cleaned out, filled with weld metal of the appropriate composition and ground flush.
- f) All surfaces of major components like top plates, saddle plates, bottom plates of the bearings shall be machined all over for correct alignment, interchangeability, proper fitting, etc.

7.2.6.3 Tolerances: Tolerances for its individual components or of the assembled bearings shall be as shown on the drawings or subject to the approval of the Engineer. Unless otherwise specified, the following tolerances shall be maintained:

- a) Diameter of Rollers, Knuckle Pins and Bores: Tolerances on diameter of rollers and all convex surfaces shall conform to K7 of IS : 919. Tolerances on diameter of all concave surfaces shall conform to D8 of IS : 919.
- b) Height of Bearings: Tolerances on height of any component casting shall not exceed +0.5 mm. No minus tolerance shall be allowed. The edges of all ribs shall be parallel throughout their length.
- c) Base Plate: Tolerance on length and width of the base plate shall not exceed +1.0 mm, tolerance on the thickness of the plate shall not exceed +0.5 mm. No minus tolerance shall be allowed. All rocking, rolling and sliding surfaces shall have a machine smooth finish to 20 micron maximum mean deviation as per IS : 3073.
- d) Castings: No minus tolerance shall be allowed in the thickness of any part of the castings. The edges of all ribs shall be parallel throughout their length.

7.2.6.4 Installation:

- a) Bearings shall be placed in the positions as shown on the drawings with all bearing surfaces in full contact and to the tolerances as specified.
- b) Roller and rocker bearings shall be placed so that their axes of rotations are horizontal and normal to the direction of movement of the members they support. Upper and lower bearing plates shall be set horizontal in both directions.
- c) During installation the bearings shall be pre-set with respect to the bearing axis to account for the movement due to the following:
 - i. Temperature variation between the average temperature prevailing at the time of installation and the mean design temperature,
 - ii. Shrinkage, creep and elastic shortening.

- d) For bridges in gradient, the bearing plates shall be placed in a horizontal plane.

7.2.6.5 Placing:

- b) On supporting structures, pockets shall be provided to receive anchor bolts; one side of the pocket shall project beyond the bearing plate. The pocket shall be filled with mortar and the concrete bearing area also shall be finished level by a thin and stiff mortar pad (the thickness not exceeding 12 mm) just before placing of bearing assemblies or bottom plate on the concrete seat. Roller and rocker bearings shall be placed so that their axes of rotations are horizontal and normal to the direction of movement of the members they support. Upper and lower bearing plates shall be set horizontal in both directions.
- c) It shall be ensured that while placing the girders, the bearings are in their exact positions as indicated on the approved drawing and not displaced therefrom.
- d) All concrete surfaces to be in contact with mortar shall be thoroughly cleaned and kept saturated with water for a period not less than 24 hours before placing mortar and operations are to be carried out when the surface temperatures of the exposed bearings are the minimum practical.
- e) No mortar that is more than 30 minutes old after completion of mixing, shall be used.
- f) After placing and finishing the mortar, the bearing shall be checked for position and shims or other temporary supports removed and the mortar made good. If the bearing has moved, it or the plate shall be lifted, the mortar shall be removed and the whole procedure to be repeated.
- g) Exposed faces of the mortar shall be cured under damp Hessian for 7 days.
- h) Placing of the bearing and mortar shall only be carried out in the presence of the Engineer.

7.2.6.6 Checking, Cleaning and Lubrication:

Before erection, each bearing shall be uncrated, disassembled and checked. Any damaged parts shall be made good for approval. All bearings with sliding surfaces shall be cleaned and lightly lubricated with an approved lubricant immediately before erection.

7.2.6.7 Testing:

- i. The materials to be used in the bearings shall conform to the specifications.
- ii. If required, a suitable number of complete bearings as specified by an accepting authority shall be tested to 1.25 times the design load. Recovery should be 100 per cent. Contact surfaces shall be

examined by illumination source for any defects, cracks, etc. Segmental rollers shall be tested for design movements.

- iii. For large lots (consisting of 12 sets or more), a quality control report shall be submitted as detailed below:
 - a) Unless otherwise agreed upon by the Engineer and the manufacturer, the latter shall furnish a complete report on the process of quality control. The Engineer may appoint an authorized inspection agency for inspection purpose on his behalf. Such an inspection agency shall also submit reports to the Engineer regarding various tests performed on the bearing or certify the acceptance of the bearings.
 - b) Test certificates of all raw materials shall be submitted. If manufacturer's test certificates are not available for raw materials, the bearings manufacturer shall perform the necessary confirmatory tests as per relevant codes of practice and shall furnish the test results.
 - c) A detailed quality control system including stage by stage inspection, starting from raw materials upto the finished bearing shall be submitted by the bearing manufacturer.
 - d) The Engineer shall reserve the right to witness such inspection at manufacturer's works with or without prior permission of the manufacturer. For this, the bearing manufacturer shall have in-plant testing facilities as far as possible and practicable.
 - e) The bearing manufacturer shall maintain a list of consumption of raw material for a period of at least previous one year.
 - f) Test certificates of bearings manufactured during preceding one year shall be made available at the manufacturer's works.
 - g) In case the lot size of similar bearings exceeds 12 sets as per the direction of the Engineer, one extra set of bearings for each 24 sets of bearings or part thereof, shall be manufactured and the cost of such extra bearings shall be borne by the user.
 - h) The Engineer shall select the extra bearing(s) at random and shall perform various tests including destructive testing on it at his discretion, either at the manufacturer's works or at any other approved test laboratory, notwithstanding the test reports submitted.
 - i) In case there is a major discrepancy regarding material, the engineer shall declare the whole lot of bearings as unacceptable.
 - j) In case minor defects in fabrication, like welding or machining, is found in the test bearing before destructive testing and if the test bearing is found to be acceptable after destructive testing, the minor defects in the test bearings shall not be a bar to the acceptance of the entire lot.

- k) The opinion of the Engineer in cases (i) and (j) above shall be binding on the manufacturer.

7.2.7 Certification and Marking:

Bearings shall be transported to bridge site after final acceptance by Engineer and shall be accompanied by an authenticated copy of the certificate that effect. An information card giving the following details for the bearings, duly certified by the manufacturer shall also be appended:

- Name of manufacturer.
- Date of manufacture
- Elastomer grade used
- Bearing dimensions
- Production batch no.
- Acceptance lot no.
- Date of testing
- Specific bridge location, if any
- Explanation of markings used on the bearing

All bearings shall have suitable index markings identifying the information. The markings shall be made in indelible ink or flexible paint and if practicable should be visible after installation. The top of the bearing and direction of installation shall be indicated.

7.2.8 Inspection and Testing:

Where any patents are used, the manufacturer's certificate with test proofs shall be submitted along with the design and got approved by the Engineer before their use in work.

7.2.9 Tests and Standards of Acceptance:

The materials shall be tested in accordance with the specifications and shall meet the prescribed criteria. The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

7.2.10 Inspection of bearing:

Each bearing assembly and the adjacent members in contact shall be inspected at least once a year by qualified Bridge Inspectors to ascertain their actual condition.

The following aspects shall be inspected:

- Adequacy for free movement
- Correct positioning
- Uncontrolled movements
- Fracture, cracks and deformations of parts of bearings

- Cracks in pedestals and in adjacent locations of sub and superstructure
- Condition of anchorage, sliding and rolling surfaces
- Corrosion of components
- Special inspection after unusual occurrences like heavy movement, earthquakes and impacts from floating debris in case of high floods.

7.2.11 Maintenance:

The bearings shall be cleaned, lubricated and coated with paints after each monsoon season. Provision shall be made for jacking up of the superstructure so as to allow for adjustment repair/replacement of rollers of the bearing. Suitable measures are taken immediately, if defects are noticed and replacement of bearing done in the event of irreparable damage to any parts.

7.2.12 Measurements & Payments:

Bearings shall be measured in MT capacity and particular specifications given on the drawings. Payment shall be provided based on supplying, fitting and fixing of bearing in position true to line and level complete as specified in BOQ.

7.3 Other Public Utilities

Some of the said utilities, presently existing within the ROW, shall require extension up to the ROW boundary whereas some of them shall require casing to undertake the construction activities. All the other utilities shall require protection / support / temporary diversion during construction and as required by the respective utility owning agencies. The utilities requiring temporary diversion shall have to be restored back to their original position as required by the respective utility owning agency. In addition to the above, during construction the Contractor shall also protect the public utilities which are being extended / diverted by the Employer Any damage caused to the utilities by the actions of the Contractor during construction shall have to be made good by the Contractor at his own cost and to the entire satisfaction of the respective utility owning agency.