GOVERNMENT OF ODISHA
DEPARTMENT OF WATER RESOURCES

BIDDING DOCUMENT FOR EPC CONTRACT

Bid Identification No. CE&BM-MB-04/2026-27

Name of Work

Construction of In-stream storage structure at Degaon across river Mahanadi in Sambalpur District, Odisha on "EPC Turn-key" basis including power connectivity system and operation and maintenance of complete commissioned project for five years or five Flood Seasons whichever is more.

VOLUME-II

TECHNICAL SPECIFICATION

(EPC CONTRACT)

Chief Engineer &Basin Manager Mahanadi Basin, Burla

CONTRACTOR
SUPERINTENDING ENGINEER

CONTRACTOR

SUPERINTENDING ENGINEER

VOLUME-II

TECHNICAL SPECIFICATIONS

CONTRACTOR

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GENERAL

THE SPECIFICATIONS CONTAINED UNDER DIFFERENT SECTIONS IN THIS DOCUMENT ARE FOR GENERAL GUIDANCE. IN CASE OF DISAGREEMENT BETWEEN THE SPECIFICATION OF THE DEPARTMENT AND STANDARD PRACTICES BEING FOLLOWED AND/OR SPECIFICATIONS NOT PROVIDED SPECIFICALLY, THEN RELEVANT SPECIFICATIONS UNDER INDIAN STANDARDS, CWC GUIDELINES, IRC CODES, MOST SPECIFICATION & RELEVANT REGULATIONS OF CEA/CERC/OERC AND APPROVED MANUFACTURER SPECIFICATIONS SHALL PREVAIL.

- **The specification as described under is mentioned for the work "Construction of In-stream storage structures at Degaon across Mahanadi rivers in Sambalpur District, Odisha of State of Odisha" in Vol-I & Vol-II.**

CONTRACTOR

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Section - I

General

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CONTRACTOR

SUPERINTENDING ENGINEER

A. EXTENT OF WORK

1.0 GENERAL

This Technical Specification relates to "Construction of Barrages, weirs and major check dams (In-stream storage structures) across various rivers of State of Odisha including hydro-mechanical works, Power connectivity works, road connectivity, staff quarters including survey, investigation, Planning, design and estimate of all components with operation and maintenance of the project for a period of five years or five flood seasons whichever is more after successful commissioning of the project." on EPC contract comprising of work of Detailed Survey, Planning, Design, Drawing, Estimation, Preparation of Land Acquisition Cases, Preparation of cases for forest land if any, and execution and commissioning of all components. The Basic Project Profile and scope of work of execution of the Barrage work under the package has been detailed in volume –I of the bidding document.

(a) These Technical specifications, shall apply to all works as are required to be executed under the contract or otherwise directed by the Engineer. In every case the work shall be carried out to the satisfaction of the Engineer and conform to the location , lines, grades and cross sections shown on the drawings or as indicated by the Engineer. The quality of work and materials, shall comply with the requirements set forth in this and succeeding sections. Where the drawings and specifications describe a portion of the work in only general terms, and not in complete detail, it shall be understood that only the best general practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer are to be fully complied with.

(b) The words like Employee, Employer, Contract, Employer's representative, Contractor's representative, Engineer, Drawings, Government works site etc. used in these specifications shall be considered to have the meaning as understood from the definitions of these terms included in Section II, Vol I Conditions of the Contract.

The contractor shall carryout the works in accordance with the specifications laid down in this section together with the detailed specifications stipulated under succeeding sections, Odisha Standard Specification, relevant codes with all amendments published up to the date of tendering and the departmental manual for quality control

1.1 Test standards for Materials and Quality of works.

The relevant standards for materials, as well as for testing procedures, indicated in this section together with detailed specifications indicated at appropriate places in the succeeding sections shall apply.

If any special material not covered here, is required to be used, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Engineer or any special provisions.

Quality: All materials and workmanship shall be of the respective kinds described in the contract and in accordance with the Engineer's instructions and shall be subjected from time to time to such tests as the engineer may direct at the place of manufacture

of fabrication or on the site or at such other places or places as may be specified in the contract or at all or any of the instruments, equipments, machines, labour and materials as are normally required for examining, measuring and testing any work and the quality, weight or quantity of any material used and shall supply samples of materials before incorporation in the works for testing as may be selected and required by the Engineer.

The Agency is fully responsible for the quality of the works & strength as well as dismatrility of the structure. Field laboratory shall be installed at site by the agency. No defective material shall be placed at site. All materials shall be tested by the Agency in his site laboratory before placing/storing at site. The testing certificate for all stacked materials is required.

1.3 Tests, inspection, rejection of defective material and work:

The contractor shall without extra cost provide samples and cooperate in the testing of materials and inspection of the works. The Engineer shall have access at all times to the places of storage and where material are being manufactured and processed for use in the works under the contract to determine whether their manufacture and process are proceeding in accordance with the drawings and specifications.

The Engineer shall during the progress of the works have power to order in writing from time to time.

a) The removal from the site, within such time or time as may be specified in the order, of any materials which in the opinion of the Engineer, are not in accordance with the contract.

b) The substitution of proper and suitable materials and

c) The removal and proper re-execution, notwithstanding any previous test thereof 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.

The contractor shall carryout such order at no extra cost to the employer; in case of default on the part of the contractor in carrying out such order, the employer shall be entitled to employ and pay other persons to carry out the same and all expenses consequent thereon or incidental thereto shall be recoverable from the contractor by the employer or may be deducted by the employer from any moneys due to or which may become due to the contractor.

Defect liability period- 05 years from the date of completion & hand over of work.

Not withstanding the approval/vetting by the Department. the responsibility regarding the stability & durability of the structure lie fully on the agency.

1.4 Setting out works.

The contractor shall be responsible for the correct setting out of all works at his cost. The Contractor shall execute the work true to alignment, grade and levels as shown in the approved drawings and as directed by the Engineer and shall check these at frequent intervals. The contractor shall provide all facilities like labour and instruments, and shall cooperate with the departmental officers to check all alignments, grades, levels and dimensions.

1.5 Power Supply.

i) Power supply is to be arranged by the contractor at his own cost.

ii) He has to lay all internal lines from the transformer at his own cost and he should bear the cost of power consumption as per bills of electricity authority.

iii) If the available capacity is insufficient to meet the contractor's requirement, the contractor has to make his own arrangements for alternatives for power supply, including deposits to electricity authority.

iv) The contractor shall satisfy all the conditions of rules required as per Indian Electricity Act 1910 and under rule 45 (i) of the Indian Electricity rules, 1956 as amended from time to time and other pertinent rules.

v) The power shall be used for bonafide departmental works only.

vi) The contractor shall take all precautions to ensure safety to the workers. The department will not take any responsibility for any accidents that may occur on the Contractor's installations.

vii) The contractor shall take action to rectify the defects if any in the installations pointed out by the departmental Engineers in a reasonable time.

viii) The following particulars should be furnished in quadruplicate by the contractor to the employer before the power is released to the equipment's.

a) A schematic diagram of the installation from the point of commencement of supply to the points of utilization showing therein the various electrical equipment, switch gear, cables with their sizes etc.

b) Transformer sub station's drawings.

c) Layout plan indicating therein the position of motors and other electrical equipment, their switch gear and earthing arrangements. The contractor shall give the particulars of his power load, if so desired by the Engineer and he shall make necessary arrangements for the Engineer to check these loads if so desired. The total power requirements and the percentage of diesel power proposed to be engaged by the contractor out of total power requirement shall be furnished by the contractor.

ix) The department is not responsible for any sort of power failures and power break down etc. and no compensation of any kind will be paid by the department on account of such failures and no extension of time will be granted under such reasons.

1.6 Water Supply

It is the responsibility of the Contractor to make own arrangements for water supply for work and labour and drainage from the work site, at his own cost. He will be permitted to draw water from nearby water source, subject to availability. The contractor has to lay pumping line from water source to barrage site and colony at his own cost. The pumps have to be installed by him at his own cost and pumping charges will also be borne by him. The distribution system, measures for purification of water, shall be the responsibility of the contractor and shall be in accordance with rules and regulations of the Public Health Department. No compensation will be allowed to the contractor on this account.

1.7 Watching and Lighting

The Contractor shall in connection with the works provide and maintain at his own cost all lights, guards, fencing and watching when and wherever necessary as required by the Engineer or Engineer's Representative, or by any duly constituted authority for the protection of the work, or for the safety and convenience of the public or others.

1.8 Approach Roads and Roads in Work Area.

a) The roads inside the work area required by the Contractor to convey huge machinery and all materials to work site shall be constructed and maintained by him at his own cost. The layout, design, construction and maintenance etc. of the road shall be subject to the approval of the Engineer.

b) The Contractor shall without charge permit the Government and such other Contractor and other workmen to see the access facilities including roads, any other facilities constructed and acquired by the Contractor for use in the performance of the works.

c) The Contractor's heavy construction traffic or tracked equipment shall not traverse any public roads or bridges unless the contractor has made arrangements with the authorities concerned and the approval of the Engineer to such arrangements has been obtained. In case Contractor's heavy construction traffic or tracked equipment is not allowed to traverse any public roads or bridges and the Contractor is required to make some alternative arrangements, no claim on this account shall be entertained.

2.0 LIFE EXPECTANCY OF WORKS

The contractor shall design the works for a life expectancy as follows:

Concrete Structures	:	60 Years
Mechanical Plants	:	20 Years

Electrical Plants	:	25 Years
Buried Earth Electrical System	:	50 Years
Control Panels	:	25 Years
External Instrumentation Systems	:	15 Years

3.0 ELECTRICAL SYSTEMS

All supply and installation works required for appropriate functioning of the work.

4.0 SUPERVISORY /ANNUNCIATION SYSTEMS

Instruments, indicators, measuring and transmitting devices, gauges, gauge plates, cabling and wiring and other equipments, material and accessories necessary for interconnection of earthing and lighting with starter grids.

5.0 GENERAL UTILITIES

Other utilities necessary for the proper functioning of the proposed works which shall be included under this Contract but not limited to the following are :

a) Site development includes ecological development. Site development also includes raising GL at barrage site by selected excavated earth including proper ramming, watering, consolidation of earth work, etc. The finished ground level of the plot shall be brought to Level above the Flood Level. The filling shall be done in uniform layers of 15 cm. to 20 cm. thick and shall be well watered and well compacted with suitable power roller.

b) Internal roads & approach road required to Head Works from existing road, etc.

c) Electric substation and distribution of power supply to all necessary points.

6.0 APPLICABLE STANDARDS

Reference to all the standards shall be meant for the latest revision of that standard and all the equipments shall be of approved make only.

A. SUBMISSIONS TO BE MADE ON DETAILED ENGINEERING OF THE WORK

1.0 DRAWINGS, DOCUMENTS, CERTIFICATES, MANUALS

The Detailed Survey & Investigation works, Planning and Design Works can be taken up simultaneously. All the components have to done work wise. The detailed scope of services for Survey & Investigation and Design & Engineering has been explained in Volume – I.

1.1 Submission and review of Engineering Documents

1.1.1 The contractor will submit the following documents for review and approval generally in the sequence given below:

(a) Hydraulic Design Report with detail hydrological analysis, General layout plan of the entire work on Survey of India sheets and village maps & General arrangement drawings for all units of works for approval of Technical Advisory Committee (TAC) by **end of 3rd month**.

(b) Detailed Design & drawings of all components of work including all drawings of the buildings and landscaping for entire project along with land schedule for processing of LA proposal **within 2 months of TAC approval of DPR**. (All structural drawings good for construction shall be drawn to appropriate scale, neatly giving all the sections for smooth execution of the work.)

(c) Item wise cost analysis & detailed estimate for the entire work on the basis of approved design and drawings within **1 month of approval of design & drawings. If the contractor does not submit the detailed estimate further payment will be held up.**

(Cost of each component as mentioned in the break up of payments is to be made clubbing different items under the respective component to form the basis of intermediate payments)

1.1.2 After review by the department/consultant of the department, Engineer in Charge will convey comments, within **30 days** from receipt of details from contractor, which the contractor shall incorporate by modifying designs and drawings accordingly.

1.1.3 In no case will design, calculations / drawings be considered complete or acceptable, if

(a) They are not duly signed by respective Architect/ Civil/ Structural/ Electrical/ Mechanical Design Engineer(s).

(b) They are not thoroughly checked and duly signed in the appropriate places by contractor and Sub Contractor (if any).

(c) Design calculations are not accompanied by supporting engineering, drawings or appropriate sketches.

(d) Design calculations are incomplete or not fulfilling the design requirements or are shabbily done or are without adequate reference, or other necessary back-up data.

(e) Any comments previously made are not incorporated on revised drawings /calculations.

1.1.4 Such unaccepted drawings / designs as described above shall be summarily rejected and contractor will be informed. Contractor shall arrange to resubmit the same duly checked, revised and signed within 15 days. No claim from contractor for extension of time or for extra cost on this account will be entertained under any circumstances.

1.1.5 The review of civil design calculations and drawings shall be carried out only in respect of correctness of Centre-to-Centre distances, elevations, important / typical

details, orientation and sizes of important members, general design principles and approach, adherence to requirements of the relevant IS or other statutory codes, compliance with the Technical Specifications, general or specific notes and with the requirements of good engineering practice and whether the details shown on drawings conform to design calculations. Check for any interference and taking remedial action is the responsibility of the Contractor.

1.1.6 No check will be specifically carried out by the Consultant / Engineer in Charge to verify arithmetical / numerical accuracy of the calculations, which shall remain entirely the Contractor's responsibility, irrespective of any approval that may have been accorded thereto by the Consultant / Engineer in Charge.

1.1.7 All values / dimensions / elevations, etc. without supporting back-up data adopted / assumed by the contractor in his calculations / drawings shall be taken by the Consultant / Department to be correct unless they are specified.

1.2 Form of Drawings

1.2.1 All drawings submitted for approval shall be ISO standard size sheets, prepared on computer with Auto CAD 2000 / 2007. Every drawing shall have a title block in the bottom right corner showing:

Drawing Title:

Job:

Client: DEPARTMENT OF WATER RESOURCES, ODISHA
CHIEF ENGINEER & BASIN MANAGER,
MAHANADI BASIN, BURLA

Consultant:

Contractor:

Drawing Number:

Revision Number:

Date:

1.2.2 Drawings / Documents

Drawings & Documents to be submitted have been outlined under Appendix- Design & Drawing of Volume-I.

1.2.3 Each drawing shall bear the signature of the Authorised Project Manager on behalf of the contractor to the effect that the drawing (whether his own or from any other source) has been checked by the contractor before submission to the Engineer-in-Charge.

1.2.4 Each revision shall be properly recorded to show the number, date, specific description of revision/s carried out, and signature of the Project Manager in the revision block. The contractor shall be responsible for incorporating all the comments issued by the Engineer In Charge/ Consultant in the subsequent revision.

1.3 Programme of Submission

1.3.1 The contractor shall furnish a programme for submitting all designs, drawings, and documents to Engineer in Charge within three weeks of award of Contract for pre-construction review. The program shall make reasonable provision for resubmission of unapproved designs, drawings and documents and for the time needed to review and transmit such designs, drawings and documents. No designs, drawings and documents will be accepted for review until the programme for submission has been approved by Engineer in Charge**.** The Engineer-in-charge will approve / convey his comments on the submitted programme within one week from receipt of programme by him.

1.3.2 The contractor shall provide six copies of all submissions for review / approval. One copy will be returned to the contractor with comments / approval.

1.3.3 The review period of pre-construction documents shall be as per conditions of contract.

1.4 Approval of Designs and Drawings

1.4.1 EPC contractor shall submit the Quality Assurance Plan(QAP) for the work and equipment used in the work. The QAP will indicate clearly the tests to be carried out which will be as per I.S and as specified in technical specifications of the tender documents. The QAP shall be approved by Employer. The Engineer-in-charge can depute third party inspector /consultant's representative / Client representative to witness the tests as per approval given for quality assurance Plan and technical specifications given in the tender.

1.4.2 Approval from Engineer In Charge to the Contractor's design or drawings shall not relieve the contractor of any of his contractual obligations or liabilities under the Contract or his responsibilities for correctness of dimensions, materials of construction, weights, quantities, design details, assembly fits, performance particulars and conformity of the suppliers with the Indian statutory laws as may be applicable, nor does it limit the Engineer in Charge's rights under the Contract.

1.4.3 Should it be found at any time after approval has been given by Engineer in Charge that any designs, drawings or documents submitted by the contractor are not consistent with any design, drawings or documents submitted or approved previously or deviate from any major aspect of the Contract Document, then such alternations or additions as may be deemed necessary by the Engineer in Charge shall be made therein by the contractor and the works carried out accordingly for which no extra payment shall be made.

1.4.4 No revision shall be made by the contractor after design, drawings or documents are "approved" by the Engineer in Charge. In case the contractor desires to incorporate any minor amendments in the "approved" drawing, he shall resubmit the same for formal approval. Contractor shall not make any revision in design / drawings, which is not related to the comments conveyed by Engineer in Charge.

1.4.5 The design would have to be got approved from department & authorized agencies. All compliance of technical requirements is to be fulfilled.

1.5 Certificates

1.5.1 Where certificates are required by the Specification or relevant Reference standard, the original and one copy of each such certificate shall be provided by the Contractor.

1.5.2 Certificates of test carried out during the construction or on completion of parts of the Works shall be submitted within 7 days of the completion of the test.

1.6 Work Wise Instruction Manuals

1.6.1 The manuals shall cover the setting to work, commissioning, testing, Operation and Maintenance of the works. The greatest importance is attached to completeness and clarity of presentation.

1.6.2 Information supplied by sub-Contractors and manufacturers employed by the contractor shall be co-ordinated into the comprehensive manual. The instruction manuals shall describe the installation as a whole and shall give a step-by-step procedure for any operation likely to be carried out during the life of each item of work, including erection, commissioning, testing, operating, maintaining, dismantling and repair.

1.6.3 Maintenance instructions shall include charts showing lubrication, checking, testing and replacement procedures to be carried out daily, weekly, monthly and at longer intervals to ensure trouble-free operation. Where applicable, fault location charts shall be included to facilitate tracing the cause of malfunction or breakdown.

1.6.4 A section dealing with procedures for ordering spares shall also be included in the manual.

1.6.5 Six draft copies of the manual shall be submitted to the Engineer in Charge prior to commissioning the works. Ten final copies of the amended and corrected manuals and drawings shall be provided by the contractor at the commencement of the Period of Maintenance.

1.7 Operating Instructions

The instructions shall be written in a simple language. Wherever possible, instructions shall be presented in a tabular form easy to understand.

1.7.2 Maintenance Instructions

A maintenance manual in four copies shall be provided as a supporting document to the equipment manufacturer’s instructions.

(a) Maintenance Manual

i) Checking, testing and replacement procedures to be carried out on all Mechanical and Electrical items on a daily, weekly and monthly basis or at longer intervals to ensure trouble free operations.

ii) Fault location and remedy charts to facilitate tracing the cause of malfunctions or breakdown and correcting faults.

iii) A complete list of recommended lubricants, oils and their charts.

iv) A spares schedule which shall consist of a complete list of itemized spares for all Electrical and Mechanical items with ordering reference and part numbers.

v) A complete list of manufacturer's instructions for operation and maintenance of all bought out equipment.

vi) Preventive maintenance details.

(b) Manufacturer's Instructions

Manufacturer's instructions for Operation and Maintenance of all bought out equipment's shall be provided. The instructions shall be supplied complete with Electrical / Mechanical drawings

B. CRITERIA FOR DESIGN OF CIVIL STRUCTURES

1.0 INTRODUCTION

This section forms the engineering design basis for structural design. The content of these documents is to form the guidelines for engineering design of Structures and to provide information about other disciplines concerned.

This technical specification summarizes the concept and relevant IS codes (Latest

Revision) to be followed for barrage, bridge, roads, buildings and afflux bunds etc.

2.0 GEO-TECHNICAL INVESTIGATION

The contractor shall be responsible for the geo-technical exploratory survey to obtain accurate information about soil condition at the site. The depth, thickness, extent, composition of each stratum and the depth of ground water shall be determined. Provide a geo-technical report based on survey data which includes boring logs, field and laboratory test results, interpretation of data, building foundation and earthwork recommendations.

3.0 LIST OF DESIGN CODES AND STANDARDS

All designs shall be based on the latest Relevant IS codes and in almence of Indian Standard codes. Suitable International Codes to be followed as approved by the Engineer-in-Charge. The design standards adopted shall follow the best engineering practice.

4.0 METHOD OF ANALYSIS

The analysis and design for all structures (RCC as well as Steel Structures) are to be carried out by STAAD-pro or equivalent standard software and accepted internationally for the worst/governing combination of loads as specified in relevant IS Codes.

5.0 METHOD OF DESIGN

Limit State method of design is to be followed.

6.0 EXECUTION OF WORKS:

The execution of works is to be carried out as per relevant IS Codes.

7.0 Geological investigation & other parameters:

(a)For Design:

The contractor has to assess soil bearing capacity for all works at his own cost and design the structures on the basis of data received (recommend geological) after investigation. The geological investigation report has to be submitted to Department.

(b) For execution:

At the time of execution, detailed geological investigation for execution purpose at the project site is to be carried out in presence of Engineer-in-Charge or his representative. In case of any variation in the data, the design is to be revisited and vetted accordingly for specific project..

(c) Design Flood:

50 years flood or 100 years flood as mentioned in the document.

8.0 Safety and durability of the structure:

Notwithstanding the approval/vetting by the Deptt. the responsibility regarding the stability & durability of the structure lie fully on the agency**.**

SECTION – II

SURVEY, INVESTIGATION, PLANNING, DESIGN AND DRAWING

SECTION – II

SURVEY, INVESTIGATION, PLANNING, DESIGN AND DRAWING

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SECTION – II

A. SURVEY, INVESTIGATION, PLANNING, DESIGN AND DRAWING

1.0 SCOPE OF WORK:

1.1 The scope of work to be carried out under this section under the package shall be as under in addition to that given under Appendix S&I and D&E of Section VI of Volume I of Bid Document 100 year flood, 500year flood and the pond level provided in the data are binding and shall not be changed. All other data provided are tentative and are for information of bidders. The employer does not guarantee the reliability or accuracy of any of these data and shall assume no responsibilities for any deductions, conclusions or interpretations that may be made from them. The Contractor shall undertake at his expenses such studies as are necessary to assess the reliability and accuracy of the information presented in the data.

1.1.1 Construction of Permanent Bench Marks on either side of the river and temporary benchmarks required for smooth execution of all components of the works in consultation with the Engineer-in-Charge.

1.1.2 Survey work for block contouring at 50 cm intervals on the revenue village maps and Survey of India Topo Sheets required for planning, design and estimate of each component of the Work under the package .Survey work will also be used for preparation of land acquisition cases and operation and maintenance manual.

1.1.3 Preparing a General Arrangement Plan (showing BMs) for each work with alternate alignments proposal with survey wherever necessary. After getting approval for the most economical and feasible alignment from the competent project authorities, contractor has to take up detail survey & investigation for each component of the work and furnish the following details :

A. Kilometer wise L-section and design statements of afflux bund and road connectivity with apex details, location of CD works, detailed designs of curves, part village map showing the alignment of that KM, cross sections at 30 M. interval on alignment for complete afflux bund and road connectivity. L-Section and cross section along the alignment of Barrage, abutments and wing walls.

Preparation of land acquisition cases in required proforma and sketch on revenue village maps as per Land Acquisition Act.

B. Details to be surveyed

The objective of the survey is to provide sufficient detail to enable the design and estimate of the whole work. The survey shall include, but not be limited to the following:

I. Establishment of a network of triangulated control points incorporating benchmarks or with a separate system of benchmarks. Existing monuments should be used wherever possible and their accuracy confirmed. In addition, where control point or benchmarks are not available, new points are to be

established. Where the distance between these points exceeds 2.0 Km, intermediate point are to be established.

II. Pucca, kacha and all other motorable roads and accesses including bridges and railways.

III. Principal footpaths and foot bridges.

IV. Location and type of all tube wells and open wells, village hand pumps etc.

V. Village boundaries (tri-junction marker pillars) where these are located on the ground. Due note of the village name within each boundary shall also be made.

VI. Services and utilities including electricity, water supply, sewerage, cable etc. and their supporting high tension poles or posts:

VII. Drainage courses including nallas, ditches, check dams or any other structures on drainage courses etc;

VIII. Water bodies including rivers, lakes, tanks and ponds, rock outcrops borrow pits and quarries, forestry (protected, reserved, preserved, private or otherwise) other significant ground cover.

C. After getting approval to the alignment from the project authorities, the contractor has to fix the chainage stone at 100m interval along alignment on central line and apex stones at every deviation of alignment duly indicating apex No. and chainage. The chainage stones and apex stones shall be of size 20x20x75 cms. Projection of the stone above ground level will be 25cms.

D. For Power System Connectivity: For Planning & development of suitable system connectivity for the work of the package from the Local Grid, the contractor shall conduct Preliminary route survey, finalization of route alignment, detailed survey, structure (tower/pole) spotting, geo-technical investigation,

optimization of structure location and check survey in respect of overhead lines. Other detail requirement has been described under Technical Specification for Electrical System Connectivity.

E. Design and drawing : Design and Drawing of all components of the work should be as per relevant IS codes, IRC codes, MOST specifications, Departmental and other prevalent norms.

1.1.4 **Preparation of Schedule of quantities**: Estimate and Schedule of quantities should be furnished separately for entire project. Item of work should be in accordance with the specification and rates mentioned in the current “Schedule of rates” of the State of Odisha and prevailing market rates for non-scheduled items supported by rate analysis and quotations from manufactures of selected material. The detailed estimates in triplicates sets and also in soft copy, which shall include detailed report, drawing, estimates and detail survey sheets.

2.0 CONSTRUCTION OF BENCHMARK STRUCTURES AS PER SPECIFICATION:

2.1 The contractor will collect the details of bench marks in the area from the concerned Executive Engineer. With this as a datum additional net-work of Permanent and Temporary Bench Marks (PBMs & TBMs) shall have to be established by the Contractor prior to commencement of survey works and shall be preserved during construction. One PBM on each side of the river and TBMs at One kilometer interval along the alignment of road and afflux bund shall be provided by double levelling and cross checking. Complete and adequate logs of all survey works shall be maintained as it progresses and it will be made available to the Engineer-in Charge for record. Their locations shall however be decided in consultation with department. Contractor shall fix temporary bench mark preferably on permanent structures. Values of such bench marks shall be fixed with reference to the Permanent Bench Mark (PBM) established by **Survey of India (SOI)** and as indicated by the Engineer-in-Charge. The representatives of the Engineer-in-Charge not below the rank of Assistant Engineer shall remain present and check the survey while establishing the temporary bench marks and permanent bench marks.

A proper system shall be evolved for numbering the PBMs & TBMs as directed by Engineer-in- Charge. A plan to a scale of 1:15000 indicating location and levels of all PBMs & TBMs established shall be prepared and submitted to the Department.

2.2 Accuracy of Surveying

(1) Horizontal distances shall normally be measured with optic or electronic distance measuring instruments. Chaining with metallic tape shall be restricted to measuring of short distances and will be rejected for use in survey of traverse nets.

(2) Elevations shall be determined by different horizontal leveling.

(3) Angles shall be measured by Theodolite.

(4) Traverse nets shall be executed with the precision and as per Survey of India practice and as per IS codes.

(5) Levelling shall be checked by closing the loop to the initial benchmark

2.3 Construction of Permanent Bench Marks (PBMs):

The PBMs shall be constructed at location as may be directed by Engineer- In-Charge. This should be located preferably at one corner of the field or field boundary, Govt./no man's land which will not hamper the agricultural operations, construction work or as instructed by the Engineer-in-charge. A 10 mm dia anchor about 300 mm in length with steel plate 120 x 120 x 6 mm shall be embedded in the concrete, and the top of the steel plate shall be 100 mm below the top level of concrete and truly horizontal. The level and number of PBM shall be established on top of steel plate. The inscriptions shall be durable and clearly legible. Adequate care shall be taken by the Contractor for curing the concrete laid for the PBMs. Where black cotton soil is met with the foundation will have to be taken to extra depth and filled with M-10 C.C & standard size bench marks shall be constructed over this.

3.0 FIELD TO FIELD SURVEY FOR BLOCK CONTOURING WITH CONTOURS at 50 cm INTERVAL AND PREPARATION OF VILLAGE MAPS SHOWING CONTOURS AND FIELD DETAILS:

For plotting contours at 50cm intervals, ground levels must be taken for each survey number covering all corners and the centre of the fields and reading shall be taken up to 5mm accuracy. Additional spot levels shall be taken on roads, nalla, drain, railway etc. The levelling staff should be placed in the field and not on the field bunds as to represent the local topography. The levels taken at point in the field shall also be marked on the village sheet. Additional spot levels must be taken at points that appear abnormally higher or lower than the general elevations of the plot so that the ridge and valley lines can be marked and ascertained. For drawing valley lines, the levels of the bottom of the nalla must be taken. All Kachha and Pucca roads, ditches, well, house, railway lines, high tension lines, electric poles, telephone poles, nalla, irrigation pipe lines, and all other prominent features etc. shall be shown on the map. The reduced levels shall be marked on village map at the corners of each field and additional spots as taken. Thereafter contours shall be marked in broken lines and full meter contours shall be marked with continuous full line. Concurrent checking of survey, investigation etc, shall be done by the departmental officer posted at work site. At least ten percent field levels shall be got checked by the Engineer-in-charge.

The levelling work should commence from the permanent Bench Marks, whose value is known. The BMs shall be constructed as per standard specifications. All the BMs shall be connected by double levelling accurately. Every day's work shall be closed on any one of the bench mark mentioned above and the accuracy of the day's work checked by Engineer's representative present throughout the activity. The contour map is to be prepared in the same scale of village maps and plotted on them.

3.1 Contouring

All relevant topographical survey data shall be incorporated in the Digital Terrain Model (DTM) using GIS applications. The contractor shall take sufficient spot heights to ensure adequate generation of contours at 0.50m interval and as done as per guidelines provided in SOI publication "MAP EDUCATION" 1993 for generation of final product or using appropriate acceptable computer software. Complete mosaic of the whole area shall also be prepared and supplied in appropriate contour interval.

3.2 Survey Accuracies

a) General

The Contractor will be required to ensure the various minimum levels of accuracy outlined below until such time as he can demonstrate supplemented with codal provisions or in vogue with examples to the satisfaction of Engineer-in-charge in the best interest of the work and these variation of accuracies should be at no additional cost to the Employer.

b) Control Points

In the case of triangulated control points and traverse work, maximum closure accuracies are to be better than 1:25,000 in plan of the distance traversed and 15 mm per kilometer vertically. All angles are to be measured to the nearest 1 second and all distances are to be measured to the nearest millimeter, Co-ordinate pairs for control points are to be reported to the nearest millimeter.

3.3 Co-ordinate System

A local grid system, based on the SOI projection, shall be established for each work such that all co-ordinates within the work are positive. This shall be agreed with the Contractor at the start of the Contract and linked to the Survey of India (SOI) grid where suitable coordinated control points are identified and the Contractor advised of the corresponding offsets. Where applicable, suitable azimuth control will be applied and the methodology adopted outlined in the report. The geographic information or geographical information system (GIS) software should be used for preparation all maps, plans and depiction of topography. Modern GIS technologies rely on digital information, for which there are a number of collection methods. The most common method of data creation is digitalisations, where a hardcopy map or survey plan is transferred into a digital medium through the use of a CAD program, and geo referencing capabilities.

3.4 Satellite Imagery

Satellite imagery of 0.8 m or higher resolution from NRSA, Hyderabad, covering the complete project area is to be procured as part of the Contract. The imagery shall be cloud free and of the Rabi/ Kharif 2019-20 period such that field boundaries are clearly distinguishable. The imagery is to provide a crosscheck of the location of existing major infrastructure and where relevant, field boundaries. The imagery is to be procured in hard copy and in digital format as well. This imagery will become the property of the Employer at the completion of the Works.

3.5 Collection, Storage and Processing of Field Data

All field measurements together with their relevant field codes are to be automatically stored in electronic data-loggers either within the field instrument or attached to field instruments and downloaded from storage remotely or directly to computer for processing. Recording by hand and transcription of field data is not considered appropriate for this project given the time frame available and will not be permitted. GIS application should be used.

4.0 Reconnaissance survey:

After fixing the alignment of the components of the work on village sheets and SOI Sheet in 1:50000/1:10000 scale, the contractor shall carry out reconnaissance survey in field to verify that the ground features as shown on plan tally with actual as existing on site. Any variation as a result of subsequent events such as development of brick kilns, new artificial drains, roads, pipe lines, transmission lines, railway lines, wells, buildings or farm houses etc shall be noted and alternation in the alignment fixed earlier may be done after Engineer-in-charge visiting the site. During reconnaissance survey special attention shall be given to ascertain that the drainage lines marked on map on the basis of contours do actually exist on site. This can be done by local

inquiry and site observations. If any variation is noticed the alignment should be refixed.

4.1 After observing these formalities layout may be considered as approved by the department and the contractor shall proceed with detailed survey according to the specifications.

4.2 Final layout:

4.2.1 After approval of the preliminary layout, the contractor shall proceed with the work of field to field surveys for taking longitudinal sections of the alignments, collecting the field data for the approved pattern.

4.2.2 The survey work should commence from an established TBM and end on established TBM only at the end of the day's work. The closing error should not exceed the permissible limit.

4.2.3 Levels shall be taken at 30 m interval for all L-Section covering apexes, lowest point of depressions, and highest point of ridges. Apex locations shall be fixed by giving location sketches with reference to the survey Nos/Block No. boundaries of fields. On approval by department the Contractor shall arrange to construct the reference Pillars of size 15cm x 15cm x 75cm.

The Contractor shall carry out topographical surveys of the original ground surface in each sector of the Works where surface excavation will be necessary, and produce sufficient and adequate cross-sections which will permit later to evaluate the volume of excavation for the measurement purposes and payment of excavation.

The Contractor shall entrust the surveying works only to persons who by their training and experience have sufficient qualifications and knowledge to ensure proper fulfillment of the survey tasks assigned to them. For the performance of the survey, the Contractor shall use a sufficient number of reliable and accurate instruments.

The contractor shall submit final layout prepared as stated above to the Engineer-in-Charge for approval. The Engineer-in-charge shall scrutinize the proposal and convey his observations to the contractor within fifteen days. The contractor shall promptly comply with the remarks and/or if necessary discuss the proposal made by him with the Engineer-in-charge and sort out differences. The Engineer-in-charge shall convey the final approval within one month.

4.2.4 Checking of works done by contractor:

(1) The department officer posted at works site shall concurrently check the work of transfer of PBM and TBM, surveying & leveling by arithmetical checking, plotting of survey work on village map, checking of contours, alignment marked on village maps & verifying same actually at site also. Any checks by the Engineer-in-Charge shall not relieve the Contractor of his full responsibility for the accuracy of structures and parts of them with regard to their position and dimensions.

5.0 Designs and Engineering

After receiving approval to the final layout, the contractor shall proceed with the task of preparing final designs of all components of the work along with all details required and preparation of plans and estimation of the complete system.

Contractor shall also furnish details of land to be used in prescribed format after marking land width and curves on village plans. Contractor shall prepare estimates based on description of the items on current schedule of rate and present market rates for non-scheduled items. Separate sub-estimate for different heads as directed by Engineer-in-Charge shall be prepared. Contractor shall also furnish a consolidated estimate of all the sub estimates for all the work assigned to him.

5.1 The Contractor shall be responsible for preparation of working drawings and the construction documents for works, as specified in the Contract.

All the studies of individual work, layout drawings and modifications if required to be prepared for taking up execution of the work, shall be prepared by the contractor and shall be got approved from the competent authority. The contractor will have to submit detailed drawings of each component with appropriate scales, measurements, Reduced Levels, full dimensions, index map showing locations of components such as godown, burrow area, dumping area, internal roads, etc. The contractor is expected to organize his work to the best of his knowledge so that final draft of various types of designs and layouts will be submitted to competent authority within stipulated time period.

All the studies layouts, drawings, design notes, which have been submitted to the department, shall become the absolute property of department under the copy right act and the contractor shall not use the same in whole or part thereof elsewhere for any purpose without explicit written permission from the department. In all difference of opinion on technical matters between the contractor and the Engineer-in-Charge, the decision given by the Chief Engineer shall be final and binding on the contractor.

5.2 The contractor is expected to take at least 1 trial pit of 1.5 m x 1.5 m x 2 m deep below GL or up to hard rock level or as directed by Engineer-in-Charge at each of the structure on afflux bund and road connectivity. The Engineer-in-charge shall check and certify the classification of the type of strata of trial pits before acceptance of final report submitted by the contractor.

5.3 All structures shall be deemed to be water retaining structures so far as application of IS-7784-Part-I 1975, IS-7784-Part-II-Section-I, 1983 and IS-456-1978 and IS- 3370-1967. Unless otherwise specified, the design will be carried out by working stress method.

5.2 ADDITIONAL POINTS:

Though design details have been supplied or referred to, the Contractor will be responsible of design of a workable and economical system. To achieve this, he may propose changes in the conceptual arrangement to the Executive Engineer and adopt them after receiving approval by Chief Engineer. The Contractor if asked will have to justify both technically and economically any of the design and layout details suggested by him and if he is not able to do so, shall have to accept changes as suggested.

6.0 ADDITION/MODIFICATIONS :

Should circumstances arise which call for addition/modifications in the design criteria, the department shall intimate the additions/modifications to the contractor. These additions/modifications will have to be taken into account without any extra cost to the Department. On approval of the proposal, contractor shall submit final presentation. All drawings shall be prepared in computer. Separate layers should be used to depict different details in Auto CAD drawings.

I. Index map to the scale of 1:15000 showing Barrage/ Bridge, afflux bund, road connectivity, Electrical system connectivity, all hydraulic structures, important roads, railways, major drains and village boundaries etc.

II. A combined contour map to a scale of 1:15000 shall be prepared showing alignments of all the component structures, link/ main drains, roads and cart tracks, S.O.I. bench marks/ bench marks given by Engineer-in-Charge and permanent & temporary bench marks constructed in one mosaic.

III. Plan and sections of all component structures showing hydraulic details, logging of bore holes, trial pit details etc.

IV. Detailed drawings of structures to a scale of 1:50. In case of layout etc. the scale can be 1:100 and in case of details of components the scale can be 1:25.

V. Village wise land plan schedule.

VI. North lines for plans shall be in same direction.

Note:

1. In case where all the details cannot be accommodated in one volume there can be two or more sections but in such case care should be taken that complete details of an item is covered in one section.

2. Where map cannot be accommodated in one drawing, the overlap of 5 cm on all sides shall be provided.

3. A uniform block shall be provided on the right side bottom corner as per the details given by the Engineer-in-charge.

4. Drawings: All drawings, map plans should be computer printed on good quality paper and transparent sheet by plotter. A proper numbering system should be used. Each such tracing/drawing should be accompanied by 5 legible photo copy taken out from it.

5. Estimate and Statements: 3 legible copies of estimates/statements/design notes/reports etc. typed on computer and its print out in laser jet printer.

6. Land acquisition proposals in the formats as per requirement of revenue department in six legible copies typed on computer and its laser print out shall be furnished.

7. The Contractor shall submit original tracing and field books. The contractor shall also return the documents furnished by the Department.

8. All above record in CD and one hard disc with operating software shall be furnished. Complete animated proposal in Media Player or in Flash showing all components of work and working animated model so as to give terrain depiction, showing villages, towns, boundaries, river, Barrage, bridge, afflux bund, road connectivity etc. shall be submitted.

9. Operation and maintenance manual draft of the project with master control.

7.0 Specifics

I. Survey work shall be handed over to the Departments in Auto CAD 2007 format drawings, separate layers will be used for each attribute and standardized blocks will be used to portray repeated features such as telegraph poles. A list of such layers and corresponding line-types and blocks as the Contractor proposes shall be agreed prior to the commencement of drawing production.

II. Drawing shall be prepared at a scale specified above and shall include a map location legend and scale bar on each sheet.

III. Drawing shall be on standard A 1 sheets. All drawing shall have a 20 mm border on all sides. The title block shall be in the bottom right hand corner of the page and the title block area above it shall be 100 mm wide. No part of the model space drawing shall extend into the title block margin. Above it all notes, scale bars and legends shall be located in the margin above the title block.

IV. All survey data shall be presented in model space (with Auto CAD) and all other non spatial data and constructions (title block, legend, frame etc) shall be located in paper space.

V. Each drawing shall include a 100 m x 100 m grid with clearly referenced co-ordinates using GIS along the drawing border.

VI. Each drawing shall show the details agreed with the Departments, the remaining layers though present in the drawing file, shall remain hidden.

8.0 Survey & Investigation for System connectivity

8.1 SURVEY AND MARKING:

8.1.1 The preliminary Survey:-Walk over survey, theodolite survey, and profile survey (if required) shall have to be carried out to establish the Route alignment by the Contractor for new lines. Survey shall cover all crossings like railways, roads including NH, power lines, telecommunication lines (under P&T Deptt), rivers, forest area, proximity to buildings etc and should be clearly indicated in the route map. Rly crossing shall be indicated clearly by color code or by bold letter. **Route alignment shall be plotted on Survey of India topographical maps [size (1:25,000) or (1:50,000) where ever available].**

8.1.2 Preliminary Survey Reports: Three copies of the alignment reports along with other information, if any, shall be submitted in report form, to Executive Engineer in charge of the Division with copy marked to C.E, for approval.

The detailed survey: - It should be taken up only after the route map is approved.

Preliminary route alignment in respect of the proposed line may undergo changes due to alteration of place and other unavoidable constraints. Detailed survey shall be covered by the following general guidelines:

- Route of the electric line shall be as short as possible.
- The line is as near as possible to the available roads in the area. Difficult and unsafe approaches are avoided
- Good farming areas, religious places, forest, civil and defence installations, aerodromes, public and private premises, ponds, tanks, lakes, gardens, and plantations are avoided as far as practicable.
- Involvement of Forest land should be least & restricted as far as possible.
- The line should be far away from telecommunication lines as reasonably possible. Parallelism with these lines shall be avoided as far as practicable.
- Angle points in the route shall be minimized. Railway and road crossing shall be minimum on the line route and in case it is not possible to avoid the same the crossings at right angles shall be preferred but the crossings shall not be less than 600 in any case.
- The survey shall be conducted along the approved alignment only.
- Relevant drawings & data shall be furnished to the appropriate authorities and obtain statutory clearances for Railway crossings, Highway/Roads, Telephone/ Power line crossings etc. All such clearances are the responsibility of the contractor.
- Owner shall arrange all required consent/approvals including civil aviation, road, river, railway, canal, power line crossings and environmental and forest clearance etc. from the concerned authorities.
- Owner in accordance with the requirement of construction shall arrange right of way and way leave clearances. Compensation for right of way and way leaves shall be given as per applicable laws, rules, regulations, guidelines/ directives of local administration/ revenue authorities.
- For river crossing/ Crossing of nallas: Taking levels at 25 meter interval on bank of river and at 50 meter interval at bed of river so far as to show the true profile of the ground and river bed. In case of railway/ Road Bridge, road, the levels shall be taken at least 100 m. on either side of the crossing alignment. Both longitudinal

and cross sectional shall be drawn preferably to a scale of 1:2000 at horizontal and 1:200 vertical.

- To facilitate checking of the alignment, suitable reference marks shall be provided. For this purpose, concrete pillars of suitable sizes shall be planted at all angle locations and for others with suitable wooden/iron pegs.

8.2 Detailed Survey Reports: After completing the detailed survey, the contractor shall submit the followings along with compliance reports, if any, to Executive Engineer in charge of the Division with copy marked to C.E, for final approval.

- **final profile and tower schedule/ pole schedule**
- **Bill of Quantity (BoQ)**

After approval, the contractor shall submit six more sets of the approved documents along with a soft copy for record purpose and submission to concerned Distribution Licensees (WESCO / SOUTHCO/TPWODL).

8.3 Way-Leave and Tree cutting:-

8.3.1 Way-leave permission which may be required by the contractor shall be arranged at his cost. While submitting final-survey report for approval, proposals for way-leave right of way shall be submitted by the contractor. Department may extend help/ facilitate to get the permission within a reasonable time for which due notice shall be given by the contractor in such a way so that obtaining permission from appropriate authority do not hinder the continued and smooth progress of the work.

8.3.2 The employer shall not be held responsible for any claim on account of damage done by the contractor or his personnel to trees, crops and other properties.

8.3.3 The contractor shall take necessary precaution to avoid damage to any ripe and partially grown crops and in the case of unavoidable damage, the employer shall be informed and necessary compensation shall be paid by the contractor.

8.3.4 All the documents required for application to the statutory authorities must be prepared by the contractor & submitted to the employer for submission of the application towards approval of Railway Crossing etc. However, the responsibilities lie with the contractor to get the clearance.

8.3.5 Trimming of tree branches or cutting of a few trees en-route during survey is within the scope of survey to be done by the contractor. Contractor shall arrange for necessary way-leave and compensation in this regard. During erection of the line, compensation for tree cutting, damage caused to crops, actual cutting and felling of the trees including way-leave permission for such route clearance shall be arranged by the contractor at his cost. The contractor will identify the number of trees and detail of obstructions to be removed for erection of the line and intimate the employer well in advance in case of any help. Other related works like construction of temporary approach roads, etc. as required, shall be done by the contractor and the same will lie

within the scope of contractor's work and such cost shall be considered to be included in the rates quoted by him.

8.4 Check survey:-

The contractor shall undertake the check survey during execution on the basis of the alignment profile drawing and pole/ structure schedule approved by Department. If during check survey, necessity arises for minor change in route to eliminate way leave or other unavoidable constraints, the contractor may change the said alignment after obtaining prior approval from the Engineer-in-Charge.

9.0 Work Ownership

Following completion of the survey work and final payment of all dues the survey work including all data and computations satellite imagery and drawings shall become the property of the Employer. The Contractor shall not distribute copies of the Work to third parties except the Departments, without the prior written consents of the Employer.

10.0 Back-up Copies

The Contractor shall submit all records with licensed software in Compact Discs (DVD) in 5 copies with proper referencing and interlinking of data with references so as to access data as web page. The data shall also be supplied in an appropriate capacity hard disc with all operating software used. The data shall also be available with contractor till the expiry of defect liability period and if required by department the same shall be supplied in soft copies.

B. LAND ACQUISITION

THE LAND ACQUISITION CASES ARE TO BE PREPARED AND SUBMITTED IN THE FORMATS PRESCRIBED BY THE REVENUE AUTHORITY COMPETENT TO PASS THE AWARDS. LAND ACQUISITION ACTS, RULES AND REGULATIONS IN RESPECT OF LAND ACQUISITION AS ENFORCED FROM TIME TO TIME ARE TO BE STRICTLY FOLLOWED

SECTION - III

CLEARING OF SITE

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SECTION - III

CLEARING OF SITE

3.1 Cleaning and Grubbing.

The portion of the right of way, where required for constructing the work under these specifications including borrow area, submergence area, shall be cleared of all plants, bushes, rubbish and other objectionable matters. The timber and other useful materials should be stacked as directed by the Engineer-in-charge and handed over to the Department. Trees designated by the Employer shall not be cut and shall be protected from injury. After handing over useful material to department the waste material shall be disposed off and removed from the site of work before the date of completion of the contract as approved by the Employer. The clearing operation shall be in accordance with clause 4.1, 4.1.1, 4.2 and 4.3 of IS 4701-1982 Indian code of practice for earthwork. Surface boulders either loose or partly embedded in the ground will have to be removed and stacked as directed.

3.2 Site Drainage and diversion and care of the river flows.

The Contractor shall handle all flows from natural drainage channels intercepted by the work. He shall perform any additional excavation and grading for drainage as directed and provide and maintain any temporary construction required to by pass or otherwise cause the flows to be harmless to the work and property. The contractor should design and construct the required coffer dams to divert the flows during execution. He should submit the design of the cofferdams and the diversion plans of the river flows and work progress schedule. They shall be submitted to the Engineer-in-charge for approval. When the temporary construction is no longer needed and prior to acceptance of the work the contractor shall remove the temporary construction and restore the site to its original condition as approved by the Engineer. The cost of all works and materials required for the above work shall be included by the bidder in the unit prices quoted in bill of quantities and no separate payment will be made for the same.

SECTION – IV

EXCAVATION FOR BARRAGE & ANCILLARY STRUCTURES

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SECTION - IV

EXCAVATION FOR BARRAGE & ANCILLARY STRUCTURES

4.1 General

a) The work to be done under these specifications shall consist of furnishing all tools, constructional plant, labour, materials and other things required for excavation in all strata, conveyance and disposal of the excavated materials, leads and lifts, temporary work for performance of all the operations connected with the work embraced under the contract as will secure a satisfactory quantity of work.

b) Construction and maintenance of diversions in case diversion of streams where they were disturbed due to excavation of dam / barrage and appurtenant works and for construction of structures.

The list of I.S codes and other publications applicable to this section is given below.

The abbreviations, OSS, IS, IRC, B.S, ASTM shall be considered to have the following meanings.

OSS - Odisha Standard Specification

I.S - Indian Standard of the Bureau of Indian Standards

IRC - Indian Roads Congress

B.S - British Standards

ASTM - American Standard of the American Society of Testing Materials.

Earthwork:

Sl. No.	I.S. Number	Short Title
01.	IS:4701-1982	Code of practice of earth work on canal.
02.	IS:3764-4966	Safety code for excavation work
03.	IS:1200(Part-I)-1974	Measurement of building and Civil Engineering works.
04.	IS:2720(Part-2)-1973	Method of test for soils part-2. Determination of water content.
05.	IS:3701-1968	Safety code for excavation works.
06.	IS”3698(Part-I)-1966	Safety code for scaffolding
07.	IS:3696(Part-B)-1966	Safety code for ladders
08.	IS:4082-1077	Recommendation of stacking and storage of construction materials at site.

In addition to the above IS codes, the specifications of OSS and manual for Quality control and inspection shall also be complied with

4.2 Planning

a) Priority to the commencement of work, all relevant data shall be collected by the Contractor and drawings prepared by him showing the location of the excavation, spoil deposition and filling.

b) The contractor shall present his planning of the work along with required details to the Engineer atleast 15 days before starting the work.

4.3 Setting out works

a) The contractor shall be responsible for the correct setting out of all works and its execution at his cost. The contractor shall execute the work true to alignment, grade and levels as shown in the drawings and as directed by the Engineer and shall check these at frequent intervals. The contractor shall provide all facilities like labour and instruments and shall cooperate with the Engineer to check all alignments, grade, levels and dimensions. Such checking shall not absolve the contractor of his own responsibility of maintaining the accuracy of the works.

b) The contractor shall establish sufficient number of reference bench marks facilitating setting out of works and taking levels for purpose of measurements.

c) Prior to commencement of work, the Contractor shall erect additional permanent bench marks, reference lines, reference points and check profiles at convenient locations approved by the Engineer. The bench mark stones shall be of 900mmx225mmx150mm size with 450mm embedded under firm ground in concrete and 150mm projecting above ground. The Word 'BM' showing value of RL shall be conspicuously carved and painted.

d) The contractor shall take all precautions to see that the lines, points and bench marks are not disturbed by his work and shall make good of any such damage.

4.4 Clearing the site

The provisions of Section 3 on Clearing of Site shall apply

4.5 Recording of working levels for soils & rocks.

a) The area required for dams/barrage and appurtenant works shall be cleared in accordance with the provisions of section 3. Measurements for soils and rocks will be based on levels. Initially on handing over site, net levels shall be taken at 2.5m or less interval as directed by the Engineer. The levels will be entered in field books and plotted in cross section sheets by the contractor in the presence of Engineer-in-charge or his representative. The contractor shall write a certificate "accepted the pre levels recorded on pages from _____ to ___" and sign at the end of levels in the level field book in token of acceptance

b) After stripping and prior to commencement of excavation cross sectional levels of the stripped surface shall be taken at the same locations and intervals and certificates as mentioned in (a) above shall be recorded.

At the earliest, cross sectional profiles taken after stripping shall be prepared duly plotting the pre levels and the contractor's signature shall be obtained on these cross section sheets. These cross sections called initial cross sections duly signed by the contractor and Engineer shall be preserved. Measurement of quantity will be based on these levels only. All linear dimensions shall be measured in metres to the nearest 0.01m; areas shall be computed in square meters nearest to 0.01 square metre. However, in case of rock excavation occurring in bed or sides, the actual quantity of rock shall be arrived at by taking block levels at 2.5m intervals all along the entire area of bed and sides.

c) No separate payment will be made to the contractor for the materials and labour provided for taking the cross sectional levels.

4.6 Earthwork Excavation for Dam/Barrage foundation.

Classification of excavated materials:

All materials involved in excavation shall be classified and got approved by the Engineer into the following groups.

a) All Kinds of soils

This shall comprise ordinary soils such as vegetable or organic soil turf, sand, silt, clay, mud, peat, black cotton soil, soft shale or loose moorum and hard soils such as stiff black cotton soil,, stiff clay, compressed hard gravel, stoney earth, stone matrix, soft disintegrated rock removable by pick axes and crow bars, boulders not exceeding 300mm in any direction and mixture of these and similar material.

b) Hard Disintegrated Rock not requiring blasting.

Hard disintegrated rock not requiring blasting, hard disintegrated rock or soft rock or conglomerate rock and hard lime kankar removable by pick axes and crow bars.

c) Rock Requiring Blasting.

i) Fissured and fractured rock and boulders of size more than 0.30 cum upto 3 cum in size requiring ordinary blasting

ii) Fissured and fractured rock and boulders of size more than 0.03 cum upto 3 cum in size requiring restricted blasting using Jack Hammer with controlled charge.

iii) Hard rock, sheet rock and boulders more than 3 cum size requiring blasting with ordinary blasting.

iv) Hard rock , sheet rock and boulders more than 3 cum size requiring restricted blasting using Jack hammer with controlled charge.

4.6.1 Excavation of Foundation

Before any of the work for the excavation of foundation is taken up, all loose rock, semi-detached rock in or close to the area to be excavated that is liable to fall or otherwise injure the workmen or the works shall be stripped. The method used shall be such as not to shatter or render unsuitable or unsafe any rock that was originally sound and safe. Any material not requiring removal as contemplated therein, but which may later become loosened or unsuitable shall be promptly and satisfactorily removed.

a) Excavation in all soils.

Overburden excavation shall include removal of all material other than rock excavation. The overburden excavation shall include earth, gravel, hard and compact material such as cemented gravel and soft disintegrated rock and also all boulders and detached pieces of rock measuring 0.03 cum or less in volume.

b) Rock excavation.

Rock excavation shall include rock in place which cannot be excavated until loosened by blasting, barring or wedging and also all boulders or detached pieces of solid rock more than one cubic meter in volume.

The excavation shall be made to sufficient depth to secure foundation on sound rock, free from weathered material, open seams or other objectionable defects. All necessary precautions shall be taken to preserve the rock below and beyond the lines or excavation in the soundest possible condition. The rock excavation shall be done by controlled blasting using Jack hammer holes of 32mm dia or less with little charge such that the blasting done will neither open up seams nor crack the rocks beyond prescribed limit.

The firing of system of blasts shall be controlled by the use of delay detonators. As excavation approaches its final lines, the depth of holes for blasting and amount of explosives used for hole shall be progressively reduced and excavation shall be done by controlled blasting. Whenever further blasting is liable to injure the concrete it is to be discontinued and the excavation for final 0.5m completed by wedging, barring, chiseling, line drilling and broaching or other suitable methods.

No blasting shall be done within 15 meters of any permanent structure. Where blasting would create a hazard to existing structures for installation, rock excavation shall be performed by methods other than blasting. The general excavation will be to levels and shapes shown in the relevant approved drawings. The foundation levels are based on indication of preliminary borings and are subject to changes as per actual site conditions warrant. Before starting concrete or masonry work, as large an area as possible should be exposed for inspection and test, so that a nearby section excavated later should not disclose that the former section should have been taken to lower depth.

c) Line drilling for rock excavation.

Where vertical or square faces of rock are required in portions of the work, such faces of excavation shall be formed by line drilling and blasting. The diameter and spacing of the holes for line drilling shall be subject to approval. The spacing of the drill holes shall be sufficiently close to ensure that rock will break along the designed lines. No blasting will be permitted in the holes along the sides of the excavation but light blasting will be permitted in areas adjacent to the holes provided that where further blasting might injure the rock upon or adjacent to which concrete is to be placed, the use of explosives shall be discontinued and excavation completed by wedging, barring or other suitable methods. Wagon drills shall not be used as it may disturb the rock structure.

d) Preparation of foundation - initial

After completion of rough excavation of foundation, scaling and trimming operations for the final removal of all shabby weathered and dummy rock and loosened mass shall be done by chiseling, picking, wedging and barring. The final foundation surface shall present a rough outline to provide added resistance to sliding and all smooth surfaces shall be roughened. The final surface shall be free from steep angles and sharp projections. Neither along the dam/barrage nor across, shall the foundation have a slope exceeding the angle of friction of concrete on rock. Where slopes are steep the rock shall be benched to give a downward slope towards upstream of about 1:10.

The foundation surface after cleaning out should be sounded by striking with hammer and portions which do not return a solid ringing sound shall be chiseled out. Sprinkling the area with water will indicate the joints in rock from the water lines which cling to the cleavages after the area has partially dried up. Such portions shall be tested for soundness and rectified where necessary.

4.5.2 Tolerance in excavation.

Measurements for soils and rocks will be based on levels. Initially on handing over the site, net levels shall be taken at 2.50 m or less interval as desired by the Engineer. The levels will be plotted in a cross section sheet and average level arrived at for purpose of determining the quantity of excavation. The contractor should sign the cross section sheets in token of his acceptance.

i. For excavation in rock a tolerance of 15cm beyond the profile will however be permitted. No extra payment will be made for the excavation beyond the designed profile. The over breakages within the tolerance limit of 15 cm shall be refilled with C.C M20 grade specified for foundations. No extra payment for filling such over breakage shall be allowed.

4.6.3 SPOILS

The excavated spoil in soils and hard rock is to be deposited outside the working area at suitable location in consultation with the Engineer.

4.6.4 Hard rock boulders of size greater than 0.03 cum. shall be stacked. The stack shall be closely packed with minimum voids and 40% will be deducted from the stack measurements to obtain solid measurements (this is subject to increase in the case of loose packing).

4.6.5 The excavated material shall be stacked within the area approved by the Engineer - in - charge. If the excavated material is deposited in unauthorized land, such work will not be measured for payment unless suitable action as may be directed by the Engineer - in - charge is taken by the contractor. In additional to non - payment of such work suitable amounts as directed by the Engineer - in - charge will be recovered from the Contractor as directed towards any extra cost which may have to bear on account of the Contractors un-authorized action.

4.6.6 USE OF EXCAVATED MATERIALS

All the materials available from excavation will be the property of Govt. and shall be disposed as directed by the Engineer - in - charge. The Material of approved quality may be used by the Contractor in the item of work included in Schedule of requirement of the tender or on ancillary for preparatory work free of charge. Prior approval of the Engineer - in - charge for such free use shall however be taken.

4.6.7 No re-handling of excavated material due to injudicious selection of the place for dumping will be paid for.

4.6.8 Blasting executed by Contractor in connection with the works shall be carried out in the manner described under “Blasting operations – Instructions to contractors” Controlled blasting shall be carried out where desired in the manner as directed.

4.6.9 In conducting blasting operations, proper precautions shall be taken for protection of persons, the work and property. All Government laws and regulations relating to the design and location of powder magazines, transportation and handling of explosives and other measures enacted for the prevention of accidents at powder magazines shall be followed.

4.7 MEASUREMENT

4.7.1 All linear measurement shall be in meters correct to 0.02 of a meter and volumes worked out in cubic meters correct to 0.01 of a cubic metre.

4.7.2 The measurements for the foundation excavation shall be made according to the sections shown on the drawings or to such other sections including stepping and slopping back as authorized by the Engineer.

4.7.3 In case of excavation in rock, when measurement is not directly possible from section it may be arrived at by measuring volume from stacks of the excavated rock. All original works shall be measured by levels.

4.7.4 The Level books, the section sheets (in which the levels are plotted) and the calculation sheets shall be treated as adjuncts to the measurement books.

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DRILLING & PRESSURE GROUTING IN FOUNDATION

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SECTION - V

DRILLING & PRESSURE GROUTING IN DAM FOUNDATION

5.1 Treatment of foundation – concrete /masonry

5.1.1 General

Low pressure blanket of grouting and high pressure curtain grouting together with drainage holes drilling subsequent to high pressure grouting shall constitute the foundation treatment for the masonry dam/barrage. Blanket grouting, required to seal and consolidate the foundation near the surface, shall be performed generally in the upstream third of the foundation area and in other areas if considered necessary. These holes are designated in drawings as 'B' holes. Curtain grouting aims at effecting a deeper seal in the foundation along the upstream edge of the structure to reduce uplift pressures and seepage. The curtain holes are designated in the drawings as 'A' holes.

The list of IS codes applicable:

i) IS 6066-1984 Recommendations of pressure grouting of rock foundation in river valley project.

ii) IS 54410-1986 Code of practice for portable pneumatic drilling machine.

iii) IS 2529-1973 Code of practice for in-situ permeability test.

The work of drilling and grouting shall include, but may not be limited to the following:

5.1.1.1 Surface treatment like cleaning etc.

5.1.1.2 Exploratory work consisting of test drilling and grouting to determine the size, depth and spacing of holes and then grout intake etc., for deciding on the detailed grouting programme.

5.1.1.3 Causing of drill holes as required, drilling washing and testing as required by the conditions encountered at the site and grouting the rock (both low and high pressure) in the area.

5.1.1.4 Installation and maintenance of special recording instruments required for the work covered by this section.

5.1.1.5 Clean up the grouting area:

A curtain grout and drainage holes will be drilled with standard rotary drilling equipment. Plug or non-coring bits may also be used. Where blanket grouting is to be done from the foundation surface, or from levelling course concrete through embedded pipes in rock which does not produce mud slurries percussion drilling in lieu of rotary drilling may be used for holes upto 10m depth. Exploratory and grout holes shall not deviate from the required direction by more than one percent of the length of the hole, as measured at the point of maximum penetration.

During drilling, testing and grouting operations the rock surface in the grout area and the surrounding 10m strip shall be kept clean and free of oil, grease, drill cuttings, much, grout, cement, pozzolana, excess water or any kind of waste.

Appearance of grout from any of the cracks, openings, cavities or drilled holes of any type in the grouting area shall be watched for. All open drill holes, cleaned out faults, cavities and larger cracks in the bed rock or concrete surface shall be protected at all times during the progress of the work from becoming plugged or filled with oil, grease, drill cutting, much, grout, cement or any kind of waste.

5.1.2 Definitions.

For the purpose of work to be performed under this section the following definitions shall apply.

A 'Zone' means a series of adjacent rock strata having similar characteristics.

A 'Section' means a partial or complete depth of hole for drilling or grouting purposes within any given zone.

An 'Exploratory hole' means any hole drilled in any material for the purpose of investigation and which subsequently may be used for grouting the bedrock. Exploratory holes may include holes drilled for testing of any kind.

A "Grout hole" means hole drilled in rock and used for injection of grout mixture under pressure for the sealing of permeable zones in the bed rock.

"Rotary Drilling" means the operation of drilling a hole in rock by continuously rotating a drill bit under pressure against the rock surface.

"Core drilling" means the operation of rotary drilling a hole in rock using a hollow cylindrical bit during which rock core is sought to be recovered continuously from the hole.

"Percussion drilling" means the operation of drilling a hole in rock using bits which are hammered against the rock surface with rotating movement.

5.1.3 General Programme

The general extent and typical details of the drilling and grouting works are shown on the specification drawings. The upper portion of the surface bed rock will require to be blanket grouted through holes which are not less than 35mm in diameter arranged on a 3m by 6m grid and to a depth generally ranging between 9m and 12m.

The actual number and spacing of the holes and the pressure to be used for grouting injections will depend upon the nature of the rock as disclosed by the foundation excavation, the results of water pressure, grouting acceptance and other tests, and the results of the progressive grouting operation itself. The procedure for grouting will be subject to modifications determined as above. "Stage drilling and grouting" is defined as any complete cycle of drilling, cleaning and pressure grouting regardless of the depth of hole drilling or grouted during any such complete operation. The number and depth of stages of drilling and grouting required to complete any hole will vary with the foundation conditions encountered.

The pattern of drilling and grouting shall be as per the recommendations of the geologist of Geological Survey of India.

The "stage" grouting method specified above involves the placement of grout by drilling and grouting in successive operations in accordance with the following general procedure.

5.1.3.1 Certain holes for foundation grouting shall be drilled to comparatively shallow depths which will be governed by the foundation conditions.

5.1.3.2 The holes thus drilled shall be washed and pressure tested and then grouted, except that when pressure testing indicates a relatively tight hole, the grouting of the hole may be omitted for that stage and the hole may be left open for drilling and grouting in the next stage.

5.1.3.3 The excess grout shall be removed from the holes by washing or by other methods before it has set sufficiently.

5.1.3.4 After an interval of 48 hours the holes not already drilled to their limiting depth shall be deepened.

5.1.3.5 The holes thus deepened shall again be washed and pressure tested, if required, and then be grouted.

5.1.3.6 Again the excess grout shall be removed from the holes as described above.

5.1.3.7 The process of successively drilling to additional depths and grouting in stages dictated by the field condition shall be repeated until all the set of holes shall be completely drilled and grouted over such sections of the foundation areas as may be found to be necessary. As the construction work progresses, the development of leakage or the conditions of the surrounding foundations may indicate that parts of the foundations already grouted may require additional grouting. In such cases even additional holes for grouting shall be drilled and grouted.

5.1.3.8 The process of successively drilling to additional depths and grouting at higher pressures in stages for the first set of holes and then for succeeding intermediate sets of holes shall be repeated for the second and subsequent zones of that section. Other sections shall be grouted in a like manner until grouting of the foundation is completed to satisfaction.

The drilling and grouting of the high pressure curtain holes shall be done in the rock through the M.S Pipes embedded in concrete, from the foundation gallery. Requirement as to depth and spacing of holes as shown on the drawings are approximate and subject to revision during the work of drilling, testing and grouting. It is, however, anticipated that the holes will be drilled at approximately 3m. spacing and to an average depth as shown in drawing or as directed by Engineer. The diameter of any grout hole shall not be less than 45mm and the hole shall be drilled to varying depths and at inclinations as shown in the drawings.

It is essentially that a exploratory drilling and pressure testing programme be performed early in the work , which, together with the first blanket grouting results and the detailed geology of the area, may indicate that an increase or decrease in the hole spacing and/or drilling of holes inclined to the vertical may be required through out or in localized areas of the foundation. In such a case, adjustment of hole spacing will be necessary. It is anticipated that the bulk of the drilling of the grout holes will be done to full depth in one operation normally. However, if during drilling of any grout hole, the drill water is lost during the drilling operation, the drilling shall be stopped and the hole grouted before drilling is resumed. Upon completion of drilling a hole it shall be temporarily capped or otherwise protected from entry of foreign matter until grouting operations require it to be opened. These will be removed and the holes refilled as soon as they are no longer required.

5.1.4 Washing of Holes.

5.1.4.1 General

On completion of drilling of a hole and before water testing or grouting of any stage of a hole is begun the hole shall be washed under pressure with water until the return water

becomes clear and no drill cuttings, rock fragment or any other solid materials are found in the water. If it is found that the hole cannot be cleaned with water only under pressure even after a reasonable length of time, it shall be washed with alternating jets of air and water under pressure, injected through a hose or a pipe lowered to the bottom of the hole. Washing of holes shall be a routine part of all drilling in rock.

5.1.4.1.1 Special washing

The result of routine washing may, in many cases, indicate that special washing procedures are required in order to remove more extensive deposits of "loose materials from tissues, fractures or other zones of loose or clayey material intercepted by the grout holes. When such a special washing programme is required, at least the nearest two holes in advance of each such hole shall be completely drilled for the same stage and the adjacent holes washed to facilitate flushing out of any intervening clay or silt seams or fractures. All intercepted rock seams and crevices containing washable material shall be washed with alternating water and air under pressure to remove as much of these materials as possible. If practicable, such material shall be ejected from one or more holes by introducing water under pressure through an adjacent hole. In no case shall such pressure exceed the maximum allowed.

5.1.5 Pressure Testing of Holes

During the drilling of holes, or after drilling is completed, or during or after grouting, holes as required shall be water pressure tested. In all grout holes when abnormal gain or loss of drill water is observed or caving of the hole or binding of the bit occurs during drilling or the drill rods fall suddenly as through an open crack or cavity, it may be required that drilling be discontinued and the hole pressure tested.

The procedure for water pressure testing shall be as specified herein. If a hole is drilled to full depth, the section of the hole to be tested shall be isolated by sealing it with double packers attached to a perforated steel pipe and lowered into the hole. If stage drilling method is used, a single packer shall be used to isolate the section to be tested. Water shall then be pumped into the test section under pressure and for periods, specified herein.

The time, pressures and quantities of water used for testing a section of a hole shall be recorded. The length of test section shall be measured parallel to the direction of hole. Holes shall be tested in 5 to 15 feet long sections. The pressure testing apparatus shall be subject to periodic tests for accuracy and satisfactory operation.

The pressure test shall be performed in one continuous operation using the following steps of pressure and times.

Step No.	Pressure (P) psi	Elapsed Time, Minutes
1	1/3 P	5
2	2/3 P	5
3	P	10
4	2/3 P	5
5	1/3 P	5

The pressure P shall be determined, depending on geological conditions and on the depth of the upper packer. However, this pressure need not exceed a maximum of 150 psi at the gauge. After steps no.4 and 5 the valve shall be closed and the pressure drop observed and recorded for a minimum period of 3 minutes in each instance.

A desirable degree of impermeability is considered to exist when the leakage obtained by applying a water test to a section of a hole drilled is less than two Lugeons (L) i.e 2 liter/meter/min of hole tested when a pressure of 10 Kg/cm^2 at the gauge point is applied for a period of 10 minutes.

5.1.6 Pipe for foundation grouting

5.1.6.1 Low Pressure Grout Holes: As soon as the drilling of a pattern is completed and all holes blown clear of muck, standard 65mm, 450mm diameter black iron pipe, long or more, as the rock conditions may require, shall be anchored in the drill hole with grout, mortar or lead wool, or other suitable material for making connection for grouting. The upper ends of all pipes shall be threaded and a coupling installed for convenience in making grout connections and each coupling shall be fitted with a standard cast-iron plug which will be screwed in loosely to prevent the entrance of debris or concrete.

Where permitted by the conditions of rock, grout-hole connections may also be made directly to the hole by means of a mechanical or a pneumatic expander without the use of embedded pipe.

In case blanket grouting is done after the base concrete, the MS Pipe will be embedded in the concrete while laying as per grouting pattern specified. Then the drilling shall be done through these pipes and grouted.

5.1.6.2 High pressure Grout Holes: Standard 75 mm, Black steel pipe shall be used wherever embedded pipe is specified for grout holes and also in foundation work over springs, crevices, seams and other spots disclosing foundation defects and elsewhere if required. Pipes and fittings that are embedded in concrete shall be thoroughly cleaned and held firmly in position and protected from damage while concrete is being built around them. The pipes for the high pressure grout holes shall be over 1m. high from the foundation gallery level and preferably upto the foundation rock so that where drilling is done later on, difficulties in keeping to the specified inclination may be avoided.

5.1.7 Grout materials and procedures.

5.1.7.1 Materials

5.1.7.1.1 **General**: Grout shall be composed of Portland cement and water or Portland cement, pozzolana, and water. It is possible that in special cases, the addition of sand may also be required.

5.1.7.1.2 **Cement**: Cement shall, unless otherwise specified, conform to the Indian standard specifications, IS:263-1958 for ordinary Portland cement. The cement shall be free from lumps. Any cement which is found to contain lumps for foreign matter of nature and in amounts detrimental to the results of the work shall be rejected.

5.1.7.1.3 **Water:** Water shall be clean and free from injurious amounts of deleterious substances such as but not limited to sewage, soil, acid, alkali, salts and organic matter.

5.1.7.1.4 **Pozzolana**: Pozzolana shall satisfy all the requirements of IS:1727-1960.

5.1.7.1.5 **Sand:** Sand, which is used as a filter, shall consist of hard dense durable uncoated rock fragments and shall conform to the relevant specification under I.S 383-1963 shall apply. The methods of testing for sand as specified in IS 2386-1963 shall apply. The sand shall remain in free draining storage for at least 72 hours prior to use.

5.1.7.2 Grouting procedure:

The water cement ratio of the grout will be varied to meet the characteristics of each hole as revealed by the grouting operation and will range between 10:1 and 2:1 by volume. In general, if the pressure tests indicate a tight hole, grouting shall be started with a thin mix. If an open hole condition exists as determined by loss of drill water or inability to build up pressure during washing operations, then grouting shall be started with a thick mix and with the grout pump operating as nearly as practicable at constant speed, the ratio will be decreased or sand added, if necessary, until the required pressure has been reached. When the pressure tends to rise too high, the water cement ratio shall be increased. If necessary, to relieve permeable stoppage, periodic applications of water under pressure shall be made. Under no conditions shall pressure or rate of pumping be increased suddenly as either may promote stoppage. As injection shall be continued (unless prevented by leakage) in any hole until, at the limiting grout pressure there is a negligible grout consumption.

A useful rule is to stop pumping when the grout consumption is less than 1.5 lugeon at pressure upto 3.5 Kg/cm^2 and 2 Lugeon at pressure between 3.5Kg/cm^2 and 10.5 Kg/cm^2. For pressure above 14 Kg/cm^2 the grouting pressure shall be maintained for such reasonable time as to ensure that the foundation has been satisfactorily grouted. Should grout leaks develop, such leaks shall be caulked promptly. If, due to size and continuity of fractures, it is found impossible to reach the required pressure after pumping reasonable volume of grout at the minimum workable water cement ratio, the speed of pumping shall be reduced. Following such reduction in pumping speed, if the desired result is not obtained, grouting the hole will be discontinued. In such event, the hole shall be cleaned, the grout allowed to set, and additional drilling and grouting shall then be done in this hole or in the adjacent area as determined in the field until the desired resistance is built up.

All pressure grouting operations shall be performed in the presence of a responsible Engineer in charge of grouting. After the grouting of any stage of a hole is finished the pressure shall be maintained by means of stop cock or other suitable devices, until the grout has set to the extent that it will be retained in the hole. The arrangement of the grouting equipment shall be such as to provide a continuous circulation of grout throughout the system and permit accurate pressure control at the hole by operation of valve on the grout return line, regardless of how small the grout intake may be. The fouling of equipment and lines shall be prevented, by constant circulation of grout, and periodic flushing out of the system with water. Flushing will be done with the grout intake valve closed, the water supply valve open and the pump running at full speed.

5.1.7.3 Grout pressure and methods of applying grout:

The pressure should be as high as practicable but controlled to avoid disturbance to rock structure. It is expected that in general grout pressure may go up to 7.0 Kg/cm^2 for consideration grouting and high pressure grouting. Grouting pressure must be properly and carefully varied to suit the depth of the holes, distance from exposed rock surface, and character of rock with reference to open joints, seams etc. The highest possible pressure consistent with safety, speedy work and the largest possible coverage, as determined by pressure testing and check leveling during grouting should be used. Where

deemed necessary, the upper seams shall be grouted in advance of the regular programme in order to permit the use of increased pressure on the lower seams.

In general, where stage grouting is to be adopted, it may be necessary or desirable, depending on site conditions to use different grouting pressure for grouting different sections of the grout hole, especially those of the high pressure grout holes. The grouting shall then be performed by attaching a packer to the end of the grout supply pipe, lowering the grout supply pipe into the hole to the top of the bottom section, grouting at the required pressure and allowing the packer to remain in place until there is no back pressure, withdrawing the grout supply pipe to the top of the next higher sections at the specified pressure until the entire hole is performed without the use of a packer. The packers shall be designed so that they can be expanded to seal the drill holes at the specified elevations, and when expanded, shall be capable of withstanding without leakage, for a period of 5 minutes, water pressure equal to the maximum grout pressures to be used.

High pressure grouting will not be started until all concrete required within a radius of 60m. has been placed to a height of not less than 25m. A primary series of holes above 6m to 10m apart (according to site conditions) shall first be treated to a depth of at least two stages over a reasonable length of curtain which should not be less than 20m. A secondary series of holes spaced midway between the primary series shall then be treated to the same depth. Water tests shall be made on a third series of holes midway between the primary and secondary series and compared with those made on the treated holes prior to injection to determine the efficiency of previous injections, the holes are then used for injection if they fail to pass the permeability requirements, when tertiary holes to be grouted through isolated holes may require grouting. But if the majority of the tertiary holes are required to be grouted, a fourth series of holes shall be drilled, tested and grouted if necessary.

In order to detect any movement or upheaval of the foundation rock due to excessive grout pressure upheaval or deformation, gauges shall be installed, prior to grouting operations, if so directed, at frequent intervals over areas where shallow grouting is required, and at 60m intervals for curtain grouting throughout the length of drainage gallery in the base of the dam/barrage. For this purpose, one inch diameter pipe shall be anchored by grouting to the bottom of the holes, drilled ten feet deeper than the proposed grout holes. Above the anchorage, the pipe shall be encased in a 5 cm asphalt dipped fibre conduit and the holes filled up with lean mortar. An iron yoke of bridge shall be anchored to the surrounding rock or concrete. Measuring tips shall be set at the top of the pipe and on the underside of the yoke. The gaps between the tips shall be frequently measured with a thickness gauge during grouting operations. For any progressive upheaval greater than 0.025 cm the pressure shall be reduced and grouting operations continued thereafter. If necessary, the pressure shall be relieved by allowing the grout to flow out of the holes until the gauge shows the settlement has ceased before continuing the operations.

5.1.7.4 Records of Grouting

Drilling, pressure washing, pressure testing and grouting records shall be kept neatly and systematically as the work proceeds. The exact location of all holes with reference to the axis and chainages along the dam shall be recorded and an accurate log of all operations kept. Record maps and sections shall be completed showing all subsurface conditions as found and corrected by grouting operations. Representative cores shall be suitably boxed and referenced. All information regarding the grouting, amount of grout taken effects observed in the surrounding holes of rock etc. may be kept under the following heads.

a. Hole number

b. Type of hole and method of drilling

c. Position, chain age with distance upstream or downstream of the axis line.

d. Top level and depth

e. Date and time of commencement of grouting

f. Date of completion

g. Quantity of cement consumed

h. Observations during grouting, concerning behaviour of holes under air and water pressure, appearance of wash water, quantity and proportion of grout used, time and pressure of grouting, application and retention of grout pressure, connection to and effect on adjacent holes, method of application of grout stage grouting and etc. and other conditions noted while drilling and grouting, to enable compilation of complete geophysical record of the foundation.

5.1.8 Drainage (Not applicable for Barrage)

5.1.8.1 General: Foundation drainage for the concrete dam will be provided by a line of holes drilled from the foundation gallery into the foundation rock at approximately 3m center to center and about 25m deep or as directed by the Engineer through 100 mm dia. pipes embedded in the concrete portion. Drainage holes shall not be drilled until all adjacent grout holes within a minimum distance of 45m. have been drilled and grouted. The bottom of each drainage hole shall have a nominal diameter of 7.5cm if after a given area is grouted and drilled for drainage, it is found necessary to drill and grout additional grout holes, previously drilled hoes may be required to be opened by re-drilling to secure satisfactory drainage.

5.1.9 Internal Drainage by formed Drains: (Not applicable for Barrage)

The internal drainage of spillway dam and non-overflow dam blocks shall be provided by means of 200 mm. diameter precast vertical drains discharging into the foundation gallery. The location of these precast drains will be as shown in the drawings. In the event that any drain hole becomes clogged or obstructed during the progress of the work, it shall be completely opened up. The top of each vertical drain hole shall be sealed with concrete capping and the bottom of each vertical drain hole shall be connected to the foundation gallery by standard black pipe and elbows as per approved drawing.

5.1.10 Measurement and payment.

No separate payment will be made for this item. It is deemed to be included in the bid price for the work.

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DRILLING & BLASTING

6.1 GENERAL

Blasting where required will be permitted only when proper precautions have been taken for the protection of persons and properly in accordance with IS 4081-1967 (Indian standard specification for safety code for blasting and related drilling operations). While carrying out excavation, adequate precautions in accordance with IS 3764-1966 (Indian standard specifications for safety code for excavation work) shall be taken.

Explosives such as gelatin, detonators and fuse coils etc. required for the rock blasting are to be procured by the contractor at his own cost. The contractor has to purchase the blasting materials mentioning the name of work and name of the contractor. The materials without mentioning the above two names on the bill will not be accepted. It shall be the responsibility of the contractor to store the explosives purchased by him in accordance with the rules of the Explosives act and other rules framed by Government of India. He should possess/acquire proper license for transport of explosives, possession and use of explosives and short fires as per Revised act, 1963.

He shall also furnish the following details.

Capacity	License No. and date	Validity period.

The contractor shall acquaint himself with all the applicable laws and regulations concerning storing, handling and use of explosives. All such laws, regulations and rules, as prevalent from time to time shall be binding upon the contractor.

The provisions detailed in the specifications supplementary to the above laws, rules and regulations, are also applicable. Further, the engineer may issue modifications, alterations and new instructions from time to time. The contractor shall comply with the same without these being made a cause for any claims.

A list of I.S. Codes applicable is furnished below.

IS 4081-1986 – Safety code of blasting and related drilling operations.

IS 3764-1966: Safety code for excavation work.

In addition to the above I.S codes, and manual for quality control and inspection shall also be complied with.

6.2 MATERIALS:

All the material such as explosives, detonators, fuse coils, tamping materials etc. that are proposed to be used in the blasting operations shall have the prior approval of the Employer. Only explosives of required make and strength are to be used.

Black powder and safe explosive shall be used wherever possible. Explosives with nitroglycerine shall be used where the above explosives are not effective.

The use of fuse with only one protection coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. Rate of burning of the fuse shall be uniform and not less than 4(four) seconds per 26 millimeters of length with 10% (ten percent) tolerance on either side. The fuse known as instantaneous fuse shall not be used.

The fuse shall be inspected before use and the moist, damaged or broken ones discarded. The rate of burning of all new types of fuses shall be examined. When they have been in stock for a long time they shall be treated before use. The detonators used shall be capable of producing effective blasting of the explosives.

6.3 PERSONNEL:

Excavation by blasting will be permitted only under the personal supervision of competent and licensed persons and trained workmen employed by the contractor at his cost. All Supervisors and workmen in-charge of make-up, handling, storage and blasting work shall be adequately insured by the contractor.

The person in-charge of the explosive magazine shall be very reliable and his deployment shall be approved by the Employer.

The contractor shall make sure that his supervisor workmen are fully conversant with all the rules to be observed in storing, handling and use of the explosives. It shall be assured that the supervisor in-charge is thoroughly acquainted with all the details of handling and blasting operations.

6.4 STORAGE OF EXPLOSIVES.

The contractor shall build a magazine or make suitable permanent arrangements at his cost for safe storage of explosives. Contractor shall provide portable magazine for carrying the explosives to work-spot from the magazine at his cost. The site of the magazine, its capacity and design shall be subject to approval by the Inspector of Explosives before construction is taken up. As a rule, explosives should be stored in a clean, dry, well ventilated, bullet proof and fire proof building in an isolated site.

The contractor shall provide armed guard security of required numbers for explosive magazines or while transporting to work site as per rules in force at his cost.

The explosives detonators and fuse coils shall each be separately stored.

A careful and day to day account of explosives shall be kept by the contractor in a register in a manner prescribed by the employer. The employer may also pay surprise visits to the storage magazine. In case of any unaccounted storage of the explosives or if the account is not found to have been maintained in a manner prescribed by the engineer, the contractor shall be liable to be penalized in which case he shall not be entitled to any compensation for the losses etc. the action taken under this clause shall be in addition to that which might be taken by the competent civil authorities in the court of law.

The magazine shall at all times be kept scrupulously clean.

No unauthorized person should at any time be admitted inside the magazine. A notice shall be hung near the storage prohibiting entrance of unauthorized persons.

The magazine on no account be opened during or on the approach of a thunder storm and no person shall remain in the vicinity of the magazine during such period.

Magazine shoes without nails shall at all times be kept in the magazine and a wooden tub or cement trough about 300 millimeters high and 450 millimeters in diameter filled with water shall be fixed near the door of the magazine.

Persons entering the magazine must put on the magazine shoes which shall be provided by the contractor for the purpose and be careful.

i) not to put their feet on the clear floor unless they have the magazine shoes on;

ii) not to allow the magazine shoes to touch ground outside the clean floor

iii) not to allow any dirt or grit to fall on the clean floor.

Persons with bare foot shall, before entering the magazine, dip their feet in water and then step directly from tub over the barrier (if there be one) on the clean floor.

A brush or broom shall be kept in the lobby of the magazine, for cleaning the magazine on each occasion when it is opened for the receipt, delivery or inspection of explosives. No matches or inflammatory materials shall be allowed in the magazine. Light shall be obtained from the electric storage battery lantern.

No person having articles of steel or iron on him shall be allowed to enter the magazine.

Only cotton, rags, waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on them.

No tools or implements other than those made of copper, brass, gun metal or wood shall be allowed inside the magazine. All tools shall be used with extreme gentleness and care.

Boxes of explosives shall not be thrown down or damaged along the floor and shall be stacked on wooden trestles.

Where there are white ants, the legs of trestles should rest in shallow copper, lead or brass bowls containing water. Open boxes of dynamite shall never be exposed to the direct rays of the sun. Empty boxes or loose packing materials shall not be kept inside the magazine. Magazines shall be inspected at least twice a year by an officer representing the Engineer.

He shall see that all the rules are strictly complied with. The magazine shall have a lightning conductor which should be got tested at least once a year. The contractor shall comply with all the recommendations made by the officer testing the lightning conductor and also rectify the defects notified to him within 15 days failing which the engineer shall be entitled to comply with the same at the contractor's expense which shall not be open to question. The engineer may take any action that he may consider fit at the cost of the contractor.

The following shall be hung in the lobby of the magazine.

a. A copy of rules both in English and in the languages which the workers concerned are familiar with.

b. A statement showing the stock in the magazine on that day.

c. A certificate showing the last date of testing of the lightning conductor.

d. A notice stating “smoking is strictly prohibited”.

6.5 USE OF EXPLOSIVES.

For the transport of the explosives and detonators between the store and the site, closed and strong containers made of soft materials such as timber, zinc, copper, leather shall be used.

Explosives and detonators shall be carried in separate boxes. For the conveyance of primer, special container shall be used.

The boxes and containers used, shall be kept closed. Explosive shall be stored and used chronologically earlier received shall be used first. A make up house shall be provided at each working place in which cartridges will be made up by competent and licensed men as required for the work. The make-up house shall be separated from other buildings. Only electric storage battery lamps shall be used in this house.

No smoking shall be allowed in the make-up house or generally while dealing with explosives.

6.6 DISPOSAL OF DETERIORATED EXPLOSIVES.

All deteriorated explosives shall be disposed off in an approved manner; the quantity of the deteriorated explosives to be disposed off shall be intimated to the engineer prior to its disposal.

6.7 PREPARATION OF PRIMERS.

The primers shall not be prepared near open flames or fire. The work of preparation of primers shall always be entrusted to the same personnel. Primers shall be used as early as possible after they are ready.

6.8 CHARGING OF HOLES.

The work of charging of holes shall not commence before all the drilling work at the site is completed and the contractor’s supervisor shall satisfy himself to that effect by actual inspection. While charging, open lamps shall be kept away. For charging with powered explosives, a naked flame shall not be allowed. Only wooden tamping rods, without any kind of metal on the rod shall be allowed to be used. The tamping rods

shall have cylindrical ends. Bore hole must be of such size that the cartridge can easily pass down them. They shall not however be too big.

Only one cartridge shall be inserted at a time and gently pressed into the hole with the tamping rods. The sand, clay or other tamping materials used for filling the holes completely shall not be tamped too hard.

6.9 BLASTING.

Blasting shall be carried during the fixed hours of the day which shall have the approval of the engineer. The hours once fixed shall not be altered without prior written approval of the engineer.

The site of blasting operation shall be prominently demarcated by red danger flags. The order to fire shall be given only by the contractor's supervisor in-charge of the work and this order shall be given only after giving the warning signal three times, so as to enable all the labour watchmen etc. to reach safe shelters.

Whistle/ bugle with distinctive note shall be used to give the warning signals. The bugle shall not be used for any other purpose. All the labour shall be made acquainted with the sound of the bugle and shall be strictly warned to leave their work immediately at the first warning signal; and to move for safe shelters. They are not to leave the shelters until all clear signal has been given.

All the roads and footpaths leading to the blasting area shall be watched.

In special cases, suitable extra precautions shall be taken. The Engineer may however permit blasting for under ground excavation, without restriction of fixed time, provided that he is satisfied that proper precautions are taken to give sufficient warning to all concerned and that the work of other agencies on the site is not hampered. For lighting the ruse, a lamp with a strong flame such as carbide lamp shall be used.

The contractor's supervisor shall watch the required time for firing of the fuses and shall see that all the workmen are under safe shelters in good time.

6.10 ELECTRICAL FIRING.

Only the contractor's supervisor in-charge shall possess key of the exploder and short firing accessories and he shall keep it always with himself. Special apparatus shall be used as a source of current for the blasting operations; power lines shall not be tapped for the purpose.

The detonators shall be checked before use. For blast in series, only detonators of the same manufacturer and of the same group of electrical resistance shall be used. Such of the electrical lines as could constitute danger for work of charging shall be removed from the site. The firing cables shall have a proper, insulating cover so as to avoid short circuiting due to contact with water, metallic parts or rock.

The firing cables shall be connected to source of current only when nobody is in the area of blasting. Before firing, the circuit shall be checked by a suitable apparatus. After firing with or without an actual blast, the contact between the firing cable and the source of current shall be cut off before any one is allowed to leave the shelters. During storm/rain , the blasting operations shall be suspended.

6.11 PRECAUTIONS AFTER BLASTING.

After the blast, the contractor's supervisor must carefully inspect the work and satisfy himself that all the charges have exploded. After the blast has taken place in the underground works, workmen shall not be allowed to go to the place till all the toxic gases are evacuated from the face.

MISFIRES:- If it is suspected that part of the blast has failed to fire or is delayed, sufficient time shall be allowed to elapse before entering the danger zone. When fuse and blasting caps are used, a safe time should be allowed and then the contractor's supervisor alone shall leave the shelter to see the misfire.

None of the drillers are to work near this hole until one of the two following operations has been carried out by supervisor.

Either: i) Supervisor should very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper or jet of water or compressed air (using pipe or soft material) and withdraw the fuse with the primer and detonator attached after which a fresh primer and detonator with fuse should be placed in this hole and fired out

Or (ii) the hole may be cleared of 300mm, of capping and the direction then be ascertained by placing a stick in the hole. Another hole may be drilled at least 226mm away, and parallel to it. Then balance of the cartridge and detonators shall be removed.

Before leaving his work, the contractor's supervisor should inform the supervisor of the relieving shift of any case of misfires and should point out the position with red

cross denoting the same, also stating what action if any, he has taken in the matter. A register of misfires and their locations and how they are dealt with shall be maintained by the contractor.

The contractor's supervisor should also at once report at the contractor's office all cases of misfires, the cause of the same and what steps were taken in connection there with.

The names of the day and night shift supervisors of the contractor must be noted daily in the contractor's office. If misfire has been found to be due to a defective detonator, or dynamite, the whole quantity of box from which the defective article was taken must be returned to the contractor's office for inspection, and shall be disposed off.

Drilling holes not completely exploded by blasting shall not be permitted.

The contractor should produce his firer's license and furnish the particulars in the following format.

Sl. No.	Name	Firer's license No.& date.	Validity period.

Blasting operation, when considered necessary shall be resorted to only with the written permission of the Engineer. Prior inspection shall be carried out for the safety of the public and property. Blasting operations in the proximity of overhead power lines, communication lines, utility lines or other structures shall not be carried out until the operator or the owner or both of such lines have been notified and precautionary measures deemed necessary have been taken.

SECTION - VII

STEEL REINFORCEMENT

SECTION - VII

STEEL REINFORCEMENT

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SECTION - VII

STEEL REINFORCEMENT

7.1 GENERAL

a. The section covers specifications for providing steel reinforcement to Dams/barrages and ancillary works and the contractor has to make his own arrangements for the procurement of tested mild steel and H.Y.S.D. Bars required for the work only from the reputed manufacturers. Necessary I.S.I. test certificates are to be produced to Engineer before use in work. Steel bars shall be stored in such a way as to avoid distortion and to prevent deterioration by corrosion. The Contractor shall make his own arrangements for transportation and storage.

b. High yield strength deformed bars shall conform to I.S:1786-1985,

The diameter and weight of plain and HYSD steel bars shall be as follows.

Sl. No	Diameter of rod	Sectional weight in Kilogram per running meter both for plain and HYSD steel.
1	6 Millimeters	0.22
2.	8 Millimeters	0.39
3.	10 Millimeters	0.62
4.	12 Millimeters	0.89
5.	14 Millimeters	1.21
6.	16 Millimeters	1.58
7.	18 Millimeters	2.00
8.	20 Millimeters	2.47
9.	22 Millimeters	2.98
10.	25 Millimeters	3.85
11.	28 Millimeters	4.83
12.	32 Millimeters	6.31
13.	36 Millimeters	7.99
14.	40 Millimeters	9.86

Sl. No	Diameter of rod	Sectional weight in Kilogram per running meter both for plain and HYSD steel.
15.	42 Millimeters	10.88

NOTE : If any rods other than those specified above are used, the weights shall be as per standard steel tables.

c. The work shall consist of shaping and placing reinforcement in conformity to the shape and dimensions shown on the drawings and as specified in the specifications, including cutting, bending, clearing, wedging, placing, binding and fixing in position. A list of IS codes applicable is furnished below:

List of IS Codes:

IS:456-1978/2000	Code of practice for plain and reinforced concrete
IS:1786-1985	Specification for High strength deformed steel bars and wires for concrete reinforcement.
IS:432-1982 (Part-I)	Specifications for mild steel and medium tensile steel bars for concrete reinforcement and hard drawn steel wire.
IS-280-1978	Mild steel wire for general engineering purposes.
IS-2502-1963	Code of practice for bending and fixing of bars for concrete reinforcement.
IS:9417-1989	Recommendations for welding cold worked bars for reinforced concrete construction
IS:2751-1979	Welding of mild steel plain and deformed bars for reinforced construction
IS:814-1991	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
IS:1278-1972	Filer rods and wires and gas welding.

In addition to the above Indian Standard codes, the specifications of OSS and manual for quality control and inspection shall also be complied with.

7.2 Material

i. a. Steel shall be clean and free from loose rust or loose mill scale and other objectionable foreign substances at the time of fixing in position and subsequent concreting.. The fact that early stage rust has no detrimental effect on bond shall not be used as excuse of careless handling and storage of steel.

b. The contractor shall procure high yield strength deformed bars, conforming to IS:1786-1985.

c. The reinforcement bars used by the contractor shall be in accordance with the Section 5.1.

ii. Cutting, Bending and binding of reinforcement.

a. Reinforcement steel shall conform accurately to the dimensions given in the bar bending schedules shown on relevant drawings.

b. Bars shall be bent cold to the specified shape and dimensions by a bar bender by hand or power to attain proper radius of bends as shown in drawings or as directed by the Engineer. Heating of reinforcement bars to facilitate bending will not normally be permitted. When, however, such heating is permitted in the case of large diameter bars, the temperature of the steel shall not exceed the temperature corresponding to a cherry red colour.

c. Bars shall not be bent or straightened in a manner that will injure the material

d. Bars bent during the transport or handling shall be straightened before being used on work, they shall not be heated to facilitate bending.

7.3 **Placing of reinforcement.**

a. Before the reinforcement is placed, the surface of the bars and the surfaces of any metal bar supports shall be cleaned of the rust, loose mill scale, dirt, grease and other objectionable foreign substances.

b. All reinforcing bars shall be accurately placed in exact position shown on the drawing, and shall be securely held in position during placing of concrete by annealed binding wire, and by using stays, blocks or metal chairs, spacers, metal hangers, supporting wires or other approved devices at sufficiently close intervals so that they will not sag between supports, nor be displaced during concreting or by any operation of the work.

c. Wire for binding reinforcement shall be soft and annealed mild steel of 16 SWG and shall conform to IS:280-1978.

d. The contractor shall also ensure that there is no disturbance caused to the reinforcing bars already placed in concrete.

e. All devices used for positioning shall be of non-corrodible material. Metal supports shall not extend to the surface of the concrete, except where shown on the drawings. Pieces of broken stone or brick and wooden blocks shall not be used. Where portions of such supports will be exposed on concrete surfaces designated to receive F2 or F3 finish, the exposed portion of support shall be galvanized or coated with other corrosion resistant material without which the concreting will not be permitted. Such supports shall not be exposed on surfaces designated to receive F4 finish unless otherwise shown on the drawings.

f. Placing of reinforcement bars on layers of freshly laid concrete, as work progresses, for adjusting bar spacing shall not be allowed.

g. Layers of bars shall be separated by spacer bars, pre-cast blocks or other approved devices.

h. Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be taken to prevent any displacement of reinforcement in concrete already placed.

i. To protect reinforcement from corrosion, concrete cover shall be provided as indicated on the drawings. All bars protruding from concrete and to which other bars are to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement grout.

j. Bars crossing each other, where required, shall be secured by binding wire (annealed) or size not less than 1mm dia and conforming to IS:280-1978 in such a manner that they do not slip over each other at the time of fixing and concreting.

k. As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed by Engineer-in-Charge. When practicable, overlapping bars shall not touch each other, but be kept apart by25 mm or 1 ¼ times the maximum size of the coarse aggregate which is greater, by concrete between them. Where not feasible, overlapping bars shall be bound with annealed steel wire, not less than 1mm thickness twisted tight. The overlaps shall be staggered for different bars and located at points, along the span where neither shear nor bending moment is maximum.

l. The minimum allowable clearance between parallel round bars shall not be less than 1 ½ times the diameter of the large bars and for square bars shall not be less than twice the side dimensions of the larger bars or 1½ times the maximum size of aggregate, whichever is greater.

m. Dissimilar diameter rods should not be joined together.

7.4 **Splicing**

a. Where it is necessary to splice reinforcement ,the splices shall be made by lapping or by welding or by mechanical means.

When permitted or specified on the drawings, joints of reinforcement bars shall be butt welded so as to transmit their full strength. Welding of bars shall be done as directed by the Employer and conforming with requirements of clause 11.4 of IS:456-1978.

If it is proposed to use welded splices in reinforcing bars, the equipment, the material and all welding and testing procedures shall be subject to the approval of the Employer. The contractor shall also carryout test welds as required by the Employer. No extra rate will be paid for welding reinforcement and test-welds, as bid price is inclusive of this item.

For welded splices for reinforcing bars conforming to IS:1786-1985 welding shall be done in accordance with IS:9417-1979. For reinforcing bars conforming to IS:432(PartI)-1982 welding shall be done in accordance with IS:2751-1979. Electrodes for manual metal arc welding shall conform to IS:814(Part-I)-1974 and IS:814(Part-II)-1974. Mild steel filler rods for Oxy-acetylene welding shall conform to IS:1278-1972, provided they are capable of giving a minimum butt weld tensile strength of 41 Kg/mm^2.

Only electric arc welding using a process which excludes air from the molten metal and conforms to any or all other special provisions for the work shall be accepted. Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding and when welding is done in two or three steps, previous surfaces shall be cleaned well. Ends of bars shall be cleaned of all iron scale, rust, grease, paint and other foreign matter before welding.

b. Reinforcing bars of 28 mm in diameter and larger may be connected by butt welding provided that lapped splices will be permitted if found to be more practical than butt welding and if lapping does not encroach on cover limitation or hinder concrete or reinforcement placing.

c. Reinforcing bars 25mm in diameter and less may be either lapped or butt welded, whichever is the most practicable.

Butt welding of reinforcing bars shall be performed either by the gas pressure or flash pressure welding process or by the electric arc methods under cover from weather.

Welded pieces of reinforcement shall be tested at the rate of 0.5% of total number of joints welded. Specimen shall be taken from the actual site of work. Strength of the weld provided shall be at least 25% higher than the strength of bars.

d. Welded joints or splices shall preferably be located at points where steel will not be subject to more than 75% of the maximum permissible stresses and welds so staggered that at any section not more than 20% of rods are welded. Approval of such additional splices will generally be restricted to splices not closer than 8 metres in horizontal bars or 4 meters in vertical bars measured between mid point of laps.

7.5 **Coupling of bars.**

Wherever indicated on the drawings or desired by the Engineer-in-Charge to use mechanical couplings for reinforcing bars, bars shall be joined by couplings which shall have a cross sections sufficient to transmit the full strength of bars. The ends of bars that are joined by couplings shall be upset for sufficient length, so that the effective cross section at the base of threads is not less than the normal cross section of the bars. The threads shall be standard with worm threads. Steel for couplings shall conform to IS:226. The contractor shall submit samples of the proposed coupling to the Engineer for approval not less than 60 days prior to their proposed use.

7.6 Care of placed reinforcement and concrete

Where reinforcement bars at construction joints and afterwards are bent back into their original position, care shall be taken to ensure that at no time the radius of the bend is less than 6xdiameter for deformed bars and 4xdiameter for plain mild steel bars. Care shall also be taken, when bending such bars, to ensure that the concrete around the bars is not damaged.

As specified in clause 11.3 of IS:456-1978 unless otherwise specified by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances.

i. For effective depth 200 mm or less = $\pm$ 10mm

ii. For effective depth more than 200mm = $\pm$ 15mm

The cover shall in no case be reduced by more than one third of specified cover or 5mm whichever is less.

a. The dowels shall be of the same HYSD bars of grade F2 415 conforming to IS-1786-1985 as used for reinforcement

b. Details for dowels shall be as shown on the drawings or as directed by the Engineer.

c. Dowels shall be placed in the concrete where shown on the drawings or where directed and will be inspected for compliance with requirements as to size, shape, length, position and quantity after they have been placed but before being covered by concrete.

d. Before the dowels are embedded in concrete, the surfaces of dowels shall be cleaned of all dirt, grease or other foreign substances which in the opinion of the Engineer are objectionable.

e. The dowels shall be accurately placed and secured in position so that they will not be displaced during the placing of the concrete.

7.7 **INSPECTION BEFORE CONCRETING :**

No concreting shall be started unless the reinforcement as laid is finally checked arid certified by the Engineer-in-charge or his authorized representative, Before starting the concreting the contractor shall make certain that the measurements of the reinforcement placed in have been recorded and that the Engineer-in-charge certifies corrections of reinforcement used. Failure to do so may mean no payment or payment at the discretion of the Engineer-in-charge for the reinforcement concrete.

SECTION - VIII

CONCRETE

SECTION - VIII

CONCRETE

(Excluding Framework, Reinforcement and Joints)

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SECTION - VIII

CONCRETE

(Excluding Framework, Reinforcement and Joints)

8.1 SCOPE OF WORK

(1) The work under this section includes all concrete works in weir, road works, afflux bund etc covering the ingredient materials, testing and services related to the concrete work to be carried out by the contractor under this contract.

(2) The concrete work shall be performed to the dimensions as shown on the construction drawings or as otherwise directed by the Engineer-in-charge. Lift drawings for each pour showing all embedment, lines and levels shall be prepared by the contractor.

(3) The contractor shall cooperate with all other contractors and organizations related to the construction of permanent works where the materials or equipment is to be fixed to or embedded in the concrete structures.

(4) Form work, reinforcement and concrete are covered separately in other sections of this specification.

(5) The approval given by the Engineer-in-charge to the contractor's plants and equipment or their operation or of any construction methods shall not relieve the contractor of his full responsibility for the proper and safe execution of concrete work or any obligations under this contract.

8.2 STANDARDS

1) Unless otherwise specified, the standard and recommendations of Indian Standards Code of Practices shall be followed in respect of all materials, equipment and performances.

2) The relevant Indian standards are to be followed in maintaining standard quality.

8.3 SUBMITTALS

8.3.1 Submittals Before Construction

1) Submittals listed herein are related to items, which require the consent of the Engineer-in-charge and are to be submitted by the Contractor before the appropriate work may proceed.

2) Within 28 days from the date of issue of Notification of Award, but before procuring or mobilizing to the site the equipment, the contractor shall submit to the Engineer-in-charge updated and detailed plans and descriptions, consistent with those submitted with his Tender and any subsequent amendments and additions agreed to by the Engineer-in-charge and the contractor, including but not limited to the following:

a) Aggregates Processing Plant:

Description, flow diagrams and drawings in sufficient details to indicate layout, type and capacity of crushing, screening , washing, conveying and other aggregate processing and handling equipment.

b) Batching Plant

Description, flow diagrams and drawings of the plants, and details of the equipment the contractor intends to use, to determine and control the quantity of each separate concrete ingredient and mixing thereof into uniform mixture.

c) Transport and Placing of Concrete.

Full details of the equipment and methods for transporting the concrete from the concrete plant to the final point of placing including numbers, type and capacity of transport vehicles, concrete pumps, vibrators, and details of standby plants to be installed.

a) Mode and methodology of concrete compaction and concrete curing.

b) Sampling and Testing of Materials: List and details of equipment of sampling and testing, detailed program for quality control of concrete work and qualification and experience of the proposed personnel.

c) Foundation and surface preparation equipment.

3) At least 56 days in advance of any concrete work being carried out at the site, the contractor shall submit to the Engineer-in-charge following notifications based on the results of the preliminary material testing:

a) Notification on the quantity of cement required ,brand of cement to be used on approval of Engineer-in-Charge and the proposed schedule of shipment and storage.

b) Notification of the source, analysis, method of delivery and storage of water for concrete manufacture.

c) Notification of any admixtures which the contractor proposes to use, manufacturers thereof, and information about the chemical names of the principal ingredients and the effects of under or over dosage. Should the contractor intend to use an accelerator in any concrete work for his own convenience, he shall give full details of the type, dosage, influence on construction, and the cost savings involved.

d) Details of the materials for formwork and surface finishes, treatment of construction joints, and construction techniques which the contractor proposes to use in order to achieve the required concrete surfaces and allowable tolerances.

e) Details of special additives like silica fume & steel fibres for production of high performance concrete.

f) Details of curing methodology

8.3.2 Submittals During Construction

a. Contractor shall provide the Engineer-in-charge with a weekly placing schedule giving the detailed location of the pours, the approximate extent of pours, and the date on which the concrete will be placed. This weekly programme of concrete placement shall be submitted to the Engineer-in-charge for his acceptance at least 2 days prior to the commencement of the week.

b. Before commencement of the concrete placement the contractor shall prepare a checklist regarding all preparations for the specified work such as cleaning and treating rock surfaces and foundations, formwork, reinforcement, embedding, instrumentation and submit this list to the Engineer-in-charge, who after his satisfaction about the work preparations will permit the contractor in writing to commence concrete placement.

c. The contractor shall keep and make available to the Engineer-in-charge records of the date ,quantity and storage location of each delivery and shall provide facilities for checking the stock of cement.

d. During the performance of the concrete work, the contractor shall keep a diary where he shall record the construction procedures related to concreting. This diary shall be

made available to the Engineer-in-charge upon request. The records shall contain at least the following.

g) Commencement and termination of concreting of various parts of the structures.

h) Quantities and quality of aggregates and cement provided and the storage from which they were drawn.

i) Temperature of air, water and concrete.

j) Meteorological conditions

k) Sampling and testing performed and summary of results.

l) Personnel employed during various stages of the concreting operation and name of the responsible inspector or foreman.

m) Equipment used.

n) Any special material or procedures employed.

e. The Engineer-in-charge reserves the right to require any additional information deemed necessary to be included in the submitted documents.

8.4. CONSTITUENTS OF CONCRETE

8.4.1. Cement

(1) Cement shall be ordinarily Portland cement conforming to IS:269 or low heat- low alkali Portland pozolana cement (PPC) conforming to IS:1489 or Grade 43 conforming to IS:8112 or Grade 52 cement conforming to IS:12269 depending upon the use and type of structure. If required slag cement may also be used.

(2) Cement, which does not comply with, relevant IS code or is damaged in consignment, handling or storage shall be promptly removed from the site.

(3) All facilities for transport and storage of cement shall be subject to approval of Engineer-in-charge and shall be such that easy access for inspection is assured.

(4) Bulk cement shall be transported from the port or factory to the site in adequately designed weather tight trucks, or other means where cement will be protected from exposure to moisture. Immediately upon receipt at the site, cement shall be stored in a dry, weather-tight and properly ventilated structure with adequate provisions for the prevention of absorption of moisture, and constructed in such a way that there will be no dead storage. The vents of the bins and silos shall be equipped with dust collectors to reduce loss of cement during handling and inconvenience to the personnel.

(5) Cement bags shall be stored in weatherproof buildings with a raised, well-ventilated wooden floor, and placed so that each consignment can be segregated if required and used in order of its age. Bags shall not be stacked more than 1.5 m high. Cement shall not be stored outdoors, except for immediate use, and in such event shall be protected during storage and handling by waterproof covers and a raised floor. Unused cement shall be placed back into the storage buildings.

(6) Cement shall be preferably used in same order in which it has been received at the site. Storage of cement shall be limited to 90 days in bags and 150 days in bulk. Cement that has been in storage for longer than these periods or which may have absorbed moisture shall not be used unless it has been re-tested by the Contractor and approved by the Engineer-in-charge. Cement that has become lumpy shall not be used. The cements coming from different factories or of different makes shall be stored separately.

(7) The temperature of cement upon arrival to the Site shall not exceed 70^0C and when entering the mixers shall not exceed 50^0C unless otherwise approved.

(8) Fly ash (pozzolana) shall not be allowed to be mixed with cement at place other than factory/manufacturing unit. Fly ash (pozolana) mixed at factory shall conform to IS:3812 and IS:1344.

8.4.2 Aggregate

8.4.2.1 General

(1) Unless otherwise specified, concrete aggregates shall conform to the requirements of IS:456 and IS:383. They shall be tested in accordance with the provisions of IS:2386

(2) Aggregate shall consist of clean, hard, dense, durable and uncoated materials and shall have stable moisture content and grading when delivered to the batching plant. Aggregates shall not contain substances, which may impair the quality of the concrete, attack reinforcing steel or reduce bond. The following substances are regarded as being harmful; loam, clay, pieces with large cavities, foam-like or vitreous pieces and organic materials such as topsoil, roots, wood, coal, lignite etc. In doubtful cases the effects of harmful substances shall be established by tests.

(3) Use of aggregates containing minerals which can cause alkali reactivity beyond acceptable limits will not be permitted. Presence of such minerals in the stones will be determined by testing.

(4) The shape of the particles shall be generally spherical or cubical. The amount of flat or elongated particles shall not exceed 25% by weight. A flat or elongated particle is defined as one in which the width to thickness, respectively length to width ratio is greater than 3. Rock, which breaks down into such shape, regardless of the type of processing equipment used, will not be approved for use in the production of aggregates.

(5) The contractor shall make provisions for crushing and processing of material in accordance with recommendations contained in IS:383 to meet the gradation and other requirements of these specifications, in order to obtain the total amount of aggregate required for concrete manufacture. Crushing, screening and washing operations, beneficiation of aggregates and blending of crushed and natural aggregates shall at all time be subject to the consent of the Engineer-in-charge.

(6) The handling, transporting and stockpiling of aggregates shall be such that there will be a minimum amount of fines resulting from breakage and abrasion of material resulting from free fall and improper handling. Excess in any of fine or coarse aggregate sizes shall be disposed of in approved manner.

(7) The contractor shall remove all rejected aggregate from the site.

8.4.2.2 Fine Aggregates.

(1) The term ‘fine aggregate’ is used to designate aggregate in which the maximum size of particles is 4.75mm.Sand obtained from natural sources like river shall be used as fine aggregate. Fine aggregates shall be tested for their gradation, specific gravity, water absorption, fineness modulus, soundness, petrography analysis, deleterious constituent and alkali aggregate reactivity to assess the suitability.

(2) The gradation of fine aggregate shall conform to specifications of IS 383 and the sand shall not fall into grading zone I and IV.

(3) The percentage of deleterious substance in the fine aggregate shall conform to IS:383, except that the fine aggregate shall contain not more than 0.1% by weight of deleterious (reactive) ferrous sulphide. The total percentage of deleterious substance must not exceed 5% by weight.

(4) Fine aggregate having specific gravity of less than 2.6 shall be rejected. Fine aggregates, when subjected to soundness test with a solution of sodium sulphate, after five cycles of tests, shall not suffer a loss of weight in excess of 10 percent.

(5) Fineness modulus of fine aggregate shall be 2.1 to 3

(6) Fine aggregate, upon delivery to the batching plant, shall have uniform and stable moisture content. The Bulk age of sand shall be less than 20%.

(7) Sand shall be free from harmful quantity of organic impurities as per IS 2386 Part II. Sand that are producing a color (obtained by dissolving 9 grams of chemically pure Terric Chloride and 1 gram of CP Cobalt in 100 ml of water to which one-third ml of Hydrochloric Acid has been added) darker than the standard in the test (Organic test for organic impurities) shall be rejected.

8.4.2.3 Coarse Aggregates

(1) The term "coarse aggregate" is used to designate aggregate which is retained on sieve opening 4.75mm. The coarse aggregate shall be well graded and its gradation will be decided based on the laboratory tests to obtain dense mass of concrete. The gradation will be approved by the Engineer-in-charge before production of the concrete.

(2) The coarse aggregate shall be tested for gradation, specific gravity, water absorption, impact and abrasion values, soundness, spectrographic analysis, deleterious constituent, flakiness and elongation indices and alkali aggregate reactivity as per IS 2386-1963(Part I to VIII) and other relevant standards.

(3) Coarse aggregates shall be stored separately in stockpiles or bins in such a manner to avoid intermixing of different size of aggregates. The storing shall be done in following sizes.

5-10 mm

10-20 mm

20-40 mm

40-80 mm

80-150 mm

(4) The percentage of deleterious substance in the coarse aggregate shall conform to IS:383 except that the coarse aggregate shall contain not more than 0.3% by weight of deleterious (reactivity) ferrous sulphide. The total deleterious material shall not exceed 5% by weight.

(5) Coarse aggregate shall have a loss not more than 40% as determined by Los Angeles Abrasion test as specified in IS:2386 (Part IV). However in extreme cases, because of non-availability of such aggregate in near vicinity the Engineer-in-charge may allow aggregates having this value as 50%.

(6) When subjected to sodium sulphate soundness test, course aggregate shall not suffer a loss of weight in excess of 12% after five cycles.

(7) Coarse aggregate shall be hard, dense, durable, nun coated rock fragments. Rock having an absorption greater than 3% or specific gravity less than 2.5 shall not be used.

(8) Aggregate delivered to the batching plant shall have uniform and stable moisture content.

8.4.2.4 The nominal maximum aggregate size in relation to the structure dimension shall be fixed as per IS 456 & IS 457 and as per the approved drawing. Coarse aggregate shall be well graded and shall conform to the grading specified in Table II of IS 383.

8.4.2.5 Aggregate storage.

(1) Aggregates shall be stored in a manner so that each size of aggregate is separate in free-draining piles in a manner that reduces breakage, deterioration, contamination and segregation to a minimum. Each grade of aggregates is to be stored separately. Storage arrangements shall be subject to acceptance by the Engineer-in-charge.

(2) The Contractor shall maintain sufficient aggregate storage at the site at all times to permit continuous placement of concrete in accordance with the contractual time schedule.

(3) The moisture content of aggregates shall be controlled as far as practicable, by wetting the stockpiles and by adequate drainage. All aggregate shall remain in a free-draining stockpile for at least 12 hours prior to use. To minimize moisture variation, the height of the stock piles shall be kept 1.25m to 1.5m and the lowest layer of about 30cm height shall be used as drainage layer and not used till end. Fine aggregates of the bottom 30cm layer shall not be used for concrete.

8.4.3 Water

(1) A reliable and adequate water supply shall be installed and maintained by the contractor for washing of aggregates, manufacturing and curing of concrete The water shall be clean and free from harmful quantities of oil, acids, alkalils, sugar, salt, silt and other organic matters and shall conform to IS:456.

(2) Permissible limit of Solids in water shall conform to Table I of IS 456.Water shall contain not more than 200mg/l of organic,3000mg/l of inorganic, 400 mg/l of sulphates (SO_3), 500 mg/l of chlorides (Cl), and 2000mg/l of suspended matter.

(3) Adequate water storage shall be provided at the batching plant to ensure smooth concrete production.

(4) Contractor shall familiarize himself with source and quality of water available. Attention is drawn to the possible requirement of settling pond and other facilities that he may be required to provide.

8.4.4 Admixtures

(1) Admixtures shall be proposed by the contractor and shall be used only upon written approval of the Engineer-in-charge. Only admixtures, with satisfactory evidence that its use does not adversely affect the properties of concrete particularly its strength, volume changes, durability, and has no harmful effect on the reinforcement, shall be permitted. All admixtures shall be manufactured by a reputed company(ies), supported by a fully staffed technical service organization and research group.

(2) The contractor may use the following admixtures when required with the approval of the Engineer-in-charge.

a) High-range water-reducing admixtures (HRWRA)/ Super plasticizer to improve workability without reducing the strength or durability of the mix.

b) Air-entraining agent,

c) Non-shrink agent,

d) Accelerating agent in the concrete, mortar or grout to increase the rate of hydration, shorten the setting time or increase the rate of hardening or strength development

(3) Admixtures shall comply with the provisions of IS:9103 or in case of lack of corresponding IS, the ASTM specifications C494 and C260.

(4) Admixtures shall be stored and handled so as to avoid contamination or damage to their properties by temperature or moisture changes or other influences.

(5) The quantity of admixture and the method of mixing shall be strictly in accordance with the manufacturer's printed instructions or as required to produce specified results as established by mix design whichever is less, and approved by the Engineer-in-charge. No excess admixtures shall be used for getting more workability than functional requirement of structure. The contractor shall be liable for penalty for such overuse of admixture. No payments shall be made for the concrete produced in case of such overuse of admixture.

(6) The contractor shall be held liable for any damages and difficulties resulting from the selection and use of admixtures such as delay in concrete placing or damage to concrete during forms removal and shall not be entitled to any time extension or claims resulting there from.

8.5 CONCRETE MIX DESIGN

(1) Denomination of concrete classes is based on the nominal cube compressive strength in Newton per square mm and maximum aggregate size, e.g. M20A20

(2) The cube compressive strength is defined as the strength as measured at 28 days. The strength shall comply with the requirements of IS:456.

(3) The specific class of concrete to be used in each area will be shown on the Approved Construction Drawings or as designated by Engineer-in-charge.

(4) At least 4 months prior to commencement of any concreting of permanent works, the contractor shall start the testing of materials, propose the composition of concrete mixes and prepare trial mix of each of the proposed concrete class. The contractor shall prepare the trial mixes using the cement, water, aggregates and admixtures intended for the work and which conform to the requirements specified in this section.

(5) Contractor shall determine, in accordance with IS standards and/or ACI Manual of Concrete Practice, the mix proportions for the designated classes of concrete. In proportioning concrete the quantity of both cement and aggregate shall be determined by weight. Water shall be either measured in volume in calibrated tank or by weight. The proportion of ingredients shall be such that concrete has adequate workability for conditions prevailing at work in question and can be properly compacted. The contractor shall submit the test reports to the Engineer-in-charge for approval.

8.6 QUALITY CONTROL

8.6.2 General

(1) The contractor shall be completely responsible for performing detailed quality control program during the execution of the work. This quality assurance program shall be subject to inspection and checking by the Engineer-in-charge or his authorized representative.

(2) The Contractor shall keep records of test results, which shall be presented to the Engineer-in-charge upon request.

(3) Should the Contractor wish to change his approved testing program he shall notify the Engineer-in-charge of these changes 2 weeks in advance.

(4) Besides Contractor's testing program the Engineer-in-charge will make control test to the extent as he deems necessary. The Contractor shall give all required assistance in sampling and provide for the proper storage and transport of the specimens to be tested by the Engineer-in-charge.

8.6.2 Site Laboratory

(1) The Contractor shall build, equip and operate the site laboratory in which the tests included in the Quality Control Programme will be carried out. In some cases where special tests are required, they will be made in other specialized laboratories after approval by the Engineer-in-charge.

(2) The laboratory shall be equipped with all the necessary equipment to carry out the tests indicated below.

a) Tests on aggregates as per IS 2386 (Parts I,II,III,IV)

- Sieve analysis
- Compressive strength
- Specific gravity
- Water absorption
- Flakiness
- Sand equivalent
- Soundness and organic matter
- Los Angeles abrasion
- Impact test

b) Tests on cement

- Equivalent alkaline content (IS 4032)
- Specific Blaine surface (IS 4031(6))
- Standard Mortar Compressive Strength (IS 4031(6))
- Shrinkage (IS 4031 (10)
- Setting time (IS 4031(5))

(c) Tests on fresh concrete

- Consistency through slump test (IS 1199)
- Workability

(d) Tests on hardened concrete

- Compressive strength on all classes of concrete (IS 516)
- Shrinkage (IS 4031(10))

8.6.3 Concrete Sampling and Testing

8.6.3.1 Aggregates

(1) Aggregate samples shall be taken from silos at the batching plant or from the conveyor belt.

(2) The sampling shall be done at the frequency of one every 1,000 m^3 of produced concrete (cumulative of all concrete classes) and once a week at minimum.

(3) The following tests will be carried out.

- Sieve analysis
- Sand equivalent
- Cleanliness of gravel
- Flakiness of gravel
- Los Angeles abrasion

8.6.3.2 Cement.

(1) Quality control of cement shall first take place at the cement factory. This will be exercised by the factory itself under the supervision and the follow-up of the owner. The quality control program at site will be established jointly with the contractor and shall be submitted for the approval of the Engineer-in-charge.

(2) The following tests will be carried out at both laboratories of the factory and the contractor and compared.

- Setting time,
- Expansion
- Specific Blaine surface
- Equivalent alkali content
- Standard mortar compressive strength

(3) Furthermore, each week, a sample of cement shall be taken at the batching plant and the following tests shall be carried out.

- Setting time,
- Specific Blaine surface,
- Standard mortar compressive strength at 3, 7 and 28 days.

8.6.3.3 Admixtures.

(1) Admixtures to be used for concrete production shall be tested for their suitability with the cement and other materials under actual working conditions. Each shipment of admixtures shall be tested for density and dry extract.

(2) Admixtures older than 12 months after their manufacturing, shall be tested for deterioration.

(3) Total lot of admixtures from which the tested sample failed the criteria, shall be rejected.

8.6.3.4 Water

A sample of water will be taken from the concrete batch plant every 3 months and submitted to chemical analysis as described in IS 3025-1964.

8.6.3.5 Fresh Concrete

(1) A random sampling shall be adopted. Sampling should cover all mixing units and spread over the entire period of concreting.

(2) Minimum frequency of sampling of concrete of each grade shall be as per IS 456-2000.

(3) Three test specimens shall be made from each sample as described in IS 456.

(4) The test strength of samples shall be average of three specimens. Individual variations shall not be more than 15 percent of the average.

8.6.3.6 Hardened Concrete

(1) Set of six samples for compressive strength tests at 7 and 28 days will be taken and tested for each part of the work, being defined as per the volume poured in one concreting operation.

(2) Compressive strength specimens shall be prepared by the Contractor and shall be performed in accordance with Indian Standards and Code of Practice.

8.6.3.7 Analysis of Results.

(1) The test results will include the different components analysis, the values obtained on fresh and hardened concrete and the characteristics of the corresponding batch given by the printer of the batching plant.

(2) The contractor shall present regularly to the Engineer-in-charge a synthesis of all the results in the form of tables, charts, statistical analysis (weekly and monthly reports).

8.6.3.8 Concrete Plant

Monthly checks, or when requested by the Engineer-in-charge of the concrete plant's weigh-batching accuracy, including the accuracy of any admixture dispenser, shall be made by the contractor in the presence of the Engineer-in-charge. When checked by standard weights and volumes , its accuracy shall be within 0.5% or as specified by the manufacturer.

8.7 ACCEPTANCE CRITERIA

(1) The acceptance criteria for hardened concrete shall be as per IS:456.About 20% of the cubes cast for each day may have values less than the specified strength provided that the lowest value is not less than 85% of the specified strength.

(2) If analysis of test cube results indicates poorer concrete in the structure as per the acceptance criteria of IS:456, the Engineer-in-charge will order the contractor to provide core tests. Location and number of cores will be decided by the Engineer-in-charge. The contractor shall take out the specified sizes of cores from the structure.

(3) In case the concrete cores fail to meet the specifications and the Engineer-in-charge is not satisfied with various tests results and quality, he will then instruct the Contractor for removal or subsequent suitable strengthening measures for such works at no extra cost. Wherever necessary the Engineer-in-Charge may make necessary changes in the proportion of mix and the contractor shall have to effect these changes and shall not be entitled to any compensation on account of such changes.

8.8 BATCHIING AND MIXING

8.8.2 General

(1) The contractor shall furnish the plant lay out and the method of concrete production, transportation and placing to the Engineer-in Charge. The contractor shall provide, operate, and maintain at the site automatic batching equipment to determine and control the quantity of each individual material entering the concrete. Batching equipment shall be designed for such capacities, which will permit performance of the concrete work in accordance with Contractual Construction Program.

(2) Water, cement, admixtures, fine aggregate and coarse aggregates shall be measured separately and not cumulatively. The accuracy of the measuring devices shall be maintained so that the indicated measure does not vary by more than 1 percent from true measure throughout their range of use. The devices shall be capable of being operated to control the delivery of materials so that the combined inaccuracies in feeding and measuring do not exceed the following limits.

Material	Percent (by weight)
Cement	1
Water	1
Aggregates	3
Admixtures	1

8.8.2 Batching Equipment.

(1) At the batching plant, standard certified test weights shall be provided and such other auxiliary equipment as may be necessary to check the operating performance of each scale of other measuring devices. When required by the Engineer-in-charge, operator shall make these tests in his presence. Unless otherwise required by the Engineer-in-charge, check tests of equipment used for measuring water, cement, aggregate and admixtures shall be made at least every week. After completion of each check test, operator shall report the results to the Engineer-in-charge and make such adjustment, repairs or replacement as the Engineer-in-charge deems necessary to secure satisfactory performance before further use of the measuring devices.

(2) The batching equipment shall be so constructed and arranged that the sequence and timing of the batcher discharge gates can be controlled to produce an intermixing of the aggregate, water and cementing materials, as the materials pass through the charging hopper into the mixer. The batching controls shall be so interlocked that a new batching cycle cannot be started until all the weighing hoppers are completely empty.

(3) The operating mechanism in the water measuring device shall be such that no leakage will occur when the valves are closed and the discharge valve cannot be opened until the filling valve is closed.

(4) The dispensing device for adding admixtures shall be interlocked with the batching and discharging operation of the water so that the batching and discharging of the admixtures will be automatic. The device shall be capable of permitting the quantity of admixture being batched to be adjusted should this prove necessary, and shall be equipped with a suitable warning device to indicate when the level in the reservoir tank is low.

(5) The batching equipment shall include an accurate recorder for providing a continuous visible record of the measurement of each separate material, including all added water and admixture.

(6) The measuring and recording equipment shall be supported on foundations independent of those for the mixing plant to prevent them from being affected by vibration.

(7) Effective communication system including telephone shall be provided between the concrete plant and the point of placement at all times, and such facilities shall also be available at either location for use by the Engineer-in-charge as required.

(8) Volume batching will not be permitted.

8.8.3. Mixing

(1) Concrete shall be mixed in power driven stationary batch mixer of approved type and size. They shall be kept clean and in proper working order. The mixing blades in the drum shall be replaced when worn by 10% of their design dimensions.

(2) The batching plant shall be provided with a bypass such that the mix materials can be discharged directly into a transit mixer drum. This bypass is to be used only in emergency and with permission of the Engineer-in-charge.

(3) The mixing equipment shall be capable of combining the aggregate, cementing materials, water and other ingredients, within the time specified, into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation.

(4) The mixers shall be so charged that some water will enter in advance of cement and aggregate and all materials shall continue to flow in as rapidly as possible. The construction of the mixers should prevent loss of materials during charging.

(5) The mixers shall not be charged beyond their rated capacities and the entire contents of the mixer shall be discharged before recharging.

(6) Unless otherwise authorized by the Engineer-in-charge for mixers of $1m^3$ capacity or less, the mixing of each batch shall continue for not less than 1.25 minutes as specified in IS:457 (but not more than 5 minute when mixing air-entrained concrete) after all materials, except the full amount of water, are in the mixer. For mixers of larger capacity, the minimum mixing time will be increased by 15 seconds for each additional $0.5m^3$.

(7) The mixing time shall be increased when, in the opinion of the Engineer-in-charge, the charging and mixing operations fail to result in the required uniformity of composition and consistency within the batch and from batch to batch.

(8) Each mixer shall be equipped with a mechanically or electrically operated timing and signaling device for indicating and assuring the completion of the required mixing period and for counting the batches.

(9) Should a mixer at any time prove unsatisfactory, it shall be replaced or its use discontinued until it is made satisfactory.

(10) Each mixer shall be cleaned after each period of continuous operation and shall be maintained in such a condition that the mixing action will not be impaired.

(11) On no account shall any addition be made to any component of a concrete batched, once that batch has been mixed and discharged from the mixer, whether for the purpose of retempering or for any other reason.

(12) Batching and mixing of concrete shall not commence unless due notice, at least 24 hours in advance, has been given to the Engineer-in-charge and written approval has been obtained for the placing arrangements, and for the preparation and accuracy of the part of the works in which concrete is to be placed.

8.9 HOT AND COLD WEATHER CONCRETING

(1) Hot weather and Cold weather concreting shall be done as per IS 7861 Part I and Part II. The maximum temperature developed after placement should not be higher than 40^0C and the concreting shall be temporarily suspended during excessive hot weather when the temperature inside the form work exceeds 63°C or the condition is such that the concrete can not be placed at the required temperature.

(2) Whenever required, the ingredients of concrete and the exposed surface of fresh or green concrete shall be adequately shaded from direct rays of the sun and protected against premature setting. The exposed faces may be kept under fine spray of water.

(3) Concreting shall be done at night during hot weather.

(4) For mass concrete in spillway and dam/barrage, the maximum lift height shall be 1.5m.

8.10 CONVEYING

(1) The method and facilities for concrete transport shall be selected by the contractor within the limitations of these specifications, and he shall be responsible for adequacy and suitability of the transporting system. The time elapse between mixing and the initial set of the concrete shall be taken into consideration. All methods used shall be reviewed by the Engineer-in-charge.

(2) The concrete transporting methods and facilities shall be such that will prevent segregation of coarse aggregate, excessive loss of slump and loss of ingredients. Equipment such as transit mixers, buckets, cars, conveyers and pumping equipment which may be used for conveying concrete, shall be of such size, design and condition as to ensure an even and adequate supply of concrete at the placement area. All equipment shall be kept clean and in good working condition.

(3) The use of chutes to convey concrete will not be permitted, except that chutes less than 3m in total length may be used immediately adjacent to or in the forms with acceptance of the Engineer-in-charge. Where chutes are used, they shall be so constructed and arranged as to permit continuous flow of the concrete without separation of the ingredients.

(4) There shall be no vertical drop greater than 1.5m, except where equipment, satisfactory to the Engineer-in-charge, is used to confine and control the falling concrete.

(5) Concrete may be dropped through flexible elephant-trunk chutes, provided methods are used at the lower end to retard the speed of the falling concrete and prevent it from segregation. Where it is necessary to drop concrete from more than 1.5m it shall fall into a hopper with a capacity of $1m^3$ more than the total capacity of the full trunk.

(6) All conveying plant shall be supported independently of the forms, except as specifically permitted by the Engineer-in-charge.

(7) The conveying plant shall be kept free from hardened concrete and foreign materials, and shall be cleaned at frequent intervals.

8.11 DRILLING HOLES AND GROUTING ANCHOR BARS IN ROCK.

In case of rock foundation, as shown in the approved drawings or as directed by the Engineer-in-Charge, holes shall be drilled into the rock to receive bars for anchoring concrete structures or parts thereof to the rock. The types and dispersions of the anchor bars and the locations, diameters and depths of the anchor bar holes shall be as shown on the drawings or as directed. The diameter of each hole shall not be less than 1 ½ times the largest transverse dimension of the bar specified for that hole subject to a minimum of 12mm over the bar diameter. Anchor bars shall be cleaned thoroughly before being placed. The holes shall be washed out and cleaned thoroughly and shall then be completely and compactly filled with grout of proper proportions. Each anchor bar shall be forced into place to full depth immediately after the grout has been placed and shall then be rapped or vibrated until the entire embedded surface of the bars is in intimate contact with the grout. Special care shall be taken to prevent any movement of bars after they have been placed till the grout has adequately hardened. Alternatively the insertion of the anchor bar into the fresh grout filled hole may be carried out immediately prior to placement of concrete in the location, the hardened concrete will then prevent undesirable vibration being imparted to the anchor bar and lead to avoidance of separation.

8.11.1 PLACING ANCHORS IN CONCRETE

Anchor bolts, structural shapes, plates and bearings required in connection with the installation of gates. Gate hoists and operating machinery shall be placed in concrete as shown on the drawings or as found necessary. Wherever practicable, anchors shall be installed before the concrete is placed and except as otherwise provided drilling for the installation of anchors in the concrete will not be permitted. Where the installation of anchors prior to placing the concrete is not practicable, satisfactory formed openings shall be provided and the anchors shall be grouted in to the openings later. Anchor bolts for machine may be placed in approved pipe sleeves to facilitate installation of machinery and the sleeves shall be completely filled with grout after the locations of the holes are finally determined.

8.12 PLACING

8.12.1 General

(1) Contractor shall place concrete in a given location only after the Engineer-in-charge has agreed with the placement of such concrete. All concrete shall be placed in presence of the Engineer-in-charge. Concrete placed without prior knowledge and approval of the Engineer-in-charge may be required to be removed and replaced at contractor's cost.

(2) The contractor shall furnish, install, maintain and operate a telephone system or radio, linking the points of placing concrete with the concrete batching and mixing plant. These facilities shall also be available to the Engineer-in-charge at all times.

(3) When placing the concrete by pumping, direct communication shall be maintained between the concrete placing crew and the pump operator.

(4) In order to reduce bleeding, slump shall not be higher than necessary to achieve proper placement and consolidation. Concrete shall be placed before initial set has occurred, initial set time being determined in the laboratory.

(5) No concrete shall be placed when the atmospheric conditions are, in the opinion of the Engineer-in-charge, such that proper placing and hardening of the concrete are not guaranteed. Specifically, the contractor shall have the responsibility for meeting the hot and cold weather concreting requirements and for postponing concreting whenever such requirements cannot be met or, based on weather forecast, probably cannot be met. Even if the above requirements are fulfilled, the contractor has the responsibility of delivering concrete product that meets specified requirement.

8.12.2 Preparation for concrete placing.

(1) Concrete shall not be placed until all formwork, installation or embedded parts, reinforcing steel, and surfaces against which concrete is to be cast have been accepted by the Engineer-in-charge.

(2) All surfaces of form and embedded items that have become encrusted with dried material from concrete previously placed shall be cleaned of all such material before the surrounding adjacent concrete is placed.

(3) Concrete shall not be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or diverted by pipes, or by other means, and carried out of the forms clear of the work. Water shall not be allowed to stand on any concrete surface until it has attained its final set. Water flow over the concrete, which may injure the surface finish will not be allowed.

(4) Pipes, conduits, dowels and other items to be embedded in concrete shall be so positioned and supported prior to placement of concrete to be stable and provide sufficient clearance (50mm min.) between said items and steel reinforcement to allow proper concreting. Securing such items in position by wiring or welding to reinforcement will not be permitted.

(5) Where excavated surfaces which are to form the foundations for structural concrete, are absorptive or likely to become otherwise unsuitable, or where shown on the Construction Drawings, the contractor shall place a 'blinding course' consisting of a layer of Class M10 or M15 concrete 50 to 100 mm. Thick, as directed by Engineer-in-charge, uniformly over the foundation such that the upper surface is at grade elevation. Blinding concrete shall be placed before installing reinforcement or formwork.

(6) Immediately before concreting, the forms and all other surfaces which will be in contact with the fresh concrete shall be cleaned of all loose material and debris including shavings, wood chips, sawdust, pieces of wire, nails, fragments of hardened concrete and mortar. Clean-out holes which may be needed for this purpose shall subsequently be securely closed in order to obtain the required surface finish.

(7) The use of compressed air for cleaning will be allowed only if adequate precautions are taken to avoid the deposition of suspended oil or construction joint surfaces, reinforcement or other items which are to be bonded to concrete.

(8) The contractor shall provide such personnel and equipment so that the performance of the concrete work is in a satisfactory manner. The transporting and placing equipment shall be clean and in good condition, adequate, and properly arranged to proceed with

the placing without undue delays. The number and condition of vibrators for use and standby shall be ample for the requirements during placement. The lighting system shall be sufficient to illuminate the inside of the forms when concrete is placed at night.

(9) The contractor shall have protective coverings available for fresh concrete surfaces if there is a possibility of rain or hail.

(10) Rock surfaces against which concrete is to be placed shall be clean and free from oil, standing or running water, mud, loose rock, objectionable coating, debris, and loose or unsound fragment. Faults, fissures and seams shall be cleaned to sound rock, and if directed, backfilled with dental concrete, shotcrete or dry-pack as appropriate.

(11) Immediately before concrete is placed, all surfaces shall be cleaned thoroughly by the use of high velocity air-water jets, sweeping with brooms, wet stand blasting, bush-hammering, or other satisfactory means including combinations of the above.

(12) Rock surface against which concrete is to be placed shall be kept wet for at least 12 hours during the 24 hour period prior to placing concrete and shall be in a damp condition at the time of placing, with all pools of water removed.

(13) Foundation of porous or free draining material shall be thoroughly compacted by flushing and subsequent tamping or rolling, if necessary. The finished foundation surface shall then be blanketed with a layer of tar paper or closely woven burlap carefully lapped and fastened down along the seems so as to prevent the loss of mortar from concrete.

(14) Before any concrete is cast against previously placed concrete the surface of the old concrete shall be prepared as described in sub-section “Construction Joints”.

(15) If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again

8.12.3 Placing and Compaction.

(1) Concrete shall be carefully placed in designated position. Where dense reinforcement or deep forms may cause segregation of concrete while placing, suitable methods shall be used to prevent segregation. The free fall of concrete shall not exceed 1.5m.

(2) Concrete shall be placed directly in its permanent position and shall not be worked along the forms to that position. Vibrations shall not be used to move concrete laterally.

(3) The addition of water into concrete after batching to compensate for stiffening of the concrete before placing shall not be permitted.

(4) All concrete, with exception of concrete tunnel lining, shall be placed in continuous approximately horizontal layers. The size of the concrete lift shall be as shown on the construction drawings. The lift height shall generally not exceed 1.5m. The thickness of the layers shal not exceed 500mm for mass concrete, and for structural and all other concrete. Each layer shall be soft when a new layer is placed upon it so that no seams or planes of weakness within the section can form, and the two layers shall be made monolithic by penetration of vibrators.

(5) The Engineer-in-charge reserves the right to order a reduced thickness of layers where the layers as stated above cannot be placed in accordance with the requirements of these specification.

(6) Time interval between successive lifts of mass concrete shall be determined by the Engineer-in-charge. Nevertheless a minimum of 72 hours shall elapse between successive lifts.

(7) No concrete shall be placed under water except where shown on the Construction Drawings or specifically so required by the Engineer-in-charge. No concrete shall be placed in running water. Water shall not be allowed to rise over freshly poured concrete until final set has been achieved.

(8) Each layer of concrete shall be consolidated to the maximum practicable density, be free from pockets of coarse aggregate, completely fill all recesses in forms and around embedded parts, and be free of all voids. The concrete shall be compacted and worked into all corners and angles of the forms, around reinforcement and embedded items without permitting the component concrete materials to segregate.

(9) No layer of concrete shall be placed until the previous layer in the same lift has been thoroughly consolidated. Each layer of concrete within a lift shall be covered with fresh concrete as soon as possible, but certainly within the period when the lower layer is still capable of being revibrated so that successive layers can be thoroughly worked together.

(10) The maximum permissible time between the placing successive layers in a pour shall not exceed initial setting time of cement or 45 minutes, whichever is less, and shall be reduced to suit the temperature, humidity and job conditions. Concrete shall not be piled up in the forms in a manner that causes movement of the unconsolidated concrete, or permits mortar to escape from the coarse aggregate.

(11) Treatment of Cold Joint

In placing the concrete, delay may occur resulting in cold joints within a lift. When placement is resumed while concrete is still green and not fully hardened (and therefore capable of ready bonding) ,all laitance shall be removed by scrubbing the wet surface with wire or bristle brushed off with a hand pick, care being taken to avoid dislodgement of any particle of coarse aggregate. The surfaces shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layer of the concrete to be placed on this surface shall not exceed 160mm in thickness and shall be well rammed against old work, particular attention being given to corners.

(12) Concrete shall be consolidated with the aid of approved immersion type mechanical vibrators complying with IS:2505 or electric or air driven vibrators operating at speed of at least 7,000 cycles/minute when immersed in the concrete. The vibrating equipment shall at all times be adequate in number of units and power to penetrate concrete when it is being placed, to the satisfaction of the Engineer-in-charge. Vibrators with flexible operating shafts shall be used for reinforced concrete and for concrete in restricted forms. At least one extra vibrator in working condition shall be constantly on hard at each point of placement for emergency use.

(13) Application of the vibrators shall be made systematically and at such intervals that the zones of influence overlap and the concrete is properly compacted.

(14) Every vibrator shall be operated in a near vertical position and the vibrating head shall be allowed to penetrate under the action of its own weight. In consolidating each layer of concrete, the vibrating head shall be allowed to penetrate and vibrate the concrete in

the upper portion of the underlying layers. Extreme care shall be taken to ensure that the vibrators do not touch or disturb the reinforcing, embedded steel or forms.

(15) To ensure even and dense surfaces which are free from aggregate pockets, honeycombing or air holes, it may be necessary to supplement internal vibration with hand-spading along the boundaries of the concrete and around embedded part while the concrete is plastic under the vibratory action. Should slip forms be used, the equipment and methods shall be such that the finished concrete will be well consolidated and homogeneous.

(16) Form vibrators shall not be used unless the forms are designed for form vibration and unless specifically authorized by the Engineer-in-charge.

8.12.4. Pumping Concrete.

(1) Positive displacement pumping or other approved methods may be used to place concrete in locations approved by the Engineer-in-charge. The type and arrangement of equipment shall be subject to approval and the equipment shall be operated only by experienced persons. Pneumatic placing will not be allowed.

(2) The equipment and its method of operation shall allow the concrete to enter the forms at a lower velocity.

(3) Concrete pumps and auxiliary equipment shall be in good condition and shall be maintained as such throughout the duration of the work. Thorough washing down of all parts that come in contact with concrete shall be performed after each concreting operation.

(4) Pump lines shall consist of rigid steel pipe or flexible pipe made of rubber, spiral-wound flexible metal or plastic, or combination of both. Use of aluminum pipe for pump lines shall not be permitted. Couplings shall be leak proof and strong enough to withstand handling during erection and poor support along the lines. They shall provide a full internal cross section with no constrictions of the smooth flow of concrete.

(5) Immediately prior to the start of all concrete pumping, the pump and pump lines shall be primed by pumping an approved grout mixture through the equipment.

(6) Concrete pumping operations shall be planned in such a way that concrete does not set before the succeeding layer is placed thereon. An adequate supply of fresh concrete shall be provided at all times.

8.12.5 Concrete in Blockouts, Second Stage in Restricted Locations, etc.

(1) All concrete required to be placed in block outs to permit the installation and adjustment of mechanical and other equipment, around formed holes and second stage concrete in other locations shall be included in respective concrete as described in these specification.

(2) The concrete surfaces of block outs and first stage concrete at other locations shall be chipped and roughened as described herein before second stage concrete is placed at such locations.

(3) Exceptional care shall be taken to place concrete in block outs in order to ensure satisfactory bond with concrete previously placed and to secure complete contact with all metal works in the block outs.

(4) The roughening of the first stage concrete surfaces shall be attained by chipping or sand blasting as approved by the Engineer-in-charge and in such a manner as not to loosen, crack or shatter any part of concrete beyond the roughened surfaces.

(5) After being roughened, the surfaces of concrete shall be cleaned thoroughly of loose fragments, dirt and the objectionable substances and shall be sound and hard to ensure good mechanical bond between the existing and new concrete.

(6) Second stage concrete shall be placed in lifts of not more than 3.0m and concrete placement rate shall not exceed 1.5m per hour except as otherwise approved by the Engineer-in-charge.

8.13 FINISHING OF CONCRETE

8.13.1 General

(1) The quality of the surface finish shall be in accordance with the requirements for the particular class of finish specified hereunder. The finished surfaces of concrete shall be free from areas of honeycombs, segregation, loss of cement or fine material, from damage due to stripping of forms, from bolt holes, abrupt irregularities caused by movement of forms or components, loose knots and similar features and bulges or depressions in the general plane of the surface.

(2) Only one type of formwork shall be used for all parts of a concrete structure which is visible from any direction.

(3) The classes of finish shall be as shown on the construction drawings or as directed by Engineer-in-charge.

8.13.2 Bush Hammer Finish

Bush hammer finish shall be applied on the surfaces when required by the Engineer-in-charge, But hammering shall not commence until at least one month after placement of concrete. The tool used for bush hammering shall be electrically driven and have a head 3 cm^2 with 16pyramid shaped teeth. The surfaces shall be finished at a rate of 250 to 400 cm2/ minute indenting the concrete surface approximately 2 mm.

8.14 CONSTRUCTION JOINTS IN CONCRETE STRUCTURES

(1) Construction joints are defined as concrete surfaces on or against which concrete is to be placed and to which new concrete is to adhere and which have become so rigid that the new concrete cannot be incorporated integrally with that previously placed.

(2) Construction joints shall be located in the position shown on the construction drawings or as required by the Engineer-in-charge and the contractor shall not be permitted to form any additional joints or deviate from the joints indicated on the Drawings, without the written authorization of the Engineer-in-charge. Necessary re-arrangement of steel reinforcement arising from such modifications shall be to the contractor's debit.

(3) Horizontal construction joints shall be arranged, wherever possible, to coincide with joints in the formwork.

(4) Joints at exposed surfaces of concrete shall be straight and continuous. Feather-edged construction joints will not be permitted.

(5) The faces of vertical joints shall be shuttered with expanded metal or other approved rough materials. The expanded metal shall be removed as far as possible before the adjacent lift is poured. If required, the surface shall be cleaned by wet sandblasting and roughened by light bush-hammering.

(6) The surface of construction joints upon or against which new concrete is to be placed and to which new concrete is to adhere shall be clean, rough and free of water when covered with fresh concrete. The laitance, loose or defective concrete and foreign material shall be removed from the surface of existing concrete. The previous concrete lift shall be saturated by water but surface dry when the successive lift is placed.

(7) The surface of the hardened concrete shall be cleaned and roughened by wet-sandblasting and washing thoroughly with air-water jet. Care shall be taken to prevent undercutting of aggregate in the concrete during sandblasting.

(8) Wet-sandblasting equipment shall be operated at an air pressure or approximately 7 bars. Sand to be used for blasting shall be dense, hard, not easily broken and sufficiently dry.

(9) In lieu of wet-sandblasting the contractor may propose high-pressure water blasting utilizing pressures not less than 400 bars, provided that such high-pressure water blasting produce equivalent results to those obtainable by wet-sandblasting.

(10) The horizontal surfaces of construction joints may be treated by cutting with an air-water jets ("green-cutting"). This shall be performed after the initial set has taken place but before the concrete has become too hard for effective cutting. This is generally done within 8 to 16 hrs of laying the concrete. The fresh concrete surface shall be cut with air-water jets to remove all laitance and to expose clean, sound aggregate. For effective green cutting, the air pressure should not be allowed to fall below 6.33 kg/cm². After cutting, the surface shall be washed with clean water. Care shall be taken that the treated surface does not become contaminated before new concrete is placed upon it. Should the surface become contaminated that a satisfactory joint with new concrete is not ensured the contractor shall clean it by means of wet sandblasting.

(11) Water used in cutting, washing and rinsing of concrete surfaces shall be disposed of in such a way that it does not stain, discolour or affect exposed surfaces of the structures.

(12) When necessary, as determined by the Engineer-in-charge structural concrete placement in forms shall be started with an over sanded mix with 20 mm maximum size aggregate, an extra 50Kg of cement per cubic meter and a 100 mm slump. This mix will be referred to as a starter mix and shall be placed approximately 50mm deep.

(13) Disturbance of the surface at a joint during the early stages of hardening shall be avoided , and traffic on the concrete will not be permitted until the concrete has hardened sufficiently to withstand such treatment without injury.

(14) All construction joints shall be kept continuously moist until they are covered with concrete, provided that, if it becomes necessary to delay the placement of new concrete on or against a construction joint for an extended period, moist curing of the surface of the joint may be discontinued at the expiration of the regular prescribed curing period.

If the moist curing is so discontinued, it shall be resumed not later than 24 hours prior to the placement of new concrete against the joints.

8.15 CURING AND PROTECTION OF CONCRETE.

(1) Plant for curing and protection of concrete shall be available at the location of each concrete placement before concrete placement is started. The water used for curing shall meet the requirements for water used for mixing concrete. The curing water temperature shall not exceed 25°C.

(2) Exposed surface of concrete, which has been finished as specified, shall be protected from the direct rays of the sun for at least 3 days after placing. Freshly placed concrete shall be protected from damage by rainfall.

(3) Exposed surfaces shall be kept moist or the moisture in the concrete shall be prevented from evaporating for at least 14 days after placing by means of continuous sprinkling or spraying with water, or by covering with saturated materials like burlop/hessian cloth etc or a system of perforated pipes, mechanical sprinklers or hose or by any other methods approved by the Engineer-in-charge.

(4) Care shall be taken not to disturb the steel reinforcement projecting from any placement for at least 24 hours after the completion of such placement.

(5) The contractor shall not move any load on concrete surfaces which in the opinion of the Engineer-in-charge have not attained sufficient strength. In case loads are required to be moved, the Engineer-in-charge may permit contractor to do so on condition that contractor provides the means for protecting the concrete surface subject to approval of the Engineer-in-charge.

(6) The Engineer-in-charge may permit the use of curing by means of membrane forming compounds. Sealing compounds proposed by the contractor will be subject to sampling and testing and will have to be approved of the Engineer-in-charge.

(7) Curing compounds shall be applied according to the manufacture's recommendations to provide a continuous uniform membrane over all area. Curing compounds shall be applied only after moist curing has been carried out for at least 24 hours. Curing membranes shall be protected from damage at all times.

(8) Curing compound shall not be used on any uniformed surface where, in the opinion of the Engineer-in-charge, the irregularities in that surface would prevent the membrane forming an effective seal, on any surface which has a temperature lower than manufacturer's recommended application temperature, on any surface where a bond is required for additional concrete or where a bonded surface coating is to be applied. Where a curing compound is placed on a surface where a bond is required, it shall be removed by sand blasting or by other means satisfactory to the Engineer-in-charge.

(9) Curing compounds used for surfaces exposed to view shall degrade completely when exposed to air for more than 3 months. They are to remain at least 80% impermeable for 1 month after application.

(10) In case any curing operations are inadequate or unsatisfactory, the Engineer-in-Charge shall be entitled to take such steps as he may feel necessary to make good the deficiencies and defects, at the contractor's risk and cost.

(11) Curing and protection should confirm to latest amendment of IS 457.

8.16 REPAIR OF CONCRETE

8.16.5 General

(1) Repair of damaged or defective concrete shall be performed by skilled workmen only, and in the presence of the Engineer-in-charge. No repair work shall be carried out until the Engineer-in-charge has inspected the location of the proposed repair and accepted the method of repair proposed by the contractor.

(2) Contractor shall correct all imperfections on the concrete surface within 24 hours of removal of forms. The proven methods of repair of concrete are outlined in the USBR Concrete manual, which include Dry-pack Mortar, Replacement Concrete, Replacement Mortar, Replaced Aggregate Concrete, Epoxy Concrete etc.

(3) Where concrete is exposed to flowing water or to weather, porous and fractured concrete and surface concrete to which additions are required to bring it to prescribed lines shall be removed by chipping into the concrete a minimum of 75mm below the reinforcement or to the depth required by the Engineer-in-charge if sound concrete is not encountered at 75mm. Repair areas shall be formed and area filled with fresh concrete. If the concrete section to be repaired contains no reinforcement, concrete shall be chipped to a minimum depth of 100m.

(4) The chipped openings shall be sharp edged and keyed and shall be filled to the require lines with fresh concrete or patching mortar, as approved by the Engineer-in-charge. Where concrete is used for filling, the chipped openings shall not be less than 75 mm in depth and the fresh concrete shall be reinforced and doweled to the surface of the openings, as directed by the Engineer-in-charge.

(5) Dry pack mortar for patching shall consist of 1 part cementing material, 2 parts by volume of regular sand, and just enough water so that after thorough mixing of the ingredients the mortar will be held together when compacted by squeezing with the hand. The mortar shall be fresh when placed, and any mortar that is not used within 1 hour after preparation shall be washed. Just prior to mortar application, the surface to which the mortar is to bond shall be kept wet for at least 2 hours, then scrubbed with a small quantity of cement grout using a wire brush.

(6) When repairs are more than 25mm deep, the mortar shall be applied in layers not more than 20 mm thick to avoid sagging. After each layer, except the last is placed, it shall be thoroughly roughened by scratching with a trowel to provide an effective bond with the succeeding layers. The last or finishing layer shall be smoothened with a trowel to form a continuous surface with the surrounding concrete. All patches on exposed surface shall be neat and smooth and as nearly as possible of the same colour as the adjoining concrete. All patches shall be thoroughly bonded to the surfaces of the chipped openings, shall be cured to the satisfaction of the Engineer-in-charge and shall be sound and free from shrinkage cracks and drummy areas.

(7) For concrete surface where high velocity flows may occur and as required by the Engineer-in-charge, repairs to surfaces having F3 and U3 finishes shall be bonded with an epoxy adhesive approved by the Engineer-in-charge and used in accordance with the manufacturer's instructions.

(8) All repairs to the surface of concrete required for flowing water shall be ground smooth to meet the tolerances specified for that surface.

8.16.5 Sealing works in Concrete Lining of Underground Structures.(Not Applicable)

(1) The contractor shall carry out sealing work to reduce water inflow and water losses through, and to guarantee the normal water tightness of the concrete lining of underground structures according to criteria stated hereafter and as directed by the Engineer-in-charge.

(2) The work shall consist of sealing the cold joints, construction joints, shrinkage cracks both vertical and horizontal, honeycombs, and poorly grouted or sealed grout holes. The work shall be performed intermittently, whenever water inflows are observed and measured wide cracks are discovered (especially after performance of tunnel pressure testing), or the future impermeability is, in the judgment of the Engineer-in-charge, doubtful.

(3) The sealing work shall be carried out when following phenomena are encountered.

a) Water inflow equals or exceed 1 liters/min measured at each single inflow source.

b) Any water inflow from grout holes and through honeycombs is unacceptable.

c) Cracks or joints, regardless whether they are dry or wet, of width greater than;

- 0.2mm in tunnels and shafts containing reinforcing steel

- 0.5mm in unreinforced stretches of tunnels or shafts

d) Areas of porous concrete (e.g. due to poor vibration) where depth of porosity is obviously deeper than superficial.

(4) The sealing work shall be executed as follows:

a) Crack or joint 0.2-0.6 mm wide shall be repaired as stipulated in the Section "Drilling and Grouting"

b) Crack or joint wider than 0.6mm shall be repaired as under (1) above, followed by cutting a groove 25x25mm along the joint or crack and subsequent filling with an epoxy mortar.

c) Wet joint may also be sealed by applying the "Oberhasli Method", which consist of cutting a groove as for the dry joint and by collecting the seepage water into one or several flexible plastic pipes. As soon as the groove is without running water shall be filled with a quick-setting mortar and, after its hardening, followed by pumping the cement bentonite-water slurry through the plastic pipe.

d) Areas of porous concrete shall be grouted under high pressure (30 bar) with cement grout mix W/C=0.7 by weight, containing suitable water-reducing air-entraining admixture. Grout holes shall be drilled at 500 mm spacing until the rock. After grouting, the area shall be repaired with epoxy mortar.

e) Grout holes filled only with water/cement mix shall be redrilled up to 2/3 of the theoretical lining thickness and filled with dry-pack mortar.

8.17 PARTICULAR REQUIREMENTS FOR INDIVIDUAL CONCRETE STRUCTURE

8.17.1 Concrete in the Spillway glacis:(Not Applicable)

(1) Where the over break in excavation below the theoretical lines and grades exceeds acceptable limits as determined by the Engineer-in-charge, the contractor shall place blinding unreinforced concrete over the rock foundation in such thickness that the upper surface is at the theoretical grade elevation. Surface shall be roughened before placing the structural spillway concrete.

(2) No construction joints shall be allowed in the spillway conveyance structure, unless otherwise approved or directed by the Engineer-in-charge. In case such joint is permitted, additional steel reinforcement shall be placed across the joint and the joint surface shall be shuttered with expanded metal.

(3) Construction joints shall be executed at the distances shown in the drawings. The surface of the joints shall be painted with bituminous coat or other approved bond breaker.

(4) All movement joints exposed to flowing water shall be chamfered 1:1 on upstream side and 1:8 on downstream side as the case may be.

(5) The top layer of the spillway glacis concrete shall be terminated approximately 300-500 mm below the final surface to provide room for placing the special concrete to increase the abrasion resistance of the structure. Similarly in the walls, which will come into contact with rapidly flowing water recesses will be blocked out to a depth of 300-500 mm and height of approximately 2m.

(6) This high performance concrete shall be obtained by adding silica fume and/or steel fibres in the concrete. Depending on the mix, design quantity of silica fume will be approximately 40 Kg. Per cubic meter and/or steel fibres of 60 kg. Per cubic meter. Mix proportions to be used will be determined by trial mix design. Test samples shall be made in accordance with IS:1199, tested as per IS:516 and analyzed as per IS;456. Source of aggregate for high performance concrete shall meet the requirement of wearing surface and shall be as identified by Engineer-in-charge.

(7) Silica fume shall comply with SABS CAN/CSA-A23.5-M86 or equivalent international standards. In addition, it shall meet the following requirements.

Particle size	Average not more than 0.2 micro, max. 0.4 micron
SiO content	Not less than 85%
Carbon content	Not greater than 5%
Total alkali content	Na_zO + 0.658 K2) not greater than 1.5% and when combined with OPC not greater than 0.6%.

In addition to the standard requirements for individual materials, the blended cement and silica fume for high strength concrete shall comply with the following requirements (IS:4031(3), (50, (6) and (10) 1988 and IS:4032-1988).

Min. compressive strength at 28 days 60Mpa

Min. initial setting time 90 minutes

Masx. Mortar shrinkage at 28 days	0.07%
Max. sulphate content (SO_4)	5%
Max autoclave expansion	0.5%
Max.CaO content	45%

The contractor shall present the results of quality control tests carried on a representative sample by the supplier. Once approved, the silica fume shall only be supplied from the same production plant. Deliveries shall in impervious sacks weighing about 40 kg. And shall be accompanied by manufacturers quality assurance certificate.

(8) Steel fibres shall be Dramix ZC 60/0.80 or equivalent, hook bends bundled fibres with normal dissolving. The fibre shall be clean and free from rust oil and deleterious materials. The method of storage shall be such as to prevent oxidation. Rusted fibres shall be refused.

(9) The concrete surface finishes in the gate structures and chute shall be F3, F3C, U3 and U3C. For surfaces in contact with high velocity water flow the permissible surface irregularities shall not exceed the following values.

Abrupt Gradual Measured along a line parallel to flow direction -- 5mm to10mm

Measured along a line traverse to flow direction -- 3mm to 6mm

(10) Abrupt irregularities are offset caused by displaced or misplaced form sheathing or lining or form sections, or by loose knots in forms or otherwise defective form lumber. They shall be tested by direct measurements.

(11) Gradual irregularities are all other irregularities and shall be tested by a2m long template. The templates will be a straight edge for plane surfaces or a "shaped" template for curved or warped surfaces.

(12) Furthermore the following shall apply if not otherwise shown on the construction drawings or directed by the Engineer-in-charge.

a) Abrupt irregularities parallel to the flow direction shall be eliminated completely by grinding to bevel of 1 to 20 ratio of height to length.

b) Abrupt irregularities traverse to the flow direction shall be eliminated completely by grinding to bevel of 1 to 50 ratio of height to length.

(1) **Concrete in the Plunge Pool**

(2) Concrete used for construction of the Plunge pool and the nallah channel at the diversion tunnel outlet shall be class M20 A40.

(3) Where the overbreak in excavation below the theoretical lines and grades exceeds acceptable limits, as determined by the Engineer-in-charge, the contractor shall place blinding unreinforced concrete over the rock foundation in such thickness that the upper surface is at the theoretical grade elevation. Surface shall be roughened before placing the structural concrete.

(4) Contraction joints shall be executed at the distances shown on the drawings. The surface of the joints shall be painted with bituminous coat or other approved bond breaker.

(5) The top layer of the Plunge pool concrete shall be terminated approximately 300-500 mm below the final surface to provide room for placing the special concrete to increase the abrasion resistance of the structure. Similarly, in the walls which will come into contact with rapidly flowing water, recesses will be blocked out to a depth of 300-500 mm and height of approximately 2m.

8.17.2 Concrete in Gravity Structures.

(1) Concrete used for the construction of mass concrete gravity structures shall be class M15/A80-150 unless otherwise approved or directed by the Engineer-in-charge. However concrete surface exposed to weathering and standing or flowing water shall be constructed of class M20/A80 concrete or as indicated on the construction drawings. Where higher strength concrete is used, part of each lift will therefore normally be composed of two classes of concrete. Water cement ratio shall not exceed 0.45.

(2) Reinforcement shall be provided at the surfaces in contact with standing or flowing water and at all openings in mass concrete.

(3) Mass concrete of dam, and spillway shall be water cured for at least 10days unless otherwise directed by the Engineer-in-charge. When curing compound is used as a bond breaking membrane at contraction joints, it shall be also be considered acceptable in meeting the curing requirements.

(4) Where the overbreak in excavation below the theoretical lines and grades exceeds acceptable limits, as determined by the Engineer-in-charge, the contractor shall place blinding unreinforced concrete class M15/A40 over the rock foundation in such thickness that the upper surface is at the theoretical grade elevation. Surface shall be roughened before placing the structural concrete.

8.17.3 Parts Embedded in Concrete.

(1) Anchors, anchor bolts, structural shapes, plates shapes, plates for gates, hoists, valves, machinery etc. and other miscellaneous parts shall be installed in the concrete by the contractor, as shown on the construction drawings or as required by the Engineer-in-charge. Wherever practicable, anchors shall be installed before the concrete is placed. Except as otherwise specified, drilling and installation of anchors in the concrete after concrete is placed will not be permitted. Before being placed in position, all anchors and embedded parts shall be thoroughly cleaned of rust, grease, paint, splashed concrete, or other anchors is not practicable before the concrete is placed, formed openings shall be provided, and the anchors grouted into the openings at a later time in a manner acceptable to the Engineer-in-charge.

(2) Embedded anchors shall be supported during embedding and embedded so that the tolerances specified will not be exceeded. Care shall be taken not to disturb or displace embedded items during concrete placement.

(3) Concrete may be placed to embed items erected by other agencies in the locations and to the dimensions shown on the construction drawings or as required by the Engineer-in-charge. The methods of placement and rates of placing concrete shall be subject to

the approval of the Engineer-in-charge. Care shall be exercised that such parts shall not be damaged or disturbed by placing operations.

Unless otherwise specified the contractor shall provide any foundation, wall or roof openings and coverings, concrete floor filling sleeves in foundations, inclusive of metal works supplied by other contractors. All adjustments to foundation levels, embedding, bedding and grouting works on foundations, and cementing works into walls and floors, shall be done by the contractor including all leveling and adjustment of works in foundations and Grouting.

8.17.4 Concrete in Blockouts for Equipment Embedding.

(1) The contractor shall form blockouts, place reinforcement and concrete as shown on the construction drawings or as directed by the Engineer-in-charge, and in such manner as to ensure good bond with the existing concrete, to secure complete contact with the metalwork to be embedded in the blockout concrete and to avoid displacement of the metal work.

(2) Blockout concrete shall include the concrete around second stage gate parts, anchor bolts and anchor plates etc.

(3) Before placing concrete, all parts to be embedded shall be checked to ensure that they are firmly fixed in their required position. The surfaces of blockouts or holes shall be thoroughly cleaned and wetted. Oil and grease shall be removed by brushing and chipping of affected surfaces to a sufficient depth, or by application of approved chemicals and flushed with clear water.

(4) The parts to be embedded shall be cleaned of rust, mill scale paint, oil or grease before they are set into place. Where bond between metal parts and concrete or grout is not desired, approved material such as flake graphite or paraffin shall be applied to the metal parts. The metal surfaces shall be wetted before placing the concrete or grout.

(5) Concrete containing an approved non-shrink agent shall be used for concrete in blockouts for equipment embedding as shown on the construction drawing.

8.17.5 Grouting of the Equipment Bearing Plates and Anchors

(1) Limited spaces and small blockouts where equipment bearing plates anchors, rails, etc. are placed shall be grouted under pressure.

(2) The grouting shall be performed using non-shink cement-based grout or non-shrink epoxy grout as proposed by the contractor and approved by the Engineer-in-charge. All mixing and grouting shall be performed in accordance with the manufacturer's recommendations and shall be tested prior to grouting. Technical service by manufacturer shall be organized by the contractor upon request by the Engineer-in-charge.

(3) Before placing grout, the surfaces of the base concrete to which the grout will be bonded shall be roughened and cleaned of all laitance, loose or defective concrete, any coatings or other foreign material, followed by thorough washing with water.

(4) Forms for grouting shall be installed where necessary and care shall be taken that the grouts fill all spaces under the plates leaving no voids. The exposed surfaces of the

grout shall be cured as recommended by the manufacturer and no loads shall be applied until the grout has reached the design strength.

8.17.6 Porous Concrete

(1) Porous concrete shall be placed where free drainage is required and shall be produced by gap grading or single size aggregate grading.

(2) The strength requirements for porous concrete shall be as for class M10/A40 concrete. The porosity shall be such that water will pass through a slab 30 mm thick at a minimum rate of 500 l/mi/m^2 with a constant depth of water on the slab of 100 mm.

(3) Porous concrete shall not be vibrated but only placed and lightly rammed. Formed surfaces shall be Class F1 finish. Exposed surfaces of the porous concrete shall be sealed in an approved manner, such as the use of polyethylene or rendering with sand and cement, before structural concrete is placed against it.

8.17.7 Tests

(1) All cost associated with testing as described in this section shall be borne by the contractor. These shall include, but not be limited to the following.

a) The costs for all tests to be carried out prior to the start of concrete work, whether carried out at site or elsewhere.

b) Routine tests for quality control during the execution of the concrete work carried out by the contractor as specified herein and as directed.

c) Other tests required during execution of the work to be carried out by an approved test laboratory(ies).

d) Preparation , storage, handling, curing and delivery of samples to a laboratory designated by the Engineer-in-charge, if so required for additional independent testing.

(2) Should the contractor fail to adhere to his testing program, all test deemed necessary by the Engineer-in-charge to check concrete work will be performed by the Engineer-in-charge or a laboratory assigned by him, at Contractor's expense.

8.18 FORM WORK

8.18.1 Procedure for Form, Centering and temporary works.

8.18.2 All centering, for work and temporary works shall be constructed according to the approved drawing and specification.

As soon as practicable, after the acceptance of tender, the contractor shall submit a work showing the procedure and method by which he proposes to carry out the work, together with such details as are necessary to demonstrate the adequacy, stability and safety of the methods.

8.18.3 The approval to the general work of centering as well as design criteria and loading shall be obtained in good time to facilitate all preparatory works. Any delay on this account shall be the responsibility of the contractor.

8.18.4 After approval of the general work, the contractor shall prepare detailed design and drawings for execution of the form work, centering and temporary works. These shall be forwarded to the Engineer-in-Charge for approval. No work shall be carried out without prior approval of the Engineer-in-Charge.

8.18.5 Not withstanding the approval given to the design criteria and loading and the general work for the centering, the entire responsibility for the satisfactory execution of centering and all temporary works for withstanding concreting and removal of form work after stipulated interval, shall rest with the contractor and he shall be liable to pay all claims and compensation arising from any loss or damage to life and property due to any deficiency, failure or malfunctioning of the centering or the temporary works.

8.18.6 The contractor is responsible to set the forms to line and grade, achieve tightness of forms and braced sufficiently to stay in alignment and strong enough to hold the concrete. There should be no loss of mortar causing any honey-combing. Stability is a very important consideration in form work. Contractor shall ensure that the forms do not suffer from inadequate cross-bracing and inadequate horizontal bracing. Immediately before concrete is placed, the forms should be properly treated with suitable form of oil or other suitable coating material to prevent sticking to the concrete. Joints between the form work and existing concrete structures shall also be grout tight. Form work shall be arranged to facilitate removal of the various parts in correct sequence, without jarring or damaging the concrete. Fixing blocks, bolts or similar devices may be embedded in the concrete, provided they do not reduce the strength or effective cover of any part of the structure below the required standard but the use of through bolts shall be avoided as far as possible. Temporary opening shall be provided at all points necessary in the forms to facilitate clearing and inspection immediately before placing of the concrete.

8.18.7 Forms shall overlap the hardened concrete in the lift previously placed by not more than 75mm and shall be tightened smoothly against the hardened concrete in the lift previously placed by not more than 75mm and shall be tightened smoothly against the hardened concrete. Particular attention shall be paid in setting and tightening the forms for construction joints so as to get a smooth joint free from sharp deviations or projection . No jute bags or other such materials be allowed to be used to make the joints of shuttering plates leak proof.

8.18.8 If a type of form does not consistently perform in an acceptable manner, as determined by the Engineer-in-charge, the type or form shall be changed and method of erection shall be modified by the contractor at his cost.

8.18.9 Re-use of Forms etc.

8.18.10 ` Forms required to be used more than once shall be maintained in serviceable condition and shall be thoroughly cleaned and repaired before reuse. When metal sheets are used, the sheets shall be placed and maintained in the forms without lumps or other imperfections. All forms shall be checked for shape and strength before reuse.

8.19 Cleaning of Forms.

8.19.1 ` All rubbish, shall be removed from the interior of the forms. The formwork in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved composition. Care shall be taken that such approved composition is kept out of contact with

the reinforcement. Before concrete is placed, the surfaces of forms designed to produce F1 and F2 finish shall be oiled with commercial form of oil that will effectively prevent sticking and will not stain the concrete surface. Form timber forms, oil shall consist of pure refined, pale, paraffin mineral oil or approved form oil. For steel forms, form oil shall be mineral oil suitably compounded with one or more ingredients which are appropriate for the purpose. Care shal be taken to keep form oil out of contact with reinforcement.

8.19.2 Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms and request him to inspect and accept the form work as to their strength, alignment and general fitness, but such inspection shall not relieve the contractor of his entire responsibility of form work to withstand concreting and for safety of men, machinery and materials.

8.20 Removal of Forms.

8.20.1 The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any form. Forms shall be removed as soon as the concrete has hardened sufficiently. Thus facilitating satisfactory curing and earliest practicable repair of surface imperfections.

8.20.2 Form on sloping surfaces of concrete, such as forms on the water sides, shall be removed as soon as the concrete attains sufficient strength to prevent sagging. Any repair or treatment required on such sloping surface shall be performed at once and followed immediately by the specified curing.

8.20.3 Forms shall be removed with care so as to avoid damage to the concrete. Damaged concrete, if any, during form removal shall be repaired in accordance with the specification for repair of concrete.

8.20.4 The following minimum time intervals of form stripping as per specifications in IS-456-1978 will generally be followed while using ordinary Portland cement.

- Walls, columns and vertical faces — 24 to 48 hours or as may be decided by the Engineer-in-Charge.
- Slabs (Prop left under) — 3 days.
- Beam soffits (Prop left under) — 7 days.
- Removal of props under slabs spanning up to 4.5m — 7 days.
- Slabs spanning over 4.5m — 14 days
- Removal of props under beam and arches.
- 8.20.10Spanning upto 6m — 14 days
- 8.20.11Spanning over 6 m — 21 days.

Note:- For other types of cement, the stripping time recommended for Ordinary Portland cement may be suitably modified.

8.20.5 The number of propos left under their sizes and disposition shall be such as to be able to safely carry full dead load of slab, beams or arch as the case may be together with any live load likely to occur during the curing or further construction.

8.21 Finish of Formed Surface.

8.21.1 The classes of finish and requirements for finishing of concrete surface shall be as shown in the drawing or as hereinafter specified. In the event of finishing not being specified in the drawings, The finishes to be followed shall be as directed by the Engineer-in-charge. Finishing on concrete surface shall be performed only by skilled workmen.

8.21.2 Completed concrete surfaces will be tested wherever necessary to determine whether surface irregularities are within the limits herein specified.

8.21.3 Surface irregularities are classified as 'abrupt' or 'gradual'. Offsets caused by displaced form sheathing, or lining or form sections or by loose knots or otherwise defective will be considered as abrupt, other irregularities shall be considered as gradual irregularities and will be tested by use of template, consisting of a straight edge or the equivalent there of for curved surfaces. The length of the template shall be 150cm for testing of formed surfaces and 300cm for testing unformed surfaces.

8.21.4 Table for finish of form work.

• F1 finish	F2 finish.
• Surfaces of the raft remaining below NSL	1. Deck of the Bridge.
• Block joint.	2. Piers.
• Key for Intermediate construction.	3. Abutment & flank wall (river side)
• Cubes	4. Abutment & flank wall (river side)
• Faces which are not exposed for public	5.Exposedsurface of upstream side barrage section i.e. glacis the profile Rigid, apron, slope.

SECTION - IX

GATE WORKS

SECTION – IX

GATE WORKS

INDEX

Schedule & Technical Specifications

1. Fixed Wheel Vertical Lift Barrage Bay/ Under sluice Gate.
2. Stoplog for Barrage Bay/ Under sluice Gate.
3. Rope Drum Hoist for the operation of Gates for Barrage Bay & Under sluice.
4. Gantry Crane for the operation of Stoplogs.
5. Automatic Engaging and Dis-engaging type Lifting beam for the operation of Stoplogs.

CONTENTS

CHAPTER – I

1.1 SCOPE OF WORK

1.1 .1 Fixed Wheel Vertical Lift Barrage & Undersluice Gate:

a) Vertical lift wheel type gates for Barrage & Undersluice bay along with all accessories such as wheel assemblies, seals, guide shoes/ rollers, lifting lugs and latching arrangement etc.

b) Equal No. of embedded parts for each openings of Barrage & Undersluice including S.S tracks, seal seats, sill beam and guides etc. including First stage anchorages and second stage embedment.

c) Rope drum hoist of adequate capacity mounted on trestles for operation of Barrage & Undersluice gates mentioned above consisting of wire ropes, Rope drums, end reduction units, central drive units including worm reducers, E.M. brakes, motors, gate position indicators etc. and arrangement for manual drive. Suitable covers for the hoist equipment shall be provided.

d) Hoist supporting structure for supporting the above hoist including all fastening bolts, anchor bolts, bearing, chequered plates, side railings, ladders, trestles and other accessories etc.

e) The Gate shall be reasonably water tight. The maximum permissible leakage being not more than 5 litres/min/metre length of seal.

f) The Gate shall close under its own weight with or without addition of ballast. Should it require a positive thrust for closing, the hoist shall be suitable for that purpose.

g) Overtopping of the gate shall not be allowed under any circumstances. The gate shall be lifted promptly when such situation arises.

1.1.2 Stoplog for Barrage & Undersluice Gate:

a) Sets of stoplogs of multiple units, vertical lift, sliding/wheel type for under sluice/ barrage gates along with all accessories such as sliding block/pad/ sluice , seals, guide roller, lifting lugs, latching arrangement. etc. Normally one set of stop logs shall be provided for every 10 Nos. of bays

b) Equal no. of embedded parts for Barrage & undersluice stoplogs including tracks, seats, sill beam, guides etc. including First stage anchorages and second stage embedment.

(c) Suitable latching arrangement shall be made for each stop log leaf.

d) Gantry crane/monorail for the operation of stoplogs -

One set of Gantry crane/monorail of suitable capacity with fixed hoists for the operation of stoplogs of Barrage & undersluice gates, including rail track

and supporting structure/ Rail Bridge for rail as required. For lifting capacity greater than 20 Tonne or for barrage length beyond 200 mtr operation of stoplog using gantry crane to be provided.

e) Lifting Beam-

One Lifting Beam of Automatic Engaging and Dis-Engaging type equipped with two hooks shall be provided for handling the above stoplogs. The arrangement of Lifting Beam, location of hooks and lifting lugs and guide rollers and stoppers shall be shown in the drawings.

1.2 Others

a) The 1st as well as 2nd stage concreting is included in the scope of this work. However, the 2nd stage concreting is to be done under the supervision of fabricating Unit. The frames consisting of embedded parts for gates and stoplogs are also required to be embedded in concrete under the supervision of the fabricating unit. The responsibility of the correctness and accuracy of alignment of embedded parts rests with the Contractor. Suitable blockouts for the 2nd stage embedded parts , sill beams/ trestle anchors, stoplog latch, walkway anchors etc. shall be provided on the peir.The blockouts shall be filled with 2nd stage concrete of atleast one grade higher than primary concrete after fixing and final alignment of 2nd stage embedded parts

b) All exposed surfaces after fabrication (except stainless steel & Bronze surfaces, Lifting pins, Gear teeth) shall be painted in the Shop as well as in the field conforming to IS:14177 with Zinc primer and finished coats of Coal tar epoxy paint. The Hoist supporting structure shall be applied with zinc primer & finished coats of Aluminum paint.

The wire ropes shall be applied with suitable coats of cardium compound after installation. All open gear surfaces, Lifting pins and bronze bushes shall be lubricated suitably.

c) Dry as well as wet tests are to be carried out by the Contractor. Any defect noticed during testing or during the defect liability period, is to be rectified/removed by the contractor free of cost.

d) The contractor shall have to perform any extra work, including furnishing material not covered by the specifications or not included in the schedule, but forming an inseparable part of the work contracted for. No extra payment shall be made for such Extra work and materials.

e) Wastage of Steel

The wastage of steel sections, received from main producers, shall not be compensated to the contractor under price variation clause. The price variation will be reimbursed for the net weight of gate/stoplog based on the sectional unit weight as per the table of standard sections (supplied by SAIL) and used in the gate/stoplog. The weight of nuts, bolts, rivets, welding, etc. will not be considered in the net weight of gate. All the wastage of steel sections supplied by the main producer will be at contractor's account and the contractor should consider this aspect while bidding for the tender.

f) All structural material shall conform to IS:2062 & all Stainless steel material shall conform to IS:1570(Part-V) and shall be procured from primary producers of steel such as SAIL/ TATA/ RINL/ JINDAL etc. having integrated steel plants using iron ore as basic raw material. Rerolled & scrap material shall not be used in any work.

g) All welding shall be done conforming to IS:816, IS:814 and other relevant IS codes, adopting best practices in the industry. Low hydrogen electrodes of Gr. E7018/ E7016 shall be used for welding of structural steel. Welding electrodes of Gr. E309L-16 shall be used for welding stainless steel material with structural steel. Welding electrodes of reputed manufacturers such as ESAB, D&H, Advani Oerlikon etc. shall only be used.

h) Suitable staircase upto hoist bridge with hand railing arrangement all along operating platform shall be provided. The hoist bridge shall be covered with min. 8mm thick chequered plate for movement of operating/ maintenance personnel.

i) Drawings and data to be furnished along with the tender

Each Bidder shall append the following technical information/drawings along with the Technical Bid.

- The general arrangement/installation drawings indicating overall dimensions, materials and weights of various components.
- Type, size, make and ratings of various bought-out items proposed to be used.
- Details of various equipment, machineries and skilled personnel available with the Bidder.

1.3 Drawings and data to be furnished by the contractor after award of work

a) The contractor shall submit the following, as soon as possible as but not later than 90(ninety) days from the date of issue of letter of intent/signing of contract agreement and before proceeding with the fabrication work, for the approval of the Engineer-in-Charge.

b) Carefully checked detailed design calculations and fabrication drawings of gates, hoisting equipment, hoist supporting structure and electrical circuit diagrams showing the specifications for each part and the type of heat treatment, wherever used to demonstrate clearly and fully that the equipment to be furnished under this contract shall conform to the provisions and intent of these specifications & specification drawings.

c) Complete list of all equipment showing the dimensions, type, grade, & class of material, numbers required and weights etc.

d) Complete details such as makes, capacities, ratings and other relevant details such as speed/torque characteristics of electric motors covering starting & running conditions with controls etc. for all standard articles shall be furnished.

e) Details of complete coordinated wiring of all electrical equipment along with the detailed drawings supported by catalogues shall be furnished.

f) The proposed methods of installations of all anchorages and complete equipment.

g) The sequence of submission of all drawings shall be such that all information are available for checking each drawing, when it is received.

h) The contractor shall revise the drawings as necessary and shall resubmit fresh prints for approval in the same routine as before. Any fabrication work performed prior to the approval of drawings will be at the contractor's risk. The Engineer-in-Charge shall have the right to ask the contractor to make changes in the design, which may be necessary in the opinion of the Engineer-in-Charge to make the equipment conform to the stated provisions and intent of the specifications, without any additional cost.

i) The contractor shall furnish complete sets of final (corrected) assembly drawings & detailed drawings of the various parts which shall be required for erection, maintenance and repair, identification of parts and for making or ordering replacement of parts. All changes and revisions made up to the time that the equipment is complete and ready for dispatch shall be incorporated in drawings.

j) Any fabrication work performed prior to the formal approval of the Engineer-in-Charge in respect of the designs and drawings shall be at the risk and cost of the contractor. The Engineer-in-Charge shall have the absolute right to ask the contractor to carry out any changes(s) in the designs and drawings, which may be deemed necessary in the opinion of the Engineer-in-Charge to make the equipment conform to the provisions of these specifications and the cost of such changes shall be borne by the contractor. However, the approval of contractor's designs and drawings conveyed by the Engineer-in-Charge shall not relieve the contractor of any of his responsibility under the contract towards the correctness and accuracy of designs, drawings, fabrication, erection, commissioning, performance and guarantee etc.

k) Unless otherwise specifically provided for in the schedule and/or in the specifications and/or in the specification drawings, the contractor shall furnish all the materials accessories, tools and tackles and appurtenant parts called for in the specification or shown on the specification drawings, but not mentioned in the specifications or any thing called for in the specifications but not shown on the drawings as if required or shown in both.

1.4 Schedule and Progress

Within 60(sixty) calendar days after the receipt of approval of drawings, the contractor shall submit to the Engineer-in-Charge for approval the schedule of fabrications and transport of the equipment so as to ensure its delivery within the specified period. The schedule shall clearly state all the stages of fabrication to enable the Engineer-in-Charge to plan his inspection accordingly as stated in these specifications. The contractor shall also (during the course of fabrication) submit a monthly progress report along with photographs of fabrications done to the Engineer-in-Charge, apprising him of the progress of equipment for the preceding month. The Engineer-in-Charge or his authorized representative shall have the right to inspect the fabrication workshop whenever required.

CHAPTER - 2

2.0 TECHNICAL SPECIFICATIONS

2.1 Description of Components Barrage bay & UnderSluice Gates

2.1.1 Skin Plate

The skin plate and stiffeners shall be designed together in a composite manner for the following conditions:

a) in bending across the stiffeners or as panels, and

b) in bending co-acting with the stiffeners.

The stresses in the skin plate for any of the above cited conditions shall be worked out in accordance with IS:4622(latest). The maximum permissible value of stresses shall not be greater than those specified in IS:4622 (latest). The min. thickness of skin plate shall be 10 mm inclusive of corrosion allowance.

2.1.2 Vertical Stiffeners and Horizontal Girders

The vertical stiffeners and horizontal girders shall be designed as simply supported or continuous beams depending upon the framing adopted for the gate. The spacing between the girders shall preferably be such that all girders carry almost equal loads. The deflection in girders shall not exceed 1/800 of span (centre to centre of wheels). The end vertical girders shall be designed as continuous beams with concentrated loads, coming from horizontal girder at points where they meet the end vertical girder.

2.1.3 Seals

Rubber seals shall be fixed to the gate by means of counter sunk screws made of stainless steel/ corrosion resistant steel. The screws shall be designed to take up full shear likely to develop during raising or lowering the gate under max. head of water between the seal and bearing plates. The screws shall be adequately tightened to a constant torque and locked by punch mark. Min. threaded length equivalent to one and half times diameters of screws shall be screwed to ensure against their loosening under vibrations during operations.

The seals shall conform to the provisions contained in IS: 11855 (latest) & 15466 (latest). The seal interference/compression shall be 2 to 5 mm. Suitable chamfer shall be provided at the bottom of skin plate/clamp plate to accommodate the bottom wedge seal in compressed position.

2.1.4 Seals seats, Seal Bases and Sill Beams

The min. thickness of seal seats shall be 6 mm after machining. The seal seats shall be stainless steel conforming to IS: 1570 part-V (latest). The seal seats shall be welded to the seal seat bases using Gr. E309L-16 welding electrodes. The seal seat shall be finished smooth to double delta surface finish.

The seal seat bases shall be made of plate or any structural section on which the seal seat is fixed. The sill beam shall be provided with the stainless steel plate as bottom seal seat. The surface of the sill beam shall be machined smooth and made flush with surrounding concrete.

2.1.5 Guides and Guide Shoes

Guide shoes shall be provided to the sides of gate to limit the lateral motion or side ways of the gate to not more than 6mm in either direction. Guide shoes/ rollers shall be adjustable and removable. These shall slide or roll on guide plate. The guide plates shall be placed at centre of the gate groove.

The guide shoes/ rollers shall be fixed with the help of bolts/screw, which shall be designed to withstand the load encountered by them during operation of gate.

2.1.6 Ballast

The gate shall be self closing type under their own dead weight. Suitable ballast, if required to make the gate self closing, may be provided in the form of dead weight. The ballast shall be in the form of cast iron/pig iron billets, concrete or any other suitable material which shall be securely placed in between the webs of horizontal girders ensuring that it does not get dislodged from its position, when the gate is in operation. The effect of dead weight of the ballast on the horizontal girders shall be analyzed. The centre of gravity of the gate shall be determined after the ballast has been placed and properly secured in position. The ballast shall be provided such that its weight does not exceed 90% of the dead weight of the gate.

2.1.7 Anchor bolts or Anchor plates

Anchorages shall be provided in the 1st stage concrete with suitable block out openings to hold the 2nd stage embedded parts. The anchor bolts in 2nd stage concrete shall be with double nuts and washers. The anchor bolts shall be of minimum 16 mm diameter.

2.1.8 Tolerances

The tolerances for embedded parts and components of gates shall be as per IS:4622(Latest).

2.1.9 Lifting Arrangement

The lifting arrangement to the gate shall be provided w.r.t the true centre of gravity of the gates in such a manner that when the gate is hung freely shall remain in true vertical plane. In case the lifting lugs are welded on the web of the top horizontal girder the hoisting forces shall be dispersed through suitable stiffeners to one or more horizontal girders below the top one. The extra stresses, if any arising due to this arrangement shall be combined with other stresses to ensure that the permissible limit does not exceed.

2.1.10 Earthquake effect

The suitability of gate shall be checked for earthquake effect (corresponding to the type of zone of the site) and the permissible stresses shall be enhanced by 33.33 % but in case of welded connection and bolts the values of permissible stresses shall be enhanced by 25% of the permissible stresses only, subject to an upper limit of 85% of yield point of the material.

2.1.11 Design Criteria

(For all the Gates mentioned above)

1	Design stresses for a) Embedded parts & skin plates b) All Components of gates	 Wet & inaccessible condition Wet & Accessible condition
2	Reference of IS codes	IS: 4622 (latest)
3	Hoist	Rope drum hoist of adequate Capacity mounted on trestles
4	Operation	The gates shall be used for regulations, and shall be operated under unbalanced head of water
5	Permissible deflection	Span/ 800
6	Permissible bearing and shearing stresses in concrete	As per IS: 456
7	Grade of concrete to be used 1st stage concrete 2nd stage concrete	 As shown in the relevant civil drawings One grade higher than the first stage concrete(Not less than M25)
8	Minimum thickness of skin plate	10 mm
9	Minimum thickness of track plate	10 mm (after machining)
10	Minimum thickness of seal seat	6 mm (after machining)
11	Minimum thickness of guide (for Barrage & Under sluice Gates)	20 mm (after machining)
12	Type of seal For sides For bottom	 Hollow/solid bulb Music note type rubber seal. Wedge type rubber seal

2.1.12 Materials

For general condition of testing the material please refer Chapter-III

Recommended materials for gates, stoplogs and its components are given below:

Sl. No	Component	Recommended Materials	Reference
1.	Skin plate, stiffeners	Structural steel	IS: 2062
2.	Main horizontal girders, end vertical girders, seal bases and clamps, guide shoes etc.	Structural steel	IS:2062
3.	Track bases, seal seat bases, guide	Structural steel	IS: 2062
4.	1st stage anchor plates & anchorages etc.	Structural steel	IS:2062
5.	Seal seats	Stainless steel	IS: 1570 (Part-V)
6.	Wheel track	Corrosion resistant/stainless steel plates	IS:1570(Part-V) shall be 50 BHN higher than that of wheel material
7.	Wheel, Lifting pulley, turnbuckles	Cast steel/ Forged steel	IS:1030/ IS:2004/IS:1875
8.	Wheel pin, lifting pin	Stainless steel	IS: 1570(Part-V)
9.	Bearings (a) Bearings in Wheels (b) Bush bearing	 Spherical roller self aligning Aluminum bronze	(SKF or equivalent) IS: 305
10.	Seals (a) Side seals (b) Bottom seals	 Natural or synthetic rubber Natural or synthetic	 IS: 11855/15466 IS:11855/15466
11.	Screws/ bolts for seals	Stainless steel	IS:1570(Part-V)
For Stoplogs			
12.	Slide block and guide roller etc.	Structural steel	IS: 2062
13.	Sliding track & seal seat	Corrosion resistant / stainless steel plate	IS: 1570 (Part-V)/ IS:6911

14.	Sliding pad	Bronze	IS:305/ IS:308

2.1.13 Stoplogs for Sluice gate

It is proposed to provide one set of stoplog for the maintenance of Barrage & Undersluice gates complete with guide roller/shoe, sliding block/pad, seals etc. The stoplogs shall be operated by means of common Gantry crane/ monorail of suitable capacity, and automatic engaging disengaging type lifting beam. The Stoplogs shall be operated under balanced water head condition. While raising, the balanced head shall be achieved by crack opening the top unit of Stoplog.

2.1.13.1 Skin Plate

The skin plate and stiffeners shall be designed together in a composite manner for the following conditions.

c) in bending across the stiffeners or as panels, and

d) in bending co-acting with the stiffeners.

The stresses in the skin plate for any of the above cited conditions shall be worked out in accordance with IS: 5620 (latest). The maximum permissible value of stresses shall not be greater than those specified in IS:5620 (latest). *The min thickness of skin plate shall be 10 mm inclusive of corrosion allowance*. To take care of corrosion, the actual thickness of skin plate shall be provided by adding 1.5 mm more in the theoretically computed thickness based on the allowable stresses given in IS: 5620 (latest).

2.1.13.2 Vertical Stiffeners and Horizontal Girder

The vertical stiffeners shall be designed as simply supported or continuous beams depending upon the framing adopted for the gate. The spacing between the girders shall preferably be such that all girders carry almost equal loads. The deflection in girders shall not exceed 1/800 of span. The end vertical girders shall be designed as continuous beam with concentrated loads, coming from horizontal girder at points where they meet the end vertical girder.

2.1.13.3 Seals

Rubber seals shall be fixed to the gate by means of counter sunk screws made of stainless steel/corrosion resistant steel. The screws shall be designed to take up full shear likely to develop during raising or lowering the gate under max. head of water between the seal and bearing plates. The screws shall be adequately tightened to a constant torque and locked by punch mark Min. threaded length equivalent to one and half times and diameters of screws shall be screwed to ensure against their loosening under vibrations during operations.

The seals shall conform to the provisions contained in IS: 11855(latest) & 15466(latest). The seal interference/compression shall be 3 to 5mm. Suitable chamfer shall be provided at the bottom of skin plate/clamp plate to accommodate the bottom wedge seal in compressed position.

2.1.13.4 Seals seats, Seal Bases and Sill beams

The min. thickness of seal seats shall be 6 mm after machining. The seal seats shall be stainless steel conforming to IS: 1570 part-V (latest). The seal seats shall be welded to the seal seat bases. The seal seat shall be finished smooth to double delta surface finish.

The seal seat bases shall be made of plate or any structural section on which the seal seat is fixed. The sill beam shall be provided with the stainless steel plate as bottom seal seat. The surface of the sill beam shall be machined smooth and made flush with surrounding concrete.

2.1.13.5 Guides and Guide Rollers

Guide rollers shall be provided to the sides of gate to limit the lateral motion or side ways of the gate to not more than 6mm in either direction**.**

Guide rollers shall be adjustable and removable. These shall slide/roll on guide plate**.** *The guide plates shall be placed at center of grooves.*

The guide shoes shall be fixed with the help of bolts/screws, which shall be designed to withstand the load encountered by them during operation of gate.

2.1.13.6 Anchor bolts or Anchor plates

Anchorages shall be provided in the 1st stage concrete with suitable block out openings to hold the 2nd stage embedded parts. *The anchor bolts in 2nd stage concrete shall be with double nuts and washers*. The anchor bolts shall be of minimum 16 mm diameter.

2.1.13.7 Tolerance

The tolerances for embedded parts and components of gates shall be as per IS:5620

2.1.13.8 Lifting Arrangement

The lifting arrangement to the gate shall be provided with respect to the true centre of gravity of the gates in such a manner that when the gate is hung freely shall remain in true vertical plane. In case the lifting lugs are welded on the web of the top horizontal girder the hoisting forces shall be dispersed through suitable stiffeners to one or more horizontal girders below the top one. The extra stresses, if any, arising due to this arrangement shall be combined with other stresses to ensure that the permissible limit does not exceed.

While designing the lifting lug due care shall be taken for impact loads.

2.1.13.9 Earthquake effect

The suitability of gate shall be checked for earthquake effect (corresponding to the type of zone of the site) and the permissible stresses shall be enhanced 33 1/3% subject to an upper limit of 85% of yield point of the material. In case of

welded connection the values of permissible & nuts the increase in stresses shall be maximum of 25% of the permissible stresses.

2.1.14 Design Criteria

Sl. No	Particulars	Design Criteria
1	Design stresses for a) Embedded parts b) Components Stoplog	 Wet & inaccessible condition Dry & accessible condition
2	Reference of IS codes	IS: 5620 (latest)
3.	Hoist	Gantry crane of suitable capacity mounted on rails or Monorail crane of suitable capacity.
4.	Operation	The stoplog shall be operated under balanced head condition, while raising balanced head condition shall be achieved by crack opening the top unit.
5.	Permissible deflection	Span / 800
6.	Permissible bearing and shearing stresses in concrete	As per IS: 456
7.	Grade of concrete to be used 1st stage concrete 2nd stage concrete	As shown in the relevant civil drawings. One grade higher than the first stage concrete(Not less than M25)
8.	Minimum thickness of skin plate	10 mm
9.	Minimum thickness of track plate	10 mm (after machining)
10	Minimum thickness of seal seat	6 mm (after machining)
11	Minimum thickness of guide	20 mm(after machining)
12.	Type of seal	

	For sides For bottom	Hollow/solid bulb, music note type rubber seal. Wedge type rubber seal

2.2 ROPE DRUM HOISTS FOR THE OPERATION OF BARRAGE & UNDERSLUICE GATES.

2.2.1 General

Electrically operated rope drum hoist of adequate capacity shall be installed for the operation of Barrage bay & Undersluice Gates. (The Rope drum hoist shall be as indicated in the Approved General Installation drawings of respective gates).

The hoist mechanism shall include a driving motor, gears/ worm reducer, rope drums, wire ropes, pulleys, turn-buckles, shafts, bearings, coupling, brakes, emergency manual- operation arrangement, limit switches, gate position indicator etc., all mounted on a fabricated steel frame. Electrical controls and necessary electrical and mechanical accessories shall be provided for the satisfactory operation of the hoist. All machinery is to be supported on hoist supporting structure and trestle of respective gates. The hoisting mechanism shall be provided with covers to protect it from dust, dirt and direct exposure to sun & moisture. Standard clearances, tolerances and finishes shall be adopted. All accessories and equipment shown on the drawings or required by the specifications, shall be of high class quality, suitable and applicable for the duty or the function that the particular accessory or equipment will be required to perform in the operation of the hoist and shall conform to the general dimensions of the associated parts, within sufficiently close limits to avoid changes in other components/assemblies already approved by the Engineer-in-Charge. The hoist shall be capable of fully opening / closing the gates and holding the gate in its fully opened position as may be required. Suitable ladder rungs for access shall be provided to approach the hoist component and sufficient space shall be provided around them for repair and maintenance.

2.2.2 Hoist Capacity

The hoist capacity shall be determined by taking into consideration the sum of the worst combination of the following forces during either raising or lowering cycle, which might be required to overcome.

i) Weight of the gate along with its entire components.

ii) All frictional forces comprising of

a) Wheel friction, b) Seal friction including friction due to initial interference, c) Guide friction, etc.

iii) Any hydrodynamic loads like hydraulic down pull/uplift.

iv) Silt load, if any.

v) Any other loads considered specific to the site.

vi) The hoist capacity thus computed shall be increased by 20 percent as reserve.

vii) Seating load shall be greater than 250 kg/m length of the gate.

2.2.3 Hoisting Ropes

The wire ropes (hoisting ropes) shall be made from improved plough steel of 6 X 36 or 6 X 37 construction fiber core conforming to IS: 2266 (latest). While calculating the rope tension and selecting the wire rope diameter, the efficiency of the pulleys / sheaves and drums shall be taken into account. In case of multiple falls, the wire rope shall be provided with turn buckle to prevent the unequal stretch of rope. The wire rope shall be guided over as few pulleys as possible. Reverse 'S' shaped bends shall be avoided. The minimum Factor of Safety based on minimum breaking strength and safe working load of wire rope shall be as under:

i) Normal operation condition 6

ii) Breakdown torque condition 3

The strength of socket ends of wire rope shall be approximately equal to that of the rope. The ends of the wire rope shall be secured against twisting. The material for wire rope sockets shall conform to IS: 2485(latest). *Molten zinc shall be used to socket the rope. The specimen shall be subjected to destructive tensile test in which ropes fail than socket or joints.*

2.2.4 Rope drums

The rope drum shall be made of cast steel or welded steel plates and shall be adequately designed to sustain the concentrated loads due to the rope tension. The drum shall be flanged at both ends. The height of flanges shall be not less than 2 (two)- rope diameters above the rope. A spur gear secured to the drum may be regarded as forming one of the flanges.

The fleet angle of the rope shall not exceed 5˚ or 1 in 12 on either side of helix angle of groove in drum. The drum shall be strong enough to withstand the crushing as well as bending. The crushing strength of drum shall be calculated by the following formula:

$$Cr = \frac{K \times T}{P \times t}$$

Where,

Cr = compressive strength in N/mm2
K = coefficient
T = tension on one wire rope in N
p= Pitch of scoring
t = Thickness of drum at the bottom of groove in mm

The pitch diameter of drum shall not be less than 20 times the diameter of rope. In case of fabricated drum, the number of segments shall not exceed two. The drum shall be machine grooved. Contour at the bottom of the groove shall be circular over an

angle of at least 120˚. The radius or the groove shall be 0.53 times the diameter of rope rounded of to next millimeter. The depth of the groove shall not be less than 0.35 times of the diameter of the rope. The groove of the drum shall have clearance as specified in clause 4.3.4.2 of IS: 6938 (latest). The size of the drum shall be such that there will be not more than one layer of rope on the drum when the rope is in fully wound position. The ends of the rope shall be fixed at minimum two points on the drum in such a way that the fixing device is easily accessible and the rope is not subjected to undue twists & turns. Each rope shall have not less than two full turns on the drums before it is fixed.

2.2.5 Sheaves or Pulleys

All sheaves or pulleys shall be made of cast steel or wrought steel. These shall be machine grooved to a depth of not less than 1.5 times the diameter of the rope. The grooves shall be finished smooth and shall be free from surface defects, likely to injure the rope. The pitch circle diameter of sheave shall not be less than those indicated in Table 3 of IS: 6938 (latest). The contour at the bottom of the grooves shall be circular over an angle of approximately 130˚ ± 5˚. The radius of the groove shall be 0.53 times of rope diameter. All revolving sheaves/ pulleys shall be in true running balance. The sheaves/ pulleys in the lower block shall be mounted on self-lubricated bronze bushings. The angle between the straight slopes at the sides of the grooves shall be approx. 52˚. The diameter at the bottom of the grooves of the equalizing sheaves shall not be less than 62% of the minimum pulley diameter.

2.2.6 Gearing and Gear Boxes

(a) Gearing

All spur gears shall be of cast steel or forged steel or carbon (surface hardened) steel. The gears and pinions shall be made of two different grades of materials. The pinions shall be of higher strength grade material and spur gears shall be of lower strength grade of material. All gears shall be machine cut with smooth finish. The gear shall be designed as per IS: 6938(latest) and other relevant Indian Standards. The face width of gears shall not be less than two times of circular pitch. Duty factor for appropriate class of mechanism shall be taken into account in design calculation. All allowable stresses for the normal operating condition shall be 20% of UTS of the material used for the manufacture of the gear. The allowable stress at breakdown torque condition shall be 80% of Y.P. of the material. The keys in gears train shall be tight fit and should not become loose in service.

(b) Gear boxes

Gear boxes shall be of rigid construction fitted with inspection covers and lifting handles. The gear boxes shall be made of cast iron or cast steels or fabricated from mild steel. The bear boxes shall be so designed that the gear can be easily removed or replaced and lubricated. Proper facilities for oil filling and draining, connections for oil level indicator and adequate breathing shall be provided. The gear boxes shall be mounted on a level surface. **The Gear boxes shall have self-locking characteristics.**

2.2.7 Electro-magnetic Brake:

The electro-magnetic Brake shall be of spring set shoe type. It shall be solenoid operated and continuously rated. The brake shall be effective in both direction of rotation and shall be capable of overcoming at least 150 percent of the full load torque exerted by the motor.

The brake shall set automatically when the current is cut off from the motor and it shall be electrically released when the current is applied to the motor. The brake shall be equipped with a hand operated release lever. A weather-proof cover complete with heaters, if required, shall be provided to prevent condensation on moving parts.

In addition to electro-magnetic brake, additional brakes shall be provided, in such case where undesirable gravity fall of gate is to be arrested or where frequent intermediate stopping of gate is required during lowering cycle or where the selected gear box is not of self locking type.

2.2.8 Bolts, Nuts, Set Screw & Washer

All bolts and nuts for mechanical equipment shall be finished and shall have hexagonal heads. The bolt heads and nuts shall bear the seat at right angle to the bolts. On castings the seats shall be on finished bases or on spot faced surfaces. Nuts subjected to vibration and frequent changes of load shall be secured by effective lock nuts. Double nuts shall be of standard thickness. Bolts shall not be used for transmitting torsion.

All set screws shall be provided with case hardened cup points and shall be of the safety type. Set screws shall not be used for transmitting torsion.

Washer shall conform to IS: 2016 and IS: 3773 with up to date amendments / revisions if any.

2.2.9 Shafts

Shafts shall have ample strength, rigidity and adequate bearing surfaces. Shafts shall be designed for the load / torque to be transmitted by them. The ratio between length and diameter shall not exceed 50. The angle of twist and the revolutions / min shall be taken into account in addition to simple bending, pure torsion, or the combined effect of bending and torsion. The twist shall be between to 1/4˚ to 1/3˚ per metre. The linear deflection shall not exceed 1mm/m length i.e., 1/1000.

2.3 Bearings

All bearings shall be either roller or ball bearings or sleeves type removable bronze bushings with flanges at both ends. Bearings shall be easily accessible for lubrication and or replacement. In case of more than one bearing of one shaft, every bearing shall be provided with separate and individual lubricating arrangements. Unless, otherwise specified herein and / or on drawing, the bearings on the revolving shaft shall be divided type, so that each shaft may be removed from the pinions and gears in position, without disturbing the adjacent parts. In all cases, where divided bronze bushings are used, the bearing caps, unless divided, shall be recessed into the base and secured by turned fitted bolts. Cap screws shall not be used for this purpose. This requirement shall not apply incase of roller or ball bearings.

The base casting for gear train bearings shall be made in one piece to ensure the accurate alignment and spacing. They will be held securely in position by turned fitted bolts. Proper provisions shall be made to hold the bearings effectively against rotations and changing position under load. All bearings shall be provided with the arrangement to make them leak proof, weather proof, drip proof, and protection from entrance of rain, dust, dirt and any other foreign matter. The pressure on bronze bushing shall not exceed 70 kg / cm2 projected area.

Antifriction bearings shall be as suited for the appropriate load condition. Static capacity of bearing shall provide a minimum safety margin of 25% over B.D.T. loading.

2.4 Coupling

All couplings shall be of forged steel or cast steel design to transmit the maximum torque, which may develop. Solid couplings shall be aligned in such a way that they meet accurately. The flexible couplings shall be initially aligned with the same accuracy as solid couplings. Flexible couplings shall be fitted between motor shafts and extension shafts.

2.5 Lubrication

Grease lubrication shall be provided for all gear trains, sleeve bushings, bearings on motors, wheels etc. Lubrication for all mechanical operating points shall be done by means of high-pressure grease gun and industrial button type fittings. Lubricating nipples, pipes and adapters shall be easily accessible and wherever necessary the copper and brass pipe of ample size shall be provided to a convenient point for lubrication. However, oil lubrication shall be provided for closed worm reducers, helical reducers.

A lubricating chart shall be provided indicating all the lubricating points, type of lubrication and recommended frequency of lubrication.

2.6 Electrical equipment

All electrical equipment and wiring shall meet all the requirements and shall be in accordance with IS: 6938 and other relevant Indian Standard Specifications unless other wise specifically called for in the specifications. Nuts, railings, screws and other accessories which are external to the apparatus, but which may be required to meet the codes for installed equipment shall be furnished by contractor. All electrical wiring shall meet the relevant provisions of Indian Electricity Act. The power supply shall be 3 (three) phase, A.C, 415 volts, 50 cycles per sec. with supply voltage variation of ± 10% and supply frequency variation of ± 3%. All electrical equipment shall be designed suitable for continuous operation under tropical conditions.

2.6.1 Motor

Motor provided for operation of the hoist shall be of adequate capacity to meet the duties, speeds and performance called for in these specifications. The rated capacity of each motor shall be such that full load torque shall not exceed in giving the specified performance of the hoist. Motor shall be totally enclosed with fan cooling,

high starting torque squirrel cage, 3 (three) phase induction fitted with A.F. converter or Slip ring induction motors fitted with external non-breakable corrosion type resistor for rotor circuit. The rpm of motor chosen shall not be more than 1000 but shall be capable of withstanding a max. speed of 2.5 times the rated speed. The break down torque/pullout torque of the motor with rated voltage and frequency shall not be less than 2 times (200%) of the full load torque. The motor shall be braced and insulated to withstanding plugging service and heavy shocks vibration transmitted to them by the driven machinery. The motor shall be provided with class – F insulation. The motor shall be out door type crane duty and suitable for reversing frequent accelerations and mechanical braking. In case of stoppage of motion of the hoist occurs due to the electric braking, the motor shall be suitable to withstand this duty. Roller or Ball bearings provided with the motor shall be suitable to withstand the heavy vibrations and shocks. All bearing shall be sealed to prevent leakage of oil and Lubricants and entrance of dust etc. Motor leads shall be brought out from the motor frame to terminals in the Terminal box fixed to the motor frame. The motor shall be so located that the terminals are accessible for inspection and maintenance with unrestricted ventilations. The contractor shall enclose the full technical particulars of each motor, indicating (a) the values of the locked rotor, starting, rated and pull out currents,(b) starting, rated, breakdown torques,(c) make, class of duty, number of poles, start/hr, CDF, type of insulation etc.

Motor shall be of standard capacity and specification in accordance with BIS or equivalent international standard marked and of reputed make like Siemens, Kirloskar, NGEF, GEC etc.(as mentioned in other para)

Efficiency of various elements of hoisting mechanism shall be as per Table 5 of IS: 6938. The over all efficiency of the system i.e. the product of individual efficiency of element shall be worked out an shall be used in calculating the capacity of the electric motor. The ratio of overall running efficiency to the over all starting efficiency shall be less than the ratio of starting torque to running torque of motor.`

2.6.2 Control Equipment

The hoist mechanism shall be complete with one local control panel with push button suitably marked as RAISE, STOP AND LOWER. Lamps, to indicate the conditions of the control circuits and direction of motion shall be provided. Necessary relays, starter heaters fuse, limit switches and indicating lights complete with suitable wiring shall be provided so that all functions are carried out smoothly. All controls shall be interlocked so that proper functioning of individual parts for the purpose is ensured. All the enclosures of the control equipment shall confer to IP55 (with double door) class of protection.

Hoist motion shall be done with the help of standard push Button type switches. The push button control voltage shall not be more than 110 volts. All push button control switches shall be capable of withstanding rough handling without being damaged and the cover shall be effectively secured.

Necessary provision shall be made in the control equipment for remote indication of various parameters like open, close etc. of the hoist control and the gate position.

2.6.3 **Limit Switches**

The limit switches shall be of the totally enclosed and shall have water proof covering. The limit switches, after being tripped, shall automatically reset within reasonable distance traveled in opposite direction. In case of resetting is achieved by strikers when moving in opposite direction, a change over type limit switch shall be provided. It shall be suitably designed and tested for normal lift and satisfactory operation under the humid climatic conditions. A limit switch to stop the motion and to apply brake when the gate has risen or lowered to a predetermined level shall be provided to prevent the over winding.

2.6.4 Wiring

All wiring shall be laid in hot dipped galvanized metal conduit. All conductors for primary power lighting and control circuit shall be insulated for not less than 1100 volts and shall have standard moist resisting double braided covering. All conductors between the secondaries of the motor conductor and resistors shall have sufficient current carrying capacity in accordance with Indian Standard and shall be insulated with 1100 volts class asbestos. The primary conductor to the motor shall have standard continuous current carrying capacity of not less than 100% of the rated full load primary current of the motor. Cable having conductors smaller than 2.5 sq. mm nominal equivalent copper area of the cross section shall not be used for the power wiring for any of the motors. For control circuits and auxiliary wiring, cables having a sectional area smaller than 1.5 sq. mm nominal equivalent copper area of the cross section shall not be used. All cables shall be adequately protected against mechanical damage and metal trunking may be used if desired. Electrical conduit shall comply with the relevant Indian Standard. For outdoor cranes except where flexible unarmoured cable are essential, cables shall be armoured or enclosed throughout their length in galvanized trunking or conduit, either flexible or rigid. A flexible metallic tube or duct may not form an effective earth connection and shall not be used for the purpose. Tapped and braided varnished cambric insulated cables shall not be used for outdoor crane.

2.6.5 Interlocking and Earthing

Off position interlocking earthing and other electrical equipment shall be provided in terms of provisions contained in IS:3043 (latest)

2.6.6 Hoist Supporting Structure

The hoist supporting structure and trestle shall be designed considering an impact factor of 1.1 as specified in IS:6938 and shall be made of structural steel (weldable) conforming to IS:2062 and shall be designed to withstand the dead weight of the hoist, hoisting load as well as vibrations coming on the hoist, while in operation. In addition wind/seismic load shall also be taken into account. Suitable anchorages for the hoist frame shall be provided to take the worst combinations of all loads under which the gates and hoists are under operation. The hoist supporting structure and trestle shall be either in riveted or welded construction Diaphragms shall be provided to distribute the loads to the sides properly. Shop connection in the frame shall be either riveted or welded so that the surface of the hoist including the outside of the

frame, case and hoist housing and viewed along with the intake structure will be a plane surface except for projections of rivet heads. The structure shall be designed for each of the following combinations.

i) Dead loads plus live load, impact load, wind load @ 50 kg /sq.m and crowd load @ 500 kg/sq. m on entire area of walkway and platform.

ii) Dead load with no hoisting load plus effect of storm wind load @ 150 kg/sq. m.

iii) Breakdown torque of the motor. The permissible stresses as specified in IS:800 for normal operation shall be increased by 331/3% limited to 80% of yield point**.**

2.6.7 Miscellaneous

(i) Gate Position Indicator

The gate position Indicator shall be provided with rope drum hoist. The design of the gate position indicator shall be as per IS:6938

(ii) Manual Operation

The manual operation arrangement shall be provided for rope drum hoist as per IS: 6938

(iii) Wrenches and Tools

A suitable grease gun and a complete set of wrenches and tools in a pressed toolbox shall be furnished for the hoist. Sufficient quantity and variety of tools shall be furnished to cover all ordinary maintenance work of the hoist Operating instruction in a suitable metal frame cover with glass shall be mounted at convenient location.

(iv) Machinery Housing and cover

Weather proof housing and covers shall be provided and fabricated from structural steel sections conforming to IS:2062.

Gear box covers shall be of rigid construction fitted with inspection covers and lifting handles. The covers shall be so shaped that the gears can be easily removed or replaced. Facilities for lubrication, oil draining, oil level indicating etc. shall be provided where necessary. The thickness of metal sheet for cover shall be not less than 3mm.

(v) Hoist Bridge & Trestle, Latch

Suitable hoist bridge & trestle, latch shall be provided and designed as per IS:6938, IS:800

(vi) Platform, Walkways, ladder, hand rails

(a) All ladders, platforms and walkways necessary to provide access to the hoist machines, shall be provided. The platform and walkways shall be designed for a live load of at least 500kg/sq.m and shall consist of suitable non-slip steel plates riveted or welded together and riveted or bolted to the steel framework except that the walkway on the top deck of the rope drum hoist shall be constructed of the floor grating. The floor shall be constructed from reinforced steel plates of welded construction. The thickness of the chequered plate shall not be less than 8mm. *The flooring shall be provided all through the hoist bridge expect the area covered by hoist machinery*.

(b) ~~The ladders shall be not less than 400mm width between side parts and shall have round rungs 20mm in dia. Spaced at 300mm centres.~~ Suitable staircase arrangements with a hand railing shall be provided upto hoist bridge for movement of men and maintenance equipments

(c) The walkways shall provide clearance of not less than 600mm between machinery and/or the structure and the hand rails. Clips shall be provided on all open edges of the walkways and platforms.

(d) Standard pipe handrails with two horizontal pipe rails shall completely enclose all walkways. The handrails and ladder rungs on the outside of the hoist bridge shall be made of steel having fittings of the flush jointed type. Hand railing shall be provided along the open side of the walkways, platform, stairs and other locations where required. The hand railing along the walkways on the plate form shall be 1200mm high.

(e) The platforms are required to be proportioned for moving a single load of 300 kg. Railing is to be proportioned for a traveling horizontal single load of 30 kg acting on the rail iron.

(vii) BDT condition

All the components of rope drum hoist including machinery, Hoist bridge, trestle, rope and lifting lug, etc shall be checked for actual break down torque of motor, while calculating stresses under BDT condition.

2.6.8 Design Data for Rope drum hoist of BarrageGate.

(i) Capacity	: Adequate Capacity
(ii) Maximum lift of the gate	: --- m
(iii) Operating speed of hoist	: 0.3 to 0.7 m/min
(iv) Number of hoist	: Equal to No. of gates
(v) Governing IS Code	: IS:6938(Latest)

Note: Hoist Mechanism shall be checked for Seismic effect

2.6.9 Materials for rope drum hoist for Barrage Gate.

For general condition of testing the material please refer **para 3.0**

Recommended materials for rope drum hoist and its components are given below:

Sl.No.	Component	Recommended Materials	Reference
1.	All Structural members	Structural Steel	IS: 2062
2.	Rope drum	Structural Steel	IS: 2062
		Cast Steel	IS: 1030
3.	Wire rope	Improved plough steel fibre core-(Ungalvanised)	IS: 2266
4.	Gears	Cast Steel	IS: 1030
5.	Pinions	Forged Steel	IS: 2004/ IS: 1875
6.	Shafts	Structural Steel/ Forged Steel	IS: 2062 IS:1875
7.	Sheaves/Pulleys/ Couplings/roller	Cast Steel	IS: 1030
8.	i) Bearing (sleeve) ii) Anti-frication bearing	Phosphor Br., Leaded Tin bronze Bronze, Aluminum Br. SKF, FAG, ZKL or equivalent	IS:28,IS:318 IS: 305
9.	Keyways and Keys	Mild Steel	IS: 2048/ 2291/2292
10.	Motor	Crane duty	IS: 325 / 900
11.	Cables and conductors		IS: 9968
12.	Conduit		IS:9573
13.	Switch gear		IS:13947
14.	Equalizer bar and turned buckles	Mild Steel	IS: 2002/2062
15.	Gate position indicator	Non-rusting metal or Enameled plate or thick Plastic sheet	
16.	Cover	Cast Iron Mild Steel	IS:210 IS: 2062

17.	Wire rope socket	Forged Steel	IS:1875
18.	Bolts and nuts	Mild Steel	IS:1363,1364, 1365,1367
19.	Wheel	Cast Steel	IS: 1030
20	Axles and pins	Forged Steel Corrosion resistant steel	IS:1875 IS:1570(Part-V)

2.7 **Gantry Crane for the operation of Stoplogs for BarrageGates**.

2.7.1 General

When the hoist capacity is more than 20 Tonne or when the length of barrage is more than 200 mtr use of gantry crane is preferred.

One no. Gantry Crane (of suitable capacity) shall be provided for the operation of Stoplogs of Barrage bays & Undersluice for isolating the gates for maintenance & inspection purpose. The Stoplogs shall be operated through automatic engaging and dis-engaging type lifting beams.

All the parts of the crane shall be in good working order, of good material and with accurate workmanship, skillfully fixed properly connected and put together. All works, materials and services not expressly called for in these specifications or shown in the drawings, which are necessary to complete and proper operation of the equipment shall be furnished by the contractor at no extra cost.

2.7.2 Materials

All materials shall conform to the requirement indicated on the drawings or referred to in these specifications and when not covered therein metal and materials of standard quality shall be furnished. Material shall be of the classifications and grades approved by the Engineer-in-Charge. In case the contractor desires to use stock materials, not manufactured specifically for the work covered by these specifications, he shall submit satisfactory evidence to the Engineer-in-Charge that such materials conform to the requirements of these specifications. And in such cases detailed test of these materials may be waived in writing by Engineer-in-Charge on an item by item basis.

All materials used in the constructions of gantry crane shall conform to the latest relevant India Standard Specification. The manufacturer shall quote the reference of IS Code of practice for materials used.

For general condition of testing the material please refer Chapter-III

Recommended materials for Gantry Crane and its components are given below:

Sl No.	Materials	B.I.S Specification
1.	Steel and castings: Structural steel:	IS: 2062

	Cast Iron Structural steel-medium & High strength Cast Steel	IS: 210 IS: 8500 IS: 1030
2.	Threaded fasteners	IS:1367, IS: 1363, IS:1364, IS: 1365
3.	Wire Ropes	IS: 2266, IS:2365
4.	Steel Forging	IS: 2004, IS: 1875
5.	Shafts	IS: 1875, IS: 2062
6.	Keyways & Kes	IS: 2048, IS: 2292, IS: 2291
7.	Bronze Bushing	IS: 28, IS: 318, IS: 305, IS: 1028, IS:1 458
8.	Gears	IS: 3681, IS: 4460, IS: 4715
9.	Ball and roller bearings	IS: 5935, IS: 5932, IS: 5933, IS: 5692 & IS: 5669
10.	Special steels a. Steel for welded Gear Rings	Carbon content: 0.25% (Max.) Elongation: As per IS: 1608-0.25% Reduction in area: As per IS:1608-15%. These physical properties shall apply after the gears have been annealed for stress relief. The gear teeth shall be flame hardened and have a maximum BHN value of 170.
	b) Steel for wheels and sheaves	In general shall have chemical composition as under: Carbon: 0.55% to 0.8% Manganese:0.5% to 0.8% Phosphorous: Not more than 0.06% Sulphur: Not more than 0.06% BHN: Not less than 250 IS: 1030, IS: 226, IS: 2062
11.	Motor (crane duty)	IS:325, IS: 900, IS: 1231 & IS: 2223
12.	Cables and conductors	IS: 9968
13	Conduits	IS: 9537
14.	Switch gear	IS: 13947

2.8 Design Criteria

2.8.1 General

The crane shall be manufactured in accordance with class-MS of IS: 3177-1999 (class 2 as per IS: 807-1976)- the Outdoor Traveling Type with rope drum hoist mounted at the top of the crane structure. The operation of the crane shall be completely electrical. The power supply shall be 3 (three) phase, A.C, 415 volts, 50 cycles per sec. with supply voltage variation of ± 10% & supply frequency variation 3%. The

power supply shall be made available from the plug receptacles located at suitable intervals along with the crane runway. To facilitate a better control of the crane, an operator's cabin shall be provided with the crane. All the controls required for the electrical equipment on the crane shall be provided in the operator's cabin along with the control panel having indicating lights for the various operations. The crane should be made to stop at the centre of each span of Gate with the help of limits switches provided along with the travels.

2.8.2 Data for Gantry Crane for Stoplogs of Barrage Gates.

The capacity, length of travel and the speed of the crane shall be as follows:

1. Capacity of hoist : As per design
2. Total lift :
3. Speed of hoisting : 1.5-1.7m / min
4. Gantry travel speed : 8-10 m /min
5. Centre to centre distance

   Between runway rails :
6. Wheel base of crane :
7. Total length of travel : m (tentative)
8. Limiting deflection : As per IS: 6938(latest),IS:807
9. All components such as machinery parts, rope, structure, girder, lifting lug, lifting beam etc. shall be checked for the stress value under actual breakdown torque conditions of motor.

2.8.3 Permissible Stresses

The crane and the structural members shall be proportioned in such a way that the actual calculated stresses for the combination of loading causing most adverse effect on the members, arrived at by any of the accepted methods of calculations, shall not exceed the permissible stresses as specified in IS:807.

The design of the component parts of the mechanism relating to crane motion shall include due allowance for the effects of the duty which the mechanism will perform in service.

In all cases the mechanism shall be classified in accordance with the provision 4.3 of IS: 807-1976 on the basis of the duty and the design of the component parts shall be in accordance with the provision given in this section.

The overall design and fabrication of gantry crane shall conform to IS: 3177, IS: 807, IS: 800, IS: 806, IS: 816, IS: 822 & IS: 9595 (Latest revisions)

2.8.4 Loading

All structural loads shall be computed as follows**:**

a) The dead load shall include the weights of the legs, horizontal members of the crane, platform, crane drive, hoist mechanism and operating cabin etc. The effect of the eccentricity of the location of the crane drive mechanism, hoisting mechanism and operator's cabin shall be included in the design.

b) The tractive force on each wheel shall be considered as 5% on the resultant, maximum wheel load considering the weight of the crane and live load equal to hoist capacity .

c) The live load shall include the weight of hooks, blocks, ropes and attachments. The live load shall be multiplied by the impact factor as per IS: 807.

d) The wind load on the crane shall be taken as 50kg per sq. m and also in accordance with IS: 875 & IS: 807. The wind area of the crane shall be taken as the vertical projection of the structure, normal to the direction of the wind. While applying wind pressure, appropriate form factors in accordance with IS: 807 shall be accounted

2.8.5 Stability.

a) Considering load under breakdown conditions of motor and steady wind pressure 50 kg per sq.m., the stability factor must be greater or equal to 1.3

b) Considering live load under service conditions with stable wind pressure of 50kg per sq m. and acceleration and retarding forces the stability factor must be grater or equal to 1.8

c) In case of crane without load and not operating and considering storm wind pressure of 150 kg/ m2, the stability factor must be greater or equal to 1.5.

d) Limiting Length of Members

e) The 1/r ratio shall not exceed 180 for main compression members and 240 for bracing and subsidiary members.

f) The 1/r ratio shall not exceed 300 for solid web girders and shall not exceed 150 for cantilevers.

g) The ratio of 1/b for any beam or girder shall not exceed the following limits:

h) Riveted box plate girders: $1/b \leq 65$.

Welded box plate girder: $1/b \leq 60$

2.8.6 Rolled Section

All rolled sections used as beams shall have a depth of not less than one sixteenth of the span and where used in pair shall have full depth separators spaced not more than

1.5m centre to centre. Stiffeners shall be provided on the webs of the rolled steel beams at the ends and at points of concentrated loads to resist buckling.

2.8.7 Structures

2.8.7.1 General

Care shall be taken in the design to produce a pleasing appearance of the crane. The crane should have the streamlined appearance and general architectural treatment that are considered as essential features of the design and that are required to be incorporated in the design and constructions.

2.8.7.2 Frame

The gantry shall be fabricated from structural steel sections and plates and shall be of either riveted or welded construction. The legs shall be of box type / rolled, with all angles on the inside of the leg. Field welding will not be accepted. Diaphragms shall be provided to distribute the loads properly to the two sides of the legs and plate stiffener shall be provided wherever necessary. Bearing surfaces of joints designed to transmit stress by bearing shall be machine finished to provide full contact. Shop connection in the frame shall be riveted or welded so that the surface of the crane including the outside of the frame cabin and hoist housing when viewed along with runway, will be a plane surface, except for the projection of rivet heads if any. The structures shall be designed to be adequate for each of following load combinations.

a) Dead and live loads, wind load of 50kg per sqm on the surface of crane with appropriate impact loads.

b) Dead and live loads, wind load of 50kg per sqm on the surface of crane with tractive forces.

c) Dead loads with no load on lifting blocks and 150 kg./ sq.m storm wind loads

d) Breakdown torque of motor

e) Collision of buffers and track stops.

2.8.7.3 Legs

The gantry legs shall be connected to the crane members by heavy gussets in a manner that will prevent skewing and ensure rigidity and strengths. Diaphragms shall be provided to distribute properly the loads from the cross embers to the side of the legs. If the centre lines of the legs are not matching with the centre lines of the crane runway rails, the eccentricity shall be considered in determining the stresses.

2.8.7.4 Machinery Housing

A weather tight housing constructed of structural steel sections and plates shall be provided. The floor shall be constructed of reinforced chequered steel plates not less

than 8mm thick and shall be welded or riveted to the framework. Clearance between the machinery floor and the roof framing shall not be less than 2 metres.

2.8.7.5 Operator's Cabin

The cabin shall be of closed type for outdoor services made of structural steel and shall be provided with sufficient ventilating type window to allow the operator to have a clear view of all operations and the cabin shall have ample space for the operation and maintenance of the equipment located in it. The floor of the cabin shall be made of steel plates fastened securely to the frame of the cabin and covered with TRANSITE' having not less than 12mm thickness. A foot operated rotary alarm gong of at least 300mm dia. shall be provided to the crane and shall be arranged for the operation from the cabin. Provision shall be made for access to the cabin by means of walkway from the ladders.

2.8.7.6 Platform, Walkways, ladders and handrails

All ladders, platforms and walkways necessary to provide access to the crane drive machines, shall be provided. The platform and walkways shall be designed for a live load of at least 500kg/sq m and shall consist of suitable non-slip steel plates riveted or welded together and riveted or bolted to the steel framework except that the walkway on the top deck of the gantry shall be constructed of floor grating. The ladders shall be not less than 400mm width between side parts and shall have round rungs 20mm in dia. spaced at 300mm centres. The walkways shall provide clearance of not less than 600mm between machinery and/or the structure and the hand rails. Clips shall be provided on all open edges of the walkways and platforms. Standard pipe handrails with two horizontal pipe rails shall completely enclose all walkways. The handrails and ladder rungs on the outside of the crane shall be made of steel having fittings of the flush jointed type. Hand railing shall be provided along the open side of the walkways, platform, stairs and other locations where required. The platforms are required to be proportioned for a moving a single load of 300 kg. Railing is to be proportioned for a traveling horizontal single load of 30 kg acting on the rail iron.

2.8.7.7 Buffers

The spring buffers shall be provided at either end of the travel of gantry crane and movable trolley and shall be capable of bringing the crane to a gradual stop in a distance of not more than 200mm when traveling in either direction at rated speed while power off and brakes not applied, without producing excessive stress or damage in the structure. The buffer stops shall be of cast or structural steel, accurately mounted to meet the buffer squarely. The centre line of contact shall be above the centre line of wheel base. The design of the buffers shall provide minimum factor of safety of six.

2.9 Mechanical Equipment

2.9.1 General

The hoist shall be designed in accordance with IS: 6938 & IS: 3177. All mechanical equipments shall be simple and substantial in design and capable of being easily erected, inspected, painted and taken apart. The hoist shall be single motor twin drum type, connected through gearing and shafting. The capacity of motor shall be such that

the specific performance of the hoist at rated load will not demand more than full load torque. The shaft connecting and end gear trains shall be provided with flexible coupling of the geared type, or any other approved arrangement which will permit one drum to be rotated with respect to the other drum and keeps the lifting beam in a level position. All shaft loads shall be transmitted by suitable keys, splines or pins. The transmission of loads by press fit only will not be permitted. A factor of safety of FIVE over UTS shall be used in design of all mechanical parts, provided that all parts of the equipment shall have sufficient strength to resist the forces produced by the rated breakdown torque of the motor without exceeding 80% of the yield point strength of material used. If the duty factor is considered in breakdown torque conditions, the stresses shall be limited as per IS: 3177. The hoist shall be so designed as to limit the maximum rope fleet angles to one in twelve, unless otherwise approved. The grooving on the main hoist drum shall be such as to allow the lifting beam to travel vertically. The hoist shall be provided with an electro-magnetic brake and means to control the position of the hooks during lowering and raising.

2.9.2 Wheels and axles

The crane shall be carried on not less than eight wheels, four wheels in tandem, fully equalized and provided for each crane travel base. The wheels shall be heat treated properly and certified copies of the test of the heat treatment shall be furnished by the wheel manufacturer. The tread width shall have the proper clearance for the rail head and shall be of sufficient size to withstand satisfactorily maximum standing and rolling loads. In no case shall be diameter of the crane wheels be less than that given in IS:3177. The wheels shall be turned or ground to true and uniform diameter concentric with the bore. The wheel axles shall be made of forged carbon or alloy steel and shall be accurately turned, ground and polished at journals. All axles shall be forced into the wheels at a force not less than 3200 kg per cm of axle dia. And driving wheel shall be keyed to the axles in addition to the forced fit. All wheel journal boxes shall be drip proof and shall be provided with self-lubricating bronze bearings accurately machined and correctly bored for the axle fits or may be provided with roller bearings with high pressure grease lubrications. The wheel assemblies shall be designed to facilitate removal of wheels, bearings and journals from the frames. They shall be arranged such that wear may be compensated in order to maintain the drive gears in proper mesh. The size of the journal shall be ample to carry the load at the specified speed without excessive heating during continuous operation. Track sweeps on each end shall be provided and shall extend below the top of the rail on both sides. Wheels shall be exchangeable.

2.9.3 Gantry Drive

The gantry crane motion shall be affected by means of motors and shall be designed to move the crane at a rated speed while supporting the rated load. Not less than 50% of the wheels on each track shall be connected for driving. Each motor shall be mounted at one end of the gantry crane shall be arranged to drive one track on each side of the crane through gears. (The general arrangement is shown in the drawing). The drive shall be free from vibrations while moving and in no case; there shall be any tendency for gantry crane structure to get misaligned.

2.9.4 Brakes

Following brakes shall be provided on the gantry crane

a) Hoist Brake

The hoist shall be provided with an automatic electromagnetic brake and a hydraulic thruster brake of suitable capacity. The electromagnetic brake shall be mounted on the same base as the hoist motor and shall be electrically operated, spring set, solenoid release, shoes type brake and shall be equally effective in both directions of motor rotation. The brakes shall have capacity equal to one and half times the rated full load torque of the motor. The brakes shall be rated on continuous basis and shall be capable of withstanding not less than 4 operations per minute. The brake shall be equipped with manual release, which must be held by hand and cannot be left in the released position. The brake shall reset automatically at all times when the power is disconnected.

The terminals of brake magnet shall be protected from accidental contact. The connections and windings shall be effectively protected from mechanical damage. When necessary, magnet shall be provided with an efficient cushioning device. In addition, a mechanical load brake is to be interposed between the winding drum and the source of power. It shall have a capacity equal to one and a half times the rated load and shall be designed to prevent the load from moving downward unless the hoist motors are revolving under power in the lowering direction. The brake shall preferably be of suitable multiple disc type and shall run in a bath of oil. The casings shall have sufficient heat dissipating capacity to maintain the temperature of both below 93 degree centigrade when lowering the rated load with the electric break in operation, and if required, an external cooling device shall be provided to prevent this maximum temperature from being exceeded.

b) Gantry motion and parking brakes

A shoe type mechanically or hydraulically operated brake controlled through a foot pedal in the operator's cabin shall be provided to control the crane travel in both directions of motion. The brake shall have a capacity equal to one and a half times rated full load torque of driving motors and shall be so designed that it may be secured in the set position. The foot brake shall require a force not more than 20 kgs at pedal and the pedal stroke shall not exceed 150 mm.

Electromagnetic brakes shall be provided for parking of crane, which shall apply automatically when the current supply to the mains is switched off. These parking brakes shall be in accordance with IS: 3177. (All brakes shall be of standard/reputed make as mentioned in other para)

2.9.5 Wire Rope

The wire rope shall be made of special improved plough steel of 6x36 or 6x 37 constructions, ordinary lay, fibre core and shall conform to IS: 2266. While calculating the dia. of wire rope, the efficiency of pulleys, sheaves and drums shall be considered. No rope thicker than 38 mm in dia. shall be used.

In case of multiple falls, the wire rope shall be provided with equalizing bar/turnbuckle to prevent the unequal stretch of rope. The rope shall be guided over as few pulleys as

possible. Reserve 'S' shaped bands shall be avoided. The minimum factor of safety based on minimum breaking strength and safe working load of wire rope shall be as under:

(ii) Normal operating condition: 6

(iii) Breakdown torque: 3

The strength of socket ends of wire rope shall be approximately equal to that of the rope. The ends of wire rope shall be secured against twisting. The material for wire rope socket shall conform to IS: 2485. Molten zinc shall be used to socket the rope. Such specimen shall be subjected to destructive tensile test in which rope shall fail first than the socket or joints.

2.9.6 **Rope Drum**

The drum design, shape of grooves etc. shall conform to IS: 6938

2.9.7 Gear and pinions

Spur gears of 20 degrees pressure angle full depth involute system conforming to IS: 3681 shall be provided in end reduction gear unit. While designing the gears and pinions, in accordance with IS: 6938 and IS: 4460 the correction factor for peripheral speeds and the efficiency shall also be considered. The teeth of gears and pinions shall be cut from solid metal and shall be free from chatter marks and other imperfections. The pitch line shall be scribed on all gears and pinions to facilitate erections, such that gears and pinions shall have a common tangent to P.C.D. In the design of gears, due consideration should be given for duty factor for appropriate class of mechanism. The materials for pinions shall be harder than that of gears by at least 50 B.H.N.

2.9.8 Reduction Gear Box

It shall consist of worm & worm wheel of bronze or steel and whole assembly housed in a dust proof steel casing with suitable lubrication facility. The gear box shall have self locking characteristic. The shaft shall extend through housing for a sufficient length to permit the attachment of flexible coupling in proper alignment and shall be designed and rated in accordance with the accepted Indian Standard Code of practice. (Gear Boxes shall be of reputed makes as mentioned in other para)

2.9.9 Shafts for gears and pinions

The shafts shall be designed for combined torsion and bending and the angle of twist shall be taken into account, as detailed in the IS: 6938. The shaft for drum shall preferably be stationary.

2.10 Sheaves and Pulleys

The rope sheaves shall conform to IS; 6938. All pulleys shall be in true running balance and shall be provided with antifriction bearing with pressure greasing arrangement.

2.11 Bearings

All the running shafts shall be provided with ball, roller or self lubricating bush bearings. The selection of the bearings shall be done on considerations of duty, load and speed of the shafts as recommended by the manufacturer. All bearings shall be leak proof, weather proof, drip proof and shall be protected against the entrance of rain, dust or any other foreign matter. (Bearings shall be of standard/reputed make as mentioned in other para)

2.12 Flexible Couplings

Flexible couplings shall be all metallic, fully enclosed, dust proof, self oiling type and shall be bored for tight fits on the shafts. Straight square keys shall be provided for fitting the coupling on shafts. All couplings shall fit true on shafts and shall be fitted accurately on shafts. The flange couplings between motors and worm gear reducers shall be provided for both angular and offset misalignment of the coupled shafts. (Flexible couplings shall be of standard/reputed make as mentioned in other para.)

2.13 Lifting Hook and block

The block shall be arranged to lift the stoplog without twisting. The pulleys shall be mounted on roller bearing. The blocks shall be so designed and constructed as to guide the hoisting ropes fully and prevent them from leaving the sheaves under any operating condition. A guiding arrangement shall be provided for the pulleys to prevent the rope from leaving the pulleys due to any jerk.

2.14 Sockets for wire ropes

The sockets may be cast, forged or machined. Molten zinc shall be used to socket the ropes. Such specimen shall be subjected to destructive tensile tests in which rope shall fail first than the socket or joints.

2.15 Gear Box Covers

Gear box covers shall be of rigid construction fitted with inspection covers and lifting handles. The covers shall be so shaped that the gears can be easily removed or replaced. Facilities for lubrication, oil draining, oil level indicating etc. shall be provided where necessary. The thickness of metal sheet for cover shall be not less than 3mm.

2.16 Counter Weight

Suitable counter weight shall be provided to make the crane stable under conditions laid down in para 3.7.3.5.

2.17 Key and Keyways

The size of the keys shall be such as to be within safe bearing and shear limits for the materials in contact and, in general shall conform to the relevant IS codes for square and flat keys. Where round end keys are used, the total cross sectional area may be considered in effective shear. But in calculating bearing stresses in keys and keyways, the projected area of the rounded ends shall not be included in the effective bearing area. If two keys are used, that shall be placed 120degree apart. The design shall be such as to hold all keys effectively in place. Further, keys and keyways shall have rounded ends having tight fits in the seats. Keyways shall not be extended into the bearings.

2.18 Wrenches and Tools

A suitable grease gun and a complete set of wrenches and tools in a pressed tool box shall be furnished for the crane. Sufficient quantity and variety of tools shall be furnished to cover all ordinary maintenance work of the clane. Operating instructions in a suitable metal frame covered with glass shall be mounted at a convenient location in operator's cabin.

2.19 Electrical Equipment

2.19.1 General

All electrical equipment's furnished under these specifications will be subjected to severe moisture conditions and shall be designed to prevent deterioration from corrosion and shall be insulated accordingly. All wiring of the electrical equipment shall be in accordance with the Indian Electricity Act in force and the relevant IS Code. The wiring shall be in hot dipped galvanized metal conduits. Conductors having nominal equivalent copper area of cross section of a 9.5 sq. mm shall be used for power wiring of motor and those having 1.5 sq. mm for control circuits and auxiliary wiring. Conductors shall normally be insulated for not less than 1100 volts and shall have standard moisture resisting, double braided insulation cover.

2.19.2 Electric Motor

Motor shall be of totally enclosed with or without fan cooling slip ring type design for operation on 3 phase, 415 volts, 50 cycles per sec. A.C. conforming to IS: 325 of rated capacity. The motor shall be suitable for supply voltage variation of ± 10% and supply frequency variation of ± 3%. Each motor shall be equipped with heater to prevent condensation of moisture drawn into the motor during shut down period.

The contractor shall enclose the full technical particulars of each motor, indicating (a) the values of the locked rotor, starting, rated and pull out currents, (b) starting, rated, breakdown torques, (c) make, class of duty, number of poles, start/hr, CDF, type of insulation etc.

Selection of motor shall be as per IS: 3177. Motors of 40 h.p. or less shall be rated in accordance with IS:325. Service factor of 1.15 shall be accounted in deciding the capacity of motor. The motor shall be suitable for out door, crane duty, S-4 class, 150 starts/hour with 40% CDF and shall be of standard capacity and specification in

accordance with BIS or equivalent international standard marked and of reputed make like. Siemens, Kirloskar, NGEF, GEC etc.(as mentioned in other para**)**

2.19.3 Master Control Equipment

Master control equipment shall be so placed in the operator's cabin that the operator may control all the functions of the crane from there. The operator's stand shall be placed in such a convenient position that enough room is available for various operations of gantry crane and operator may have unrestricted view of the load. All motor controls shall be fully magnetic, reversing with definite time limit and equipped with frequency controlled acceleration devices, instantaneous over current, over loads and low voltage protections. When starting from complete standstill with full rated load of the hook, they shall be designed so that it will be possible to limit the vertical movement within 10mm from main hook. All hoist motor controllers shall have at least six speed control points in each direction of operation. The contact of protection relays of any motor shall be so wired that the operation of the relay will trip the motor primary conductor, thus making it necessary to return all control to the OFF position before the motor can be started. The control shall be so interlocked that only one operation can be performed at a time.

The instantaneous relays shall be adjustable between 200% to 300% of motor full load current. The power supply from the main connections shall be protected by three pole 415± 10% Volts. A.C. totally enclosed air circuit breaker equipped with three time relays, direct acting overload tripping element and one shunt trip coil located in the operator's cabin for emergency tripping. A circuit breaker shall be provided to control and protect the control circuit for each motor and all control circuits shall be fused properly. An indicating lamp shall be provided to show that the control circuit is healthy. All switches, contactors and relays shall be enclosed in suitable cabinets and placed in accessible location to facilitate inspection and maintenance. All motor controls shall have master switches with vertical handles. Changes in speed while lowering the load shall be under the direct control of the operator and shall permit him to stop the motor without time delay from any position by the master switches. All resistors shall be non-breakable corrosion resisting type and shall have a low temperature coefficient. Where practicable, controller handle should move in the direction of the resultant movement. Each controller shall be marked in a permanent manner to show the motion concluded and wherever practicable of the direction of the movement. The notching for the controller handle in 'off' position shall be more positive than the notching in other position. The control lever shall be provided with stop and/ or latches, to ensure safety and facility of operation.

The resistor shall be placed in accessible places outside the cabin and in a well ventilated non-combustible cabinets which will not emit flame. Each main supply circuit breaker shall have interrupting capacity of not less than 50 KA. All switches, conductors, primary relays and preliminary circuits on controllers shall have a thermal capacity of 50 KA, for one second without injury. The resistor shall preferably be intermittently rated and their rating will be as per IS: 3177. Allowable temperature rise during operation of the crane under service condition shall not exceed the limits specified in relevant IS code. The contractor shall state in his tender the make and types of all electrical equipment, which he proposes to furnish. All switches controller

levers and other operating mechanism and electrical devices shall be subject to the approval of the Engineer-in-Charge.

2.19.4 Cables and Cable Reel

The rubber insulated cable or polyvinyl chloride insulated cables used for crane wiring should comply with the relevant Indian standard code. The gantry crane shall be equipped with an automatic spring actuated device to take up cable reel. Power will be obtained from plug receptacles placed at convenient intervals of the runway. The cables and reels shall be provided with sufficient length of flexible cable and with limit switches arranged to cut off the power supply to the cable of the motors, when all but two turns of the cable are unreeled. The attachment plug for the receptacle and of the cable shall be furnished by the contractor.

2.19.5 Wiring

All wiring shall be hot dipped galvanized metal conduit. All conductors for primary power lighting and control circuit shall be insulated for not less than 1100 volts and shall have standard moist resisting double braided covering. All conductors between the secondaries of the motor conductor and resistors shall have sufficient current carrying capacity in accordance with Indian Standard and shall be insulated with 1100 volts class insulation. The primary conductor to the motor shall have standard continuous current carrying capacity of not less than 100% of the rated full load primary current of the motor. Cables having conductors smaller than 2.5 sq.mm nominal equivalent copper areas of the cross section shall not be used for the power wiring for any of the motor. For control circuits and auxiliary wiring, cables having a sectional area smaller than 1.5 sqmm nominal equivalent copper area shall not be used. All cables shall be adequately protected against mechanical damage and metal trunking may be used if desired. Electrical conduit shall comply with the relevant Indian Standard. For outdoor cranes except where flexible unarmored cables are essential, cables shall be either armored or enclosed throughout their length in galvanized trunking or conduit, either flexible or rigid. A flexible metallic tube or duct may not form an effective earth connection and shall not be used for that purpose. Tapped and braided varnished cambric insulated cables shall not be used for outdoor crane.

2.19.6 Limit Switches

The limit switches shall be of the totally enclosed type. All limit switches shall be capable of being reset by reversing the controllers. The limit switches shall have water proof coverings and shall be suitably designed and tested for normal lift and satisfactory operation under the humid climatic conditions. They shall be of approved and standard type and shall be suitable for service under extreme position in either direction. The design shall be such as to facilitate easy servicing and replacement when worn-out. Limit switches shall be provided for following operations.

1) To limit the travel of gantry crane at both ends of the travel and to stop the gantry crane at centre of each span

2) To limit the hoisting travel of the hook

3) To limit the travel of the trolley at the both ends of the travel and to stop the trolley at limiting point

2.19.7 Isolating Switches

The manufacturer shall fit a main isolating switch in the cabin or adjacent to it., capable of disconnecting the supply of power driven and associated equipment on the crane but not the auxiliary loads such as lighting and heating circuit. In the case of main isolating switches being combined with the crane protective panel, it shall be mechanically interlocked with the door giving access to the panel, and the terminal shall be screwed to prevent accidental contact when the door is opened When so combined a suitably worded red warning plate shall be attached to the cover of the protective gear and all other panels and controllers, not fitted with interlocked isolators. The main isolating switch and the additional isolating switches should be so situated that it will be possible to carry out any maintenance work or functional testing on them without danger.

2.19.8 Protective Equipment

Iron clad electric protective gear in accordance with IS:3177 shall be provided except that if the aggregate power of the two largest motors is less than 30kW, and their aggregate current rating is less than 60 amps, a manually operated equipment as per IS:3177 may be used.

2.19.9 Emergency push button

A push button emergency stop shall be so located as to be readily accessible for prompt use by the operator in case of emergency. This emergency push button shall be connected in the operating coil circuit in case of contactor and in the under voltage release circuit in the case of a circuit breaker.

2.20 Lighting at convenient outlets

The permanent 220 volts lighting system on the crane shall consist of four 500 W high bay lighting units to illuminate the area under the crane, one 500 W high bay lighting unit to illuminate the area under the cantilever and 2x80 W fluorescent tubes in the operator's cabin. The system shall be supplied from 415V± 10% crane power system through a circuit breaker with a convenient outlet in the operator's cabin. One branch circuit system shall be connected for lighting hoist mechanism through flexible conduit with 4 x 100 W lighting units. Each of the two 500W high bay lights and another branch circuit shall be connected to give convenient outlets. The wiring shall be done in accordance with the Indian Electricity Rules 1937. The circuit breakers shall be enclosed, two pole type with an over load tripping element for each pole.

2.21 Interlocking and Earthing

‘ Off position interlocking, earthing and other electrical equipment shall be provided as per IS: 3177.

2.23 List of approved reputed manufacturers of mechanical and electrical equipment used in hydro-mechanical installations are given below.

Sl. No	Item	Make
1.	Reduction Unit	David Brown, Elecon, New Allenberry, Allen-Max., Allmax., Allroyd ,Shanti Gears
2	Bearings	SKF, FAG, NSK, NTN, KOYO & NBC
3.	Flexible Couplings	New Allenberry,Allflex
4.	Motors	Siemens, Kirloskar, NGEF, GEC, Crompton Greaves Cotton.
5.	Brakes	Electromag, Strom Kraft, Elmar, AEC, Sterling controls.

2.24 Automatic Engaging and Disengaging Type of Lifting Beam for the operation of Stoplogs for Spillways.

2.24.1 General:

1. Lifting beam of automatic engaging and disengaging type equipped with two hooks shall be provided for handling of stoplogs for Spillways.

2. The arrangement of lifting beam, location of lifting lugs and side guide rollers and stoppers shall be as shown in the specification drawings.

2.24.2 Details

1. Two numbers of guide rollers shall be provided on each side of the lifting beam. Guide rollers/shoes on the same side shall be adequately separated from each other to prevent any tilt of the lifting beam during operation. The centre to centre distance of side guide rollers shall not be less than one tenth of the length of the lifting beam or 500 mm whichever is larger.

2. Hooks:

a. Lifting beam hook mechanism shall provide for automatic engagement and release of the equipment to be handled. The two hooks shall be mechanically linked together for simultaneous operation.

b. Hook profile shall be such that with consideration of the guide plate location and of the clearances provided on the gate equipment to be handled, the hook shall work properly even in the worst condition of alignment due to shoes and due to manufacturer's deviation from design dimensions.

c. The hooks and lifting lugs provided with lifting beam shall be located at centre of gravity of the gate equipment to be operated when the lifting beam guides rollers/shoes are engaged in the guide

d. The engaging surface (profile) of the hook shall be hard faced to a minimum depth of 10 mm. and shall be machined smoothly for uniform bearing of pin.

e. In case of curved shaped hooks, the design shall be done as curved beam with appropriate structural design method.

3. The lifting beam shall be counter weighted as required to hang plumb and level when suspended.

4. All rotating parts of the lifting beam shall be provided with corrosion resistant steel pins and aluminum bronze bushing/roller bearings. All nuts, bolts and washers and retaining devices for pins shall be of corrosion resistant steel.

5. The lifting beam shall be provided with suitable stoppers, which shall rest on the gate equipment to be handled / engaged in spear rods provided on gates when it is lowered and pull of the hoist is completely released.

6. Seating brackets shall be provided to sit the lifting beam on the floor without damaging the hook. The bracket shall be retractable when required to avoid interference with gate equipment when lifting beam is in operation.

2.25 Design Criteria:

2.25.1 Mandatory features:

The lifting beam shall be designed in accordance with IS :13591. General features indicated in the specification drawing shall be adopted without change or substitution. Alternative arrangement and alternative features indicated on specification drawings shall be accepted only if in the opinion of the engineer-in-charge, the result is not inferior to the arrangement and details indicated in the specification drawings. Mandatory features shall be as under:-

a. All features referred to in these specifications and as shown in the specification drawings.

b. Feature related to civil construction and equipment to be furnished by other agencies such as civil work outline dimensions and gantry

c. All elevations.

d. General layout and arrangement of the equipment to be handled and the dimensions defining the location of equipment relative to civil work.

e. Dimensions, clearances, measurements etc. designated by “maximum”, “minimum” to be applied as upper or lower limit for design. All tolerances mentioned in the drawing/ related Indian Standards and as recommended by the Engineer-in-Charge.

f. All machining involved and designation of surface finish qualities.

g. All indications referring to manufacturing processes (such as machine after welding” or “drill during shop assembly”) as contained in specifications, specification drawings and related B.I.S. Standards.

h. All applicable Indian Standards shall be specified by the Engineer-in-Charge.

(Request regarding adoption of a particular Standard only, from contractor shall not be binding on the Engineer-in-Charge.)

i) If lifting beam frame arrangement is adopted, the depth of frame shall not be less than 1/12 times the span (length) or lifting beam or 1m whichever is more.

ii) *While computing the deflection of lifting beam, it shall be ensured that due to the deflection of beam, side guide shoes or rollers neither develop excessive gap with guide tracks / plates, nor get jammed with them. The check has to ensure rigidity of the beam for proper functioning*.

2.25.2 Design Loading

a General:

i) The lifting beam shall be designed to comply with the specified structural and mechanical requirements, when subjected to each one of the loading conditions listed in the Para b

ii) Calculations may be limited to critical loading cases if it is evident that only those cases are critical. If the selection of the critical cases is not evident or if so requested by the Engineer-in-Charge, the manufacturer shall furnish the technical demonstration to justify its selection

iii) All load combinations shall be made as specified in these specifications and related Indian standards. Whenever any particular load specification is not specified, the method of calculations shall be submitted to Engineer-in-Charge for his approval. The overall design loading shall be such that with unfavorable load combinations, greatest factor of safety is achieved in design.

b. Design load:

The lifting beam and its connections with gantry cranes and stoplog gate shall be designed for following conditions:-

i) Hook loading with impact factor of 1.3 over hoist capacity under the normal load conditions.

ii) The impact factor need not be considered under breakdown torque condition of gantry hoist motor.

iii) Loading caused by the guiding system shall be calculated and accounted for in (i) & (ii) above as under :-

a) When stoplog unit is not submerged in water, the effort required to counteract gate swing shall be considered – higher of either 5% of the weight of gate or surface loading of 50 kg/sq.m of gate surface area. The projected area of gate outline in either direction shall be considered as Gate area.

b) Water turbulence shall be considered as force acting on projected area of the lifting beam of intensity equal to 200 kg/sq.m

c) Additional friction and/or blocking forces originating in the guiding devices and seal of the gate when the hoist exerts a force equal to the rated hoist capacity instead of the normal hoisting force.

d) Dead weight of the lifting beam alongwith its hooks, rollers, links, counter weights etc. shall be combined with all loading conditions.

2.25.3 The Structural Design

The structural design of the lifting beam or frame shall conform to IS: 13591 and IS: 800 (latest). Various provisions as mentioned in IS: 13591 and IS: 800(latest) for structural components shall be met with allowable stresses as specified in these specifications. Wherever specific value of stress or design factor are not specified decision of Engineer-in-Charge or his representative or his authorized consultant shall be final.

2.25.4 Allowable Stresses:

a. The allowable stresses shall be adopted as mentioned hereunder:-

Sl.No.	Type of Stress	Normal Loading	B.D.T. Loading
1.	Direct bending and bending in compression/tension (a) Mechanical components like pin, hooks etc (b) Structural members	0.2 U.T.S. of material 0.55 YP of materials	0.8 YP 0.8 YP
2.	Shear stress	0.3 YP of material	0.4 YP
3.	Bearing stress	0.75 YP of material	0.85 YP
4	Bearing stress for bronze	0.035 U.T.S.	0.08 YP

b. For overload conditions, allowable stresses given for normal loading may be increased by 33% except that bearing stress shall not exceed 80% of yield point stress.

c. Equivalent stress resulting from combination of biaxial or triaxial stresses may be 25% higher than allowable monoaxial stresses subject to maximum of 0.8 YP.

d. In allowable stresses appropriate duty factor of the crane should be accounted for.

e. Antifriction bearings shall be as suited for the appropriate load condition. Static capacity of bearing shall provide a minimum safety margin of 25% over B.D.T. loading on lifting beam.

2.25.5 Material Specifications:

For general condition of testing the material please refer Chapter-III.

Recommended materials for Lifting beam and its components are given below:-

Sl.No.	Component	Recommended material	Reference
1.	Structural components of lifting beam, guide roller, diaphragms etc.	Structural steel	IS: 2062
2.	Axles	Corrosion resistant steel	IS:1570 (Part 5)
3.	Hooks	a. Forged steel b. Structural steel	IS:1875 IS: 2062
4.	Bush for hooks	Aluminum bronze	IS:305
5.	Bearing for Pulleys	Roller bearings	Standard make
6.	Sheaves & Rollers	Cast steel	IS: 1030

CHAPTER – 3

3.0 MATERIALS

3.1 All the materials shall be of tested quality, new, unused, free from defects and of the grades/classification envisaged in the designs. The contractor shall furnish the test certificate for each lot of materials, if so required by the purchaser. Plates with laminations discovered during welding or during inspection shall be rejected. Materials not supplied according to the approved Design/Drawing shall be rejected, removed and replaced. Approval of purchaser shall not relieve the manufacturer from responsibility materials.

3.2 The contractor shall furnish a list of names of manufacturer(s) of the bought our items, which are contemplated for incorporation in the work, together with performance characteristics and other pertinent information pertaining to the equipment, for the approval of the purchaser, Samples of materials, if desired and so directed, shall be submitted for approval. Any equipment, materials and articles used or installed without the prior approval of the purchaser shall of the risk and cost of the contractor.

3.3 If for any reason, the contractor desires to deviate from these standards, be shall submit a statement starting the exact nature of the deviations or substitution along with complete and detailed specification and test reports for the materials, which are proposed to be used. In all such cases, the prior approval of the purchaser has to be obtained before the fabrication work is taken in hands. All the materials, supplies and articles not manufactured by the contractor shall be the standard products of recognized and reputed manufacturers.

3.4 Defective materials shall not be required and used in the construction of the equipment without prior approval. No penning, caulking or filling shall be permitted in repairing cracks, pinholes, or blowholes. Defects in weld shall be repaired by chipping out to sound metal and shall be rewelded. For defects in casting, the method of repair shall be mutually agreed upon by both the contractor and the Engineer-in-Charge. However, this shall not be construed to prevent repair of material purchased in accordance with ASTM or similar standards to the extent and in the manner permitted therein.

CHAPTER - 4

4.0.0 MANUFACTURE

4.1.0 General Workmanship

All fabrication work under this Contract shall be done in accordance with the specifications, which meet the purchaser's approval. All the works shall be performed and completed in a through workman like manner as per best practice in the manufacture and fabrication of materials of the types covered by these specifications. In all cases the work shall be of highest quality and carefully performed to the satisfaction of the Engineer-in-Charge. The Contractor shall warrant all materials and workmanship furnished by him to be free from injurious defects. He shall replace, free of cost, any defective material or workmanship noticed during creation. And shall bear all cost of the modification of any defect, in the field, for which he is responsible. Workmanship shall conform to the latest standards, laid down in Indian Standards Specifications.

All members shall be free of twists, bends or other deformations and all surfaces that will be in contract shall be thoroughly cleaned before assembling, parts shall be adjusted to line and fir and shall be firmly bolted or otherwise hold securely together so that surface are in close contract before drilling, reaming or welding commenced.

Plates with lamination discovered during cutting, welding or at any other time shall be rejected. Minor surface imperfections can be required wherever possible with the prior approval of the purchaser. Materials not supplied or workmanship not performed in accordance with approved drawing and specification shall be rejected and replaced. If transport clearances do not permit the weight and sixe due to limitations, the anchorages and miscellaneous embedded parts shall be fabricated into sub-assemblies into which be propose to fabricate the gates, stoplogs, anchorages, other assemblies and embedded parts for transporting them to site.

All the parts of the gates and stoplogs, shall be fabricated in accordance with these specifications, and drawings. The manufacturer shall take special care in fabrication of the parts affecting strength, rigidity and water tightness of the gate and stoplogs. Attention is directed to the fact that rolled edged plates are not suitable for caulking. The seal bores shall be finished after the plates have been welded to the skin plates and the finished surfaces of the seal bases shall be in the same plane within tolerance as specified in relevant IS code.

The Contractor may submit for the approval of the purchaser an alternative procedure for finishing the seal bases or for fastening then to the gates provided that the suggested method produces a water tight seal arrangement and that the final shape and size of the plate meet the dimensional and the tolerance requirements, shown on the drawing or stated in these specifications.

Holes for the wheel pins shall be bored and counter-bored in pairs to a common axis, after the leaf has been assembled and all the shop welding has been completed. The axis of these holes shall be in common plane, which shall be parallel to the finished surface of the seal bases within specified tolerances. All holes shall be accurately

spaced, cylindrical and perpendicular to the members. All counter sinking shall be true and square with holes. The seal rings provided in the wheel assembly shall be products of established manufactures and must be perfectly watertight.

4.2.0 Tolerances

Where tolerance of fits are not specified on the drawing, the Contractor shall follow the best modern shop practice for apparatus of the type covered by those specifications and drawings, due considerations being given to the special nature of function of the parts and to the corresponding accuracy required to secure proper operation.

4.2.1 Fabrication Tolerances

All components shall be fabricated in accordance with relevant IS Code on gates and hoist except as below :-

All dimensions under 400 mm. shall be within a tolerance of $\pm$ 0.8 mm. unless otherwise specified and are not-cumulative. All other dimension shall be within a tolerance of $\pm$ 1.5 mm.

The machines surface of the sill seat shall be straight with $\pm$ 0.5 mm. and level with $\pm$ 1.0 mm. over the whole length with a straight

4.2.2 Installation Tolerances

Installation tolerances shall be exceed 1.5 times the corresponding fabrication tolerances or the tolerances specified in the relevant codes on gates and hoists, whichever is more stringent. The design and fabrication of the gates, hoists and embedded parts shall be such that the required tolerances are achieved during installation.

4.3.0 Machine Finish

The type of finish, unless otherwise specified shall be the most suitable for the part to which it applies and shall be smooth, average or rough as defined under IS: 3073-1974. In general, a very smooth finish (three delta > 0.2 to 1.6 microns) will be required for all surfaces in sliding / rolling contact, an average or commercial finish (two delta > 1.6 to 6.3 microns) for surfaces in contact where a tight joint is required and a rough finish (single delta > 6.3 microns) for all other machined surfaces where selective assembly for matching parts is required. The parts shall be ground to obtain the limiting tolerances, if necessary.

4.4.0 Castings

While making patterns for the castings, care shall be taken to avoid sharp corners or abrupt changes in cross section and sample fillets shall be used. All casting shall be true to patterns and the thickness of the metal shall not vary at any point by more than 5 mm from that shown in the drawings. Care shall be taken in the foundry to cool the castings properly so that they will not warp or twist. No casting will be accepted if it is

warped or twisted to such an extent that machined surfaces cannot be properly finished to the dimensions shown on the drawing.

All casting shall be sound, clean, free from cracks, holes or sand holes and other defects. These shall have a workman like finish. Castings shall not be required, plugged or welded without the permission for the purchaser. Such permission shall be given only when the defects are small and do not affect the strength, use or mach inability of the castings. No welding shall be done after the castings are finally annealed. No defect shall be removed / painted nor oil be applied to the surface of any casting until it has been inspected by the Engineer-in-Charge.

The treatment for casting involves heating slowly up to a temperature of about 40^0 C above is upper critical temperature, holding its at such temperature long enough to attain uniform temperature throughout the casting and then allowing it to cool slowly in furnace. During the process of annealing the temperature shall not exceed and over beating shall be avoided. End products shall conform to the requirement of relevant Indian Standard. All casting shall be ultrasonically tested to ascertain soundness of castings. Acceptance criteria as specified by purchaser shall be binding.

4.5.0 Forgings

Forging unless otherwise specified, shall be in accordance with IS 2004. The ingots from with the forgings are made shall be casted in metal moulds. The workmanship shall be first class in every respect and the forging shall e free from all defects affecting strength and durability, including seams, pipes, flows, cracks, scales, fins, porosity, hard sports, excessive non-metallic inclusions and segregations.

4.5.1 All forging shall be given such uniform heat treatment as required to produce materials conforming to the requirements of the specification, and shall be annealed or normalized and tempered as final heat treatment. In case of shafts forged solid, required to be bored, and final heat treatments shall be performed after the forging has been rough bored.

4.5.2 In each heat treatment, the forging shall be held at a desired temperature for a sufficient length of time to ensure penetration of the heat and proper grain refinement throughout the whole forging. A record of beat treatments to which the forging has been subjected shall be supplied to Engineer-in-Charge.

4.5.3 The billet corresponding to largest section shall be used wherever a change in section occurs. Tool marks or tearing of metal be the finishing tool shall not be acceptable on the surface of fillets. Such marks, if occurred, shall be removed by grinding or polishing. All finished surfaces or forging shall be smooth and free from tool marks.

4.5.4 All important forging like gate wheels, wheel pins, hoist drum, gears, crane, wheels etc. shall be ultrasonically tested. The acceptance limit of ultrasonic testing of forging shall be as per SA 388 of ASME section-5.

4.6.0 Fabrication of Structural Steel

The contractor is expected to perform fabrication in the best possible manner to meet the requirements of design and drawings.

4.6.1 Straightening of Members

Before being laid off or worked in any manner, structural steel be straight, without twists, bends or kinks, and if straightening is necessary, it shall be done by a method which shall not injure the metal to ensure good welding and fittings of members. All steel shall be cleaned of dirt, mill scale and rust prior to fabrication.

4.6.2 Shearing, chipping and gas cutting

Shearing, chipping and gas cutting shall be performed carefully and all portions of the work, which will be exposed to view, shall present a neat appearance. Sheared or cut edges of plates shall be finished to shapes as noted in these specification.

4.6.3 Edges to be welded

The edges of plates and shapes to be joined by welding shall be properly formed to suit the type of welding selected. The edges, of sheared plates to be joined by welding, shall be machined or chipped to sound metal. Plates and shapes to be field welded shall have their edges prepared in the shop for the type of weld selected.

4.6.4 Bent Plates and Shapes

Where bending or forming of plates or shapes is required, the plates or shapes shall be bent by cold forming. Heating and hammering to correct bends will not be permitted.

4.6.5 Welding

a. Welding Technique

Care shall be taken in designs that the welds, when being made, are well accessible. Overhead welding is to be avoided, if possible flat position should be strived for.

Drawings should clearly indicate the joint position, shop or field welding kind of welding method of welding, welding sixes and other required information. Symbols to be shown on the drawing should conform to relevant Indian Standards.

All welding shall be done by the electric are method by a process which will exclude the atmosphere from the molten metal, except where otherwise specifically permitted. All welding electrodes shall be finished by the contractor. Correct selection of electrodes shall be done taking due care of welding method and base metals of components. The welding electrodes shall be of the heavily coated type designed for all position welding. The make, type and size of all welding electrodes shall be subjected to the approval of the purchaser.

In assembling and during welding, the component parts of built up members shall be held in place by sufficient clamps or other adequate means to keep all parts in proper position. The surface to be welded shall be cleared of scale, slag, rust, paint and other

foreign matter. The thin coat of linseed oil need not be removed before welding. Where weld metal is deposited in two or more layers, each layer shall be brushed with a wire brush or otherwise cleaned before the subsequent layer is deposited. In welding, precautions shall be taken to minimize stresses due to heat by using the proper sequence in welding.

Upon completion, the welds shall be brushed with wire brush and shall show uniform section smoothness of weld metal. Edges and ends of fillets and butt joint welds shall indicate good fusion and penetration into base metals. Specific requirements for butt joints and fillet joints are given below.

Radiographic tests shall be carried out for all critical full strength butt weld. Welded joint requiring radiographic testing shall be decided by the purchaser.

i. Butt joints

In principle, butt joints should be made with back run. Should it not be possible to do the back-run, a backing strip should be placed and welding should be so made that the method metal fully penetrates to the backing strip of the slide butt welding should be executed so that the method metal reaches the back of the groove and a full penetration is achieved. Die-penetration test shall be carried out after each pass of the weld.

10% of butt welds in major stress caring members like horizontal girders, unsupported butt joints on skin plates shall be examined by radiographic tests. 50% of the remaining butt joints shall be examined by ultrasonic tests or magnetic particle tests**.**

ii. Fillet Joints

All fillet welds shall be continuous. For the main members, no fillet welding should be made on members whose thickness differ substantially. Filled weld at `T' joined should be made as a rule, on each side of the joint, unless it is otherwise agreed due to some practical reasons. Radiographic tests is not normally required for fillet welds. However, they shall be tested ultrasonically for soundness.

a. Qualification of Welding Process

A specification of the welding process, that is proposed to be used, shall be established and recorded and, if required, a copy of such specification together with a certified copy of report of results of tests made in accordance with the process and specifications shall be finished. The qualification of the welding process shall be at least equal to that required by `Standard Qualification Procedure' of the Indian Standards and the minimum requirement of the tests shall be at least as stated in the said 'Standard Qualification Procedure'.

b. Qualification of welders

The contractor shall be responsible for the quality of the work performed by his welding staff. All welders assigned to the work shall have passed qualification tests for welders. If at any time the work of any welder appears questionable, the welder shall be required to pass additional qualification tests to determine his ability to perform the type of work on which he is engaged.

4.6.6 Riveting

Rivers shall be drivers by power riveters, employing pneumatic, hydraulic or electric power. After driving their finished heads shall be of approximately hemispherical shape of uniform size throughout the work for the same size rivet, nearly finished and heated uniformly to a temperature not exceeding 1065^0 C. They shall not be driven after their temperature has fallen below 528^0 C. All shop drives rivets within a distance of 425 mm. from a shop welded joint shall be driven after the welding is completed. Recapping and caulking of loose or defective rivets will not be permitted. While removing defective units, care shall be taken not to injure the adjacent metal and, if necessary, this shall be drilled out.

4.6.7 Turned and Fitted Bolts

In cases where bolts have to be used but strength of a riveted connection is required, this can be obtained by using special bolts in special holes to a driving fit. The bolts are specially made from black round bars and turned down to the exact diameter. The inside of the head and flat face of the nut should be machined. The hole must be accurately drilled or reamed with a clearance of not move that 0.25 mm. The holes after assembly of the parts must be true throughout the thickness of all parts and perpendicular to axis of the member. Washers for turned and fitted bolts should be machined on both faces.

4.6.8 Set Screws

All set screws shall be provided with case hardened cup points and shall be safety type. They shall not be use for transmitting torsion.

4.6.9 Drilling and Reaming

Holes shall be accurately located and drilled or reamed perpendicular to the face of the member and, if necessary, shall be drilled to a template. Counter sinking, where required, shall be done carefully and to the full depth of head. Open holes in materials of 18 mm or less in thickness, shall be sub-drilled or sub-punched before assembly and reamed during assembly. Holes in structural steel of more than 18 mm in thickness shall be drilled 3 mm smaller than the normal diameter of the river or bolt, before assembly and reamed to the full size during assembly. All members shall be shop assembled before reaming or drilling holes for field connections.

4.6.10 Punching

For sub-punching, the diameter for the punch shall be 4.5 mm smaller than the nominal diameter of the rivet or bolt and holes shall be clean cut without torn or ragged edges.

4.7.0 Stress Reliving

Stress relieving of welded parts shall be done where permitted after all the welding is complete. Machined surfaces of the parts requiring stress relief shall be machined to

final dimensions after the parts have been stress relieved. Localized stress relieving will not be permitted for shop welded parts. The procedure for stress relief shall conform to IS :10801, IS: 10234 and IS:2825 (latest).

4.8.0 Painting

4.8.1 General

All prints, painting materials and accessories for painting shall be supplied by the contractor and shall be included in the price bid. The paints proposed by the contractor must be approved by the representative of the purchaser before application of the same. The analysis in respect of paint properties, paint composition and performance requirements of the paints shall be submitted by the contractor for examination and approval.

4.8.2 Preparation of Surface

1. Gate, Stoplogs, Hoists, Cranes, Lifting beam and Embedded parts

   a. Surface preparation shall be done in accordance with IS : 14177 and as per the following classification:-

      i) Gates, Exposed Embedded parts – Class A (Clause 4.2.1.1)

      ii) Stoplogs, Lifting beam, Rope drum hoist, Gantry crane,- Class B (clause 4.2.1.2)

   b. Weld spatters or any other surface irregularity shall be removed by any suitable means before cleaning.

   c. All oil, grease and dirt shall be removed from the surface, which is to be painted, by the use of clean mineral spirits, xylol, or white gasoline etc. and clean wiping materials prior to sand blasting is done. All surfaces to be printed shall, thereafter, be cleaned by sand grit blasting to bare metal without any residual adherents in any from. Small quantities or oil may be removed by the blasting process in which case, however, the abrasive should not be re-used, if it contains sufficient oil or grease to render it unsuitable for blast cleaning purposes.

      The average surfaces roughness after sand blasting should not exceed 40 microns. Sand blasting should be conducted with sand / grit/ shot of type approved as per IS : 14177 (Part –I). After blast cleaning, surface should be cleaned of loose dust and debris etc. with the help of air blast or blower.

   d. Surface of stainless steel, nickel, bronze and machined surface adjacent to metal work being cleaned or painted shall be protected by masking tape or by other suitable means during the cleaning and painting operations.

   e. Primers shall be applied as soon as the preparation of surface is complete and prior to the development of rust. The time gap between the application of primer and surface preparation shall normally not exceed six hours. In case there is considerable time gap, the surface should be re-brushed prior to priming.

II. Hoist and Supporting Structures

In respect of hoist, support structures and latch, the surface preparation shall be done as per the requirements of class B as specified in para 4.2.12 of IS :14177. In case the surface preparation is done manually by wire brush, mechanical tool etc. instead of sand blasting all ferrous surfaces exposed to atmosphere or water shall given a coat or

rust inhibitive phosphate wash by brush immediately following cleaning operation and surface shall be thoroughly wetted with rust inhibitive was @ approximately 30 ml / sq.m and allowed to dry for 24 hours rinsing after application generally not required but un-reacted residue, if any, shall be removed wiping the inhibitive surface with damp cloth within one hour of rust inhibitive wash had dried thoroughly and after removing un-reacted residue, the application of primer and finishing coats shall be carried out as indicated in the following paras.

4.8.3 Painting Schedule

4.8.3.1 Measures During Painting

a. Any bare spot shall be recoated with additional application of primer.

b. All run, sags, floods, or drips shall be removed by scrapping and cleaning. The cleaned area should be re-touched or all such effects shall be remedied by re-blasting or re-priming.

c. Special attention should be given to good coverage on rivets, welds and sharp edges and covers.

d. Suitable measure shall be taken to protect the applied primer from contact with rain, fog, mist dust or other foreign matter until completely hardened and next coat is applied.

c. The air temperature at the time of application must not he below 10 deg. C and relative humidity must not be above 90%.

4.8.3.2 Application Procedure

All paints and coasting materials shall be in homogeneously mixed condition at the time of application and shall not be thinned except as hereinafter specifically provided. Warming of the paint shall be performed by means of hot water bath. All surfaces to which paint shall be applied immediately after cleaning and except otherwise specifically provided, shall be applied by either brushing or by airless spray. When paint is applied by spraying, a mechanical agitator type of paint pot shall be used. Means shall be provided for removing all free oil and moisture from the air supply line of all spraying equipment. Each coat of print shall completely cover the surfaces and shall be free from runs, sags, pinholes etc. Each coat of paint shall be allowed to dry for harden thoroughly before the succeeding coat is applied.

All paints shall be applied by skilled workers in a workmanlike manner. Paint shall not be applied during damp weather and on the surfaces which are not entirely free from moisture. Rust preventive compound shall be applied by any convenient method to ensure complete coverage of heavy coating. After the final application, the paint film shall be allowed to cure at least for 7 days.

4.8.3.3.0 Gate & Embedded parts

4.8.3.3.1 Primer coat

After surface preparation the following coats of primer paints shall be applied:

a) Exposed Embedded parts

Over the prepared surfaces one coat of Inorganic Zinc Silicate primer preferably with the help of airless spraying equipment giving a dry film thickness of 70 $\pm$ 5 microns should be applied. Alternatively two coats of Zinc rich primer, which should contain

not less than 85% Zinc on dry film, should be applied to give a total dry film thickness of 75 ± 5 microns.

b) Gate & Stoplgs

Over the prepared surfaces one coat of Inorganic Zinc Silicate primer preferably with the help of airless spraying equipment giving a dry film thickness of 70 ± 5 microns should be applied. Alternatively two coats of Zinc rich primer, which should contain not less than 85% Zinc on dry film, should be applied to give a total dry film thickness of 75 ± 5 microns.

4.8.3.3.2 Finishing coats

a) Exposed embedded parts

Finishing coat shall consist two coats of solvent less Coal tar epoxy paint. These shall be applied at an interval of about 24 hours. Each coat shall give a dry film thickness of 150 ± 5 microns. The total dry film thickness of all the coats including primer coating shall not be less than 350 microns.

Gate & Stoplogs

Finishing coat shall consist two coats of solventless Coal tar epoxy paint. These shall be applied at an interval of about 24 hours. Each coat shall give a dry film thickness of 150 ± 5 microns. The total dry film thickness of all the coats including primer coating shall not be less than 350 microns.

4.8.4.0 Hoists & Supporting Structure

4.8.4.1 Primer Coat

After surface preparation the following coats of primer paints shall be applied:

a) Structural Components

Two coats of Zinc Phosphate primer shall be applied to give a dry film thickness of 40 ±5 microns per coat.

b) Machinery

Except machined surfaces, all surfaces of machinery including gearings, housing, shafting, bearings and pedestal etc. shall be given one coat of Zinc Phosphate priming paint to give a minimum dry film thickness of 50 microns. Motors and other brought out items shall be painted, if necessary.

c) Un-machined Surfaces

All unmachined surfaces shall be give one primer coat of Chlorinated rubber based Zinc Phosphate primer to give a dry film thickness of 50 ± 5 microns.

4.8.4.2 Finishing Coats

a) Structural components

The finishing coats of paints shall consist on one coat of alkyed based Micaceous Iron Oxide paint to give a dry film thickness of 65 ± 5 microns followed by two coats of synthetic Enamel paint conforming IS: 2932 to give a dry film thickness of 25 ±5 microns per coat. The interval between each coat shall be 24 hours. The total dry

thickness of all coats of paint including the priming coat shall not be less than 175 microns.

b) Machinery

The finished paint shall consist of three coats of Aluminium paint conforming to IS: 2339 or Synthetic Enamel conforming to IS : 2932 to give a dry film thickness of 25 ± microns.

c) Unmachined Surfaces

The un-machined surface of rope drum hoist, monorail crane and supporting structure shall be cleaned and given three coats of Vinyl Resin/ Chlorinated Rubber to give a dry film thickness of 30± 5 microns per coat to obtain a minimum dry film thickness of 125 microns including priming coat.

d) Machined Surfaces

All machined surfaces of ferrous metal including screw threads, which will be exposed during shipment or installation shall be cleaned by suitable solvent and given a heavy uniform coating of gasoline soluble removable rust preventive compound or equivalent. Machined surfaces shall be protected with the adhesive tapes or other suitable means during the cleaning and painting operation of other components.

4.8.5.0 Embedded Parts in contact with concrete

All surface of embedded parts, which are in contact with concrete shall be cleaned as given in para 4.2.1.4 of IS : 14177 to meet the requirement of class D and shall be given a coating of cement Latex to prevent rusting. Exposed machined surfaces of ferrous metal, which are to in rolling and sliding contact shall not be painted but shall be coated with heavy gasoline soluble rust preventive compound. In all exposures, where metal will be partially embedded in concrete, it is good practice to extend the protective coating on the non-embedded portion a short distance into the area later to be embedded, thus eliminating problem at the junction point.

4.8.6.0 Surface not to painted

The following surfaces are not to be painted unless or otherwise specified.

(a) Machine finish or similar surfaces, however, such surfaces should be protected with a corrosion preventive compound.

(b) The surfaces, which are in contact with concrete.

(c) Stainless steel overlay surfaces

(d) Surfaces in sliding or rolling contact,

(e) Galvanized surfaces, brass and bronze surfaces

(f) Aluminum alloys surfaces.

(g) Bare electrical conductors and insulating materials.

(h) Equipment name plates and instruction etc.

4.8.7.0 Handling of painted metal work

The metal work to transported by rail or road transport shall be loaded so as to prevent shifting and scuffing or gauging of the coating. In loading and unloading and during insulation reasonable are and suitable handling equipment shall be employed to keep abrasion damage at a minimum.

4.8.8 Inspection and testing of painting

Inspection and testing of paint shall be carried out in accordance with the provisions laid down in IS : 14177.

4.8.9 Field Painting

The painted metal work shall be handled with care so as preserve the shop coats. The area of the shop paint, which has been damaged during transport shall be cleaned to base metal and re-painted. Paint applied to such areas shall be of the same type used originally in shop painting.

5.0 Catalogues and Operating Instructions

Six sets of catalogues indicating the complete list of parts and operating instructions in the English language, which may be needed or useful in operation, maintenance, repair, dismantling or assembling and for the repair and identification of parts for ordering the replacement, shall be supplied by the contractor to the purchaser. Such catalogues shall be in hard cover bound books and should have suitable jacked of thick polythene paper.

5.10 Instruction Parts

All gauges, meters and other instruments etc. shall have dials or scales calibrate in metric system. All name plates, instruction plates, warning signs, etc. shall be in English language as well as in Odia. All markings to be used shall be submitted to the purchaser for approval before the equipment is marked or labeled.

5.11 Shop Assembly and Test

All gates, frames , and appurtenances shall be assembled in the shop to assure accurate fit and proper alignment of all parts and that the over all dimensions and clearance are as covered by these specifications. All the shop connection of gates shall be tested for water tightness prior to shop painting. While the units are assembled, the holes for field connection shall be reamed to full size.

The embedded metalwork to be furnished under these specifications shall be shop assembled the extent possible.

Special care shall be taken in all phases of work affecting the strength and rigidity of anchorage ties and embedded girders since the correct operation and stability of gates are largely dependent upon the strength and accuracy of these parts.

The stoplogs shall be shop assembled so as to allow for adjustment of various dimensions to make it confirm with the designed dimensions, fits, tolerances, surface finish, clearances etc. in the event it is not possible to complete the assembly of stoplog unit or such other components in the shop, they will be accurately assembled in the shop using temporary connections and various critical dimensions shall be verified.

The cost of carrying out the test, not including the cost of inspection by the government personnel shall be borne by the contractor and included in the lump sum, price bid in the schedule. However at the discretion of the Engineer-in-Charge the above tests shall be carried out by the contractor on the shop assembled parts and brought our items to the extent and in accordance with the instructions of the Engineer-in-Charge.

5.12.0 Preparation for Dispatch

5.12.1 Unit marking, Match Marking and Transportation Designation.

Each part of the stoplogs and embedded parts, which is to be transported as a separate price, shall be marked to show the unit which it is a part and match marked to show its relative position in the unit to facilitate assembly in the field. Unit marks and match marks shall be made with heavy steel stamps and paint. Each price, sub-assembly or package transported separately shall be labeled or tagged with transport designation consisting of the specifications number and the marks number of such prices, number of parts grouped of such sub –assemblies are contained in package.

5.12.2 Weights

Before dispatch the contractor shall determine (by the most accurate means available) the net weight of each piece of assembly that is to be shipped as a unit exclusive of boxes, crates or kits. These copies listing the net weight shall be painted on the respective prices of assemblies or stated on the tags attached thereto.

5.12.3 Packing

All parts shall be prepared for dispatch so that slings for handling may be attached readily while parts are to be moved. Where it is unsafe to attach slings to the box, parts shall be packed with slings attached to the part and slings shall project through the box or crate so that attachment can be made easily. All parts shall be properly secured, packed to withstand handling during transportation. All packing shall allow for easy removal and checking at sites. Special precautions shall be taken to prevent rusting of steel and iron parts during transit.

Suitable methods proposed to be adopted for protection against moisture shall be subject to the prior approval of the purchaser. Each bale or package is to contain packing note, quoting number and date of contractor’s order and the name of office placing the order.

After delivery of material at site, all packing shall become property of the purchaser. Notwithstanding anything stated in this clause the contractor shall be entirely responsible for loss, damage or depreciation to the stores due to faulty and insecure packing. The equipment shall be insured for loss or damage during transit at the cost of the contractor.

CHAPTER - 5

5.0.0 ERECTION

The equipment covered by these specification shall be furnished and created by the contractor at the project site. The contractor shall be required to furnish all erection drawings. The contractor shall prepare a complete erection procedure, which shall describe the sequence of operations to be carried out and the method to the used, the measurement to be taken out and the tolerances to be met, in the erection and alignment of the equipment. Such procedure shall have the approval of the purchaser prior to the commencement of fabrication and when approved shall from a part of the specification furnished by the contractor.

5.1.0. Installation of 1st Stage Embedded parts

The contractor should be prepared to accept reasonable inaccuracy in the location of 1st stage anchors, without asking for compensation.

5.2.0. Installation of 2nd Stage Embedded Parts

All gate frames, guides, tracks and seal seats etc. - shall be assembled and installed, brought to line, grade and plumb within the erection tolerances and secured in place by anchorages as shown on the drawings or otherwise according to the best method in practice and as may be necessary for successful functioning of these units. The installation of 2nd stage embedded parts shall be done in accordance with IS:7718. Use of suitable template (Go-No-Go Gauge) is recommended to check face of track plate to face of side seal seat and face of track to central line of guide for corresponding portion of vertical embedded parts from sill level up to the top of embedded parts . The erection tolerances for the frames and guides shall be as indicated on the drawings or as per latest relevant BIS codes. Extreme care shall be taken to ensure that their surfaces be in a true plane within the tolerance throughout their entire length. The 2nd stage anchorages shall be strong enough to hold the frames and guides securely in position while concrete is being placed.

5.3.0 Installation of Gate leaves, Stoplogs, Hoists and operating mechanism

All the components of the gates, and operating mechanism for gates shall be erected perfectly, giving due cognizance to the unit and match marks on the components. All components shall be designed and assembled to fit snugly and shall be watertight.

It is desirable to avoid the flood period to perform erection of gates. Should it be necessary to do so, due precaution shall be taken against floods, as the gates may be submerged in water sustaining damages, or the half erected gates may disturb the water flow causing damages to the civil structures. One of the measures may be that

the hoists should be erected first, and when the flood forecast is made, the half executed gates should be hoisted up to clear the flooding water.

5.4.0 Placing of Concrete

2nd stage Concreting shall be done by the purchaser and the contractor shall give a detailed programme of fixing and aligning the embedded parts to the purchaser for this purpose. Before placing the concrete in anyone lift and between placement of successive lifts, alignment tolerances shall be checked and remedial action taken by the contractor, if any displacement has occurred. The grade of 2nd stage concrete shall be at least one grade higher than 1st stage concrete .

5.5.0 Erection Personnel

Except for the concreting, skilled as well as unskilled personnel shall be arranged by the contractor for erection of the equipment covered in these specifications.

5.6.0 Tools & Tackles

At the time of tender the contractor shall submit the list of tool & tackles that he proposed to supply for erection, testing and maintenance of equipments.

The contractor shall provide all tools & tackles used in the erection testing and maintenance work.

CHAPTER - 6

6.0.0 INSPECTION, TESTING AND FINAL ACCEPTANCE

6.1.0 Place of manufacture & inspection

The tenderer shall state in his tender the place of manufacture, testing and inspection of various portions of the work included in the contract. Authorized representatives of the purchaser may be present at the time of any or all tests and the tenderer shall provide all necessary facilities for the same. Representatives of the purchaser shall be entitled to access works of tenderer, sub-contractor at any time, during the working hours, for the purpose of inspecting the manufacture of equipment and materials.

6.2.0 Inspection

All supplies (which include without limitation raw materials, components, intermediate assemblies and end products) shall be subject to inspection and test by the purchaser to the extent practicable at all times and places. Inspection shall be carried out in accordance with relevant Indian standards.

If any inspection or test is made by the purchaser in the premises of the contractor or sub-contractor, the contractor without additional charge shall provide all reasonable facilities and assistance for the safety and convenience of inspectors in the performance of their duties. If on the request of the purchaser, inspection or test is made at a point other than the premises of the contractor or sub-contractor of the contractor, it shall be at the expense of the purchaser except as otherwise provided in the contract, provided that in case of rejection, the purchaser shall be liable for reduction in value of samples used in connection with such inspection and test. All inspection and tests by the purchaser shall be performed in such a manner as not to unduly delay the work. The purchaser reserves the right to charge the contractor any additional cost of inspection and test when supplies are not ready at the time of such inspection and test. Acceptance or rejection of the supplies shall be made as promptly as practicable after delivery except as otherwise provided in the contract but failure to inspect and accept or reject supplies shall not relieve the contractor of the responsibility for such supplies to be in accordance with the contract requirements.

The inspection and test by the purchaser of any supplies or lots thereof does not relieve the contractor from any responsibility regarding defects or other failure to meet the contract requirements, which may be discovered prior to the acceptance. Except as otherwise provided in the contract, acceptance shall be conclusive except as regards latent defects, fraud or such gross mistakes as amount to fraud.

The contractor shall provided and maintain the inspection system, acceptable to the purchaser covering the supplies hereunder. Records of all such inspection of works shall be kept complete by the contractor and available to the purchaser during the performance of the contract and for such longer period as may be specified elsewhere in the contract.

6.3.0 Operational Tests

The contractor shall carry out in the presence of project authorities such tests on the gate equipment to determine that the gates will fulfill the functions for which it has been designed. Tests shall be repeated, if necessary, until successfully carried out to the satisfaction of the purchaser. Leakage tests and operational tests shall be carried out at the convenience of the project authorities after completion of other portions of the work.

6.3.1 Dry Test

Operational tests in dry shall be carried out as soon as possible after completion of erection. The tests shall include at least two complete traverses from the maximum raised position to the fully closed! seating position. All adjustments, clearance etc., shall be checked for proper operation.

6.3.2 Wet Test

These tests should simulate the actual operating conditions as closely as possible. At least two complete traverses will be made from the fully closed position to the normal raised position as follows:

a. When gate is closed, raise gate to their normally open position in steps and observe the performance including vibration.

b. Lower the gate to the fully closed position in steps and observe the performance of the gate including vibration.

c. Operation of filling valves for stoplogs shall be tested.

d. Check up proper operation of Limit switches.

6.4.0 Leakage Tests

Leakage tests shall be carried out with the gate/stoplog lowered on to the sill. Before measuring the leakage, the gate/stoplog shall be raised and lowered several times by a metre or so in order to dislodge any debris that may have lodged in the side seal seats. The leakage shall be measured and recorded The maximum permissible leakage shall not exceed 5 to 10 litres per mm. per metre length of sealing surface.

6.5.0 Final Acceptance

The final acceptance of the equipment shall be based on the following:

a. Quality and workmanship of the equipment.

b. Satisfactory operation of the equipment after erection as required under these specification.

c. Acceptance of various tests or test certificates by the purchaser as mentioned in above paras.

d. All tests may be witnessed by the contractor or his authorized representative. On successful completion of all tests the equipment shall be accepted but all the responsibilities shall remain with the supplier within the guarantee period.

6.6.0 Guarantee

Within (To be filled in by project authority, minimum one year) year after acceptance of the equipment if any part of the gate, embedded parts, hoist etc., is found defective because of workmanship or material or otherwise, the contractor shall at his own expense, furnish and install new parts and materials approved by the purchaser.

6.6.1. Failure to Meet Guarantee

Should any of the equipment or part fail to meet the guarantees or other requirements of the technical specifications within the time covered by the guarantees, the purchaser may direct the contractor to proceed at once to make alterations or furnish new parts as may be necessary to meet the requirements. AU expense of furnishing, delivering, and installing new parts or· making alterations to existing parts and of tests made necessary by failure of the equipment to meet the guarantees and other requirements of the technical specifications shall be borne by the contractor.

If, after due notice, the contractor refuses or persistently neglects to correct any failure of the equipment to meet the requirements of the technical specifications during the guarantee period, the purchaser may proceed at his own expense to correct such failure and to collect from the contractor an amount equal to the actual expenses so incurred, including overhead and all other incidental expenses. The remedy of the purchaser is in addition to any and all other remedies provided for in the technical specifications, or as provided by law.

6.6.2 Defective Equipment

In case any part of the equipment is found to be defective in materials or workmanship or develops defects or does not otherwise meet the requirements of the specifications including errors or omissions on the part of the contractor the following shall apply:

a. Defects Disclosed Prior to Final Acceptance

.Any defect in materials or workmanship or other failure to meet the requirements of these specification including errors or omission on the part of the contractor, which are disclosed prior to final payment or prior to final acceptance tests, whichever occurs at a later date, shall, if so directed by the purchaser, be corrected entirely at the expense of the contractor.

b. Defects Disclosed After Acceptance

Any latent defect not disclosed before date of final acceptance shall be corrected promptly by the contractor entirely at his expense provided that the total period during which the contractor is liable for replacement due to latent defects shall not exceed twelve months after date of final acceptance of the equipment.

6.6.3 Operation of Unsatisfactory Equipment

The purchaser shall have the right to operate all permanent equipment as soon as and as long as it is in operating condition whether or not such equipment has been accepted. Such operation by the purchaser shall not lessen or impair any express or implied warranties concerning such equipment. All repairs or alterations required shall be made at such times as directed by the purchaser and in such a manner as will cause the minimum interruption in the use of the equipment by the purchaser. Operation of the equipment pursuant to this section shall not relieve the contractor of his responsibility to supply all equipment in complete accordance of technical specifications. While unsatisfactory articles can be taken out of service, for correction of latent defects, errors or omissions, the period of such operation of any use pending the correction of latent defects, errors or omissions shall not exceed one year without mutual consent of the contractor and the purchaser.

SECTION – X

EMBANKMENT CONSTRUCTION & SLOPE PROTECTION

SECTION – X

EMBANKMENT CONSTRUCTION & SLOPE PROTECTION

10.0 EMBANKMENT CONSTRUCTION

10.1 SCOPE

Site clearance, stripping and formation of embankment of homogeneous section/zonal section viz. casing zone/hearting zone with the useful excavated soils and balance soils of approved quality from the borrow area including the cost of soil, if any sampling, testing and pre-wetting of soils at source of excavation and conveyance of soil and extra soils required for shrinkage including swell factor with all leads, lifts, delfts, laying on bank, spreading, breaking clods, sectioning, extra watering and consolidation including benching of old embankment slopes, joining with the new embankment formation of Dowel banks etc. as per drawing and as directed by the Engineer-in-charge to complete the finished item of work.

10.2 General Requirements.

a) The cross sections for embankments are to be designed to suit the characteristics of the best quality soils available in the vicinity of the proposed work. If the contractor proposes to use any other type of soils than those mentioned in the design pursuant to the relevant I.S Code and standard specification. The contractor has to form the embankment to the approved profiles.

b) Embankment shall be built to the height, top width and side slopes as shown in the drawings. All the edges of the embankment shall be neatly aligned symmetrical to the centre line. They shall be absolutely straight in all reaches except at bends. At bends they shall be smoothly curved.

c) The top of each embankment shall be leveled and finished so as to be suitable for road way and given a cross slope to drain away rain water. The bank carrying road shall be given a suitable cross slope.

10.3 Materials; -

a) The suitability of foundation for placing embankment materials thereon and all materials proposed for use in construction of embankment shall be determined well in advance on the basis of Laboratory Test results. Chemical and physical tests of the material proposed for construction of embankment shall be carried out to ensure that the soil does not contain soluble lime content, soluble lime salt content or cohesion less fines, in quantities harmful to the embankments..

b) Material for construction of embankment should be free from organic materials. Unless otherwise directed by the Engineer all materials shall be deposited in embankments so that cobbles, gravels and boulders are well distributed through other material and not nested in any portion within or under the embankment as per clause 6.4 of IS.4701-1982.

c) Suitable excavated materials available from the cut off trenches, canal cutting, extra cutting for seating to lining, foundation excavation for structures, approach and tail channels for structures, nalla diversions, removal of ramps, obstruction removal on the upstream and downstream of surplus weirs and excavation in surplus course and any such excavations, shall be used for construction of adjacent embankments and also embankments of deficit reaches.

d) After completing the construction of embankments with the materials as indicated in (c) above, material required for the construction of balance embankment shall be obtained from the borrow area.

e) The soils and moorum excavated and useful for construction of the embankment shall be classified as impervious and semi-pervious based on laboratory Test result. They shall be utilized on the embankment work.

10.4 Preparation of ground surface for embankment.

a) Clearing site : As per Section III

b) Stripping : As per Section III

c) All portions of excavation made for test pits or other subsurface investigations, all holes, hollows and all other existing cavities found within the area to be covered and to the extent below the established lines of excavation for embankment seat shall be filled in earth of the corresponding zone of the embankment and suitably compacted. The pits of surface boulders shall be filled with suitable material and compacted at no extra cost.

d) Pools of water shall not be permitted in the foundation for embankment and such water shall be drained and cleared prior to placing the first layer of embankment materials.

e) On sloping ground or in case of existing banks, where embankment portion are to be modified, benching of slopes shall be done with a little slope towards the inside of benching so as to give a good grip to the embankment soil with the sub-grade. Unless otherwise specified the benches shall be 0.3x0.6m on the front and rear slope of the embankment. Before benching , the bank slopes shall be clear of all roots and vegetables matter. No separate payment will be made for either benching or refilling. The bank section shall be brought to design

standards by filling the scours with suitable material and compacting to 95% proctor density by suitable compaction measures.

f) Soil foundation:

The ground surface under embankment and area of bed filling wherever necessary (except rock surfaces) shall be loosened or scarified making open furrows by means of a plough, or ripper or any other methods to a depth of not less than 20mm, deep below the stripped surface at intervals of not more than 1m. to the satisfaction of the Engineer-in-charge. Roots or other debris turned up during scarifying, shall be removed from the entire foundation area for the fill. The areas under the embankments shall be prepared by sprinkler before the construction of embankment begins. The moisture content shall be optimum.

g) Rock foundation:

The treatment of the rock surface under the embankment shall be done so as to ensure tight bond between embankment and the foundation. This shall be done by the following procedure.

i) The area of the rock surface which is to be in contact with the embankment shall be fully exposed by removing all the loose and disintegrated rock having the surface of rock rugged. Hard rock projections and overhangs shall be removed. If blasting is to be resorted to, care shall be taken to avoid objectionable shocks to foundation rock. As far as possible the whole contact area shall be exposed at one time to enable examination of rock surface characteristics and planning the method of treatment.

ii) Exposed rock shall be benched.

10.5 Compaction.

a) General

The earth compacting equipment specified in Appendix-C of IS.4701-1982 shall be used for compacting the soils shown against them. The compacting equipment shall confirm to the relevant I.S specification. While the I.S. specifications specify the compacting, it is contended that the use of improved compaction equipment for embankment construction shall be encouraged as may be most suited to the site conditions and the programme of construction. The methods of compaction shall confirm to clause 7.2, 7.2.2 and 7.2.3 of I.S 4701-1982.

10.6 Cohesion Materials:

a) When each layer of material has been proposed so as to have the proper moisture content uniformly distributed throughout the material, it shall be compacted by passing the roller. The layer shall be compacted thin strips over lapping not less than 0.30m. Rolling shall commence at edges and progress towards centre longitudinally. The roller shall travel in a direction parallel to the axis of the bank. Turns shall be made carefully to ensure uniform compaction. Density tests shall be made after rolling and dry density attained shall be not less than 95% of the maximum dry density (standard proctor) as obtained in the laboratory for the type of material used. The density achieved shall not normally be less than the designed density. The dry density of soil in field shall be determined in accordance with IS 2720 (Part-XXVII)-1974 or IS.2720(Part-XXIX)-1975.

b) Standard proctor density test shall be carried out at regular intervals to account for variations in the borrow area materials as well as that in in-situ excavated material. Not less than three tests shall be carried out to indicate variations in the standard proctor density attained in the laboratory.

c) Engineer might review the design if necessary on examination of density test results and the contractor shall have no claim arising out of such a review and consequent change, if any, in the design.

d) In case embankment covers the barrels of cross drainage or any other structure, first 45cm. of the embankment shall not be compacted with roller but it shall be compacted with pneumatic/hand tampers in thin layers. The compaction above this layer of total 45cm shall be done by using suitable light rollers to avoid damage to the structure, by adjusting the thickness of layers until sufficient height is achieved to permit compaction by heavy rollers. Density test shall be conducted from time to time on site to ascertain whether the compaction is attained as specified above.

e) Separate tests shall be conducted for each zone of the embankment for every 1500 cubic meters of compacted earth work. At least one field density test shall be taken in each layer. Minimum two density tests shall be taken in each layer per day irrespective of the quality of earth work specified above. In case the test shows that the specified densities are not attained, suitable measure shall be taken by the contractor either by moisture correction or by entire removal and relaying of layer or checked again by taking fresh tests at the same locations. Necessary skilled labour required for carrying out such density tests shall be provided by the contractor.

f) Compaction shall be achieved by the use of smooth roller pneumatic type rollers, sheep foot rollers, mechanical compactors like vibratory rollers, vibrating plates, rammers, power rammers, slope compacting equipment, pneumatic tamping equipment and such other equipment as shall be specified by the Engineer based on the type of material and actual field tests.

g) The dimensions and weight of the rollers should be such as to extend a ground pressure of not less than 12 Kg/cm2 of tamping when it is empty and 25kg/cm2 when blasted. The number of passes required for each layer to obtain the specified density shall be determined by actual field tests.

10.7 Cohesionless Materials

a) Where compaction of cohesionless free-draining material such as sand and gravel is required, the materials shall be deposited in horizontal layers and compacted to the relative density specified. The excavating and placing operations shall be such that the material, when compacted, shall be blended sufficiently to secure the highest practicable degree of compaction and stability. Water shall be added to the materials, if required to obtain the specified density depending on the method of compaction being used.

b) As per clause 6.6.2.1 of IS.4701-1982, the thickness of embankment layer shall not exceed 25cm. (loose) before compaction and it should be spread over the full width of embankments and compaction shall be done by rollers or tampers to obtain specified density. The thickness of the horizontal layers after compaction shall not be more than 10cm, if compaction is performed by tampers. Similarly, the thickness of layers shall not be more than 15cm if compaction is done by 8 to 10 tonnes rollers and not more than 30cm if compaction is performed by vibratory or pneumatic rollers or similar equipments. The relative density of the compacted materials shall not be less than 70 percent as determined by Laboratory tests as per I.S 2720 Part –XI. If compaction is performed by internal vibrators, the thickness of layers shall not be more than the penetrating depth of the vibrator.

10.8 Embankment without controlled compaction.

a) No materials shall be placed in any section of the earth fill portion of the embankment until the embankment seat for that section has been approved by the Executive Engineer.

b) Where the natural ground surface is above the maximum water level but below the top of the embankment, the embankment shall be built in layers not exceeding 15cm in thickness and to the full width of embankment. Each layer shall be commenced from the edge farthest from excavation. It shall be compacted with two ton roller.

c) The excavating and hauling equipments shall travel over the embankments to evenly distribute the material and compacting effort over the whole surface.

10.9 Embankment with controlled compaction:

a) Bushes, roots, sods or other perishable or unsuitable material shall not be placed in the embankment.

b) (i) Unless otherwise specified embankment materials shall be spread in successive horizontal layers generally not exceeding 25cm. thickness (loose layer) in the zones where these are required to be laid extending to the full width of the embankment including slopes at the level of the particular layer. Each layer shall be commenced from the edge farthest from excavation. In no case shall embankments be widened by material dumped from the top.

ii) Top of each layer shall be kept slightly depressed in the centre.

c) i) Extra width of 600mm in thickness perpendicular to the slope shall be provided on either side so that when compacted, lines of the finished embankment slopes shall have not less than specified density.

ii) Later on, the extra width shall be neatly trimmed and the trimmed material shall be permitted for re-use in embankment at higher elevations.

iii) No payment shall be made for providing removal of the extra section. Removal of extra section in the embankment shall be deemed to have been included in the bid price.

d) Thickness of layers shall be adjusted with particular type of compactors used to give the required density by carrying out trial compaction and requisite tests and required number of passes should also be determined as directed by the Engineer.

f) No fresh layer shall be laid until the previous layer is properly watered and compacted as per requirement. The work of spreading and compaction shall be so adjusted as not to interfere with each other and in such a way that neither of the operations is held up because of non-completion of the rolling and watering. The surface of the banking shall at the times of construction be maintained true to required cross sections. If the surface of any compacted layer of earth fill is too dry or too smooth it shall be moistened and scarified to provide a satisfactory bonding surface before the succeeding layer is placed. All the rollers used on any one layer of fill shall be of the same type and same weight.

f) The contractor shall ensure that only approved soils are used for construction of embankment.

g) For proper bond of the embankment done in the previous season with the new embankment, the work shall be carried out as detailed below.

i) In case of the old bank to be extended horizontally, it shall be cut to a slope not steeper than 1 in 4 and the surface so prepared shall be scarified and made loose at least for a depth of 15cm. Necessary watering shall be done and the earth surface shall be thus prepared to receive the new embankments. The soil shall be laid in layers and compacted to the required degree of compaction to have a proper bond with the old one.

ii) If the old bank is to be raised vertically, vegetation shall be cleared followed by scarifying, watering and placing of the new earth layer as specified above.

iii) The surface which are damaged due to rain shall be made good by filling with proper soil duly compacted by tampers. A cross slope away from the centre of canal of about 1 in 80 shall be maintained throughout the rainy season to ensure proper drainage in the event of occasional rainfall. No extra or separate payment shall be made for these items of work.

h) Settlement allowance.

i) The canal embankments shall be constructed to a higher elevation than that shown on drawings at the rate of 2.5cm. per every one meter height of bank if power driven equipment is used and 25cm/mt height if other than power driven equipment is used for compaction towards shrinkage / settlement.

ii) No extra or separate payment shall be made for this work as this shall be deemed to have been included in the price bid.

iii) Care shall be exercised that all large clods are broken and no clod bigger than 8cm rock are buried in the banks.

i) Homogeneous Section:

The homogeneous section for embankment shall be provided as specified in the drawings. The available coarser and more pervious materials shall be placed nearby outer slopes in order to have increasing permeability from inner to outer side. The compaction shall be carried out as per clause 6.6.2 of I.S 4701-1982.

j) Zonal Embankments:

IN Zonal sections the selected and approved soils shall be spread to the required widths of respective zones. All the zones shall be tackled simultaneously and the difference in level between zone to zone shall not be more than 150mm.

10.10 Moisture content:

a) The initial moisture content of the material shall be determined at the source of supply (all excavations including from the borrow areas) in field laboratory test. Prior to and during compaction operations, the embankment shall have optimum moisture content required for the purpose of compaction and this moisture content required for the uniform throughout the layer, as per clause 6.6 of IS 4701-1982. In so far as practicable the moistering of the material shall be performed at the site of excavation but such moistening shall be supplemented as required by sprinkling water at the site of compaction, if necessary. Flooding shall not be permitted under any circumstances. Sprinkling of water shal be done either through a proper sprinkler tanker or using proper spray nozzles. Sprinkling straight from the water house shall not be allowed.

b) If the earth delivered to the embankment is too wet, it shall be dried by aeration, exposure to the sun, ploughing, disc harrowing or other methods, till the moisture content is reduced to acceptable optimum for compaction. If due to wet weather, the moisture content cannot be reduced to the required optimum by the above procedure, work on compaction shall be suspended until such time the earth has dried to the optimum moisture content. For such suspension of work no extra claim by the contractor shall be allowed.

c) If the moisture content is not uniformly distributed throughout the layer or less than the optimum rolling shall be stopped and shall be started again only when the above conditions are satisfied. After adding the required amount of water, if found necessary, the soil shall be processed by means of harrows, rotary mixers or as otherwise approved until the layer is uniformly wet to optimum moisture content.

d) Moisture content of each layer of soil shall be checked in accordance with IS:2720(Part-II) 1973 and unless otherwise mentioned shall be adjusted, making due allowance for evaporation losses that at any time of compaction, upto 1% +2% than the optimum moisture content in casing zones and upto +1% to –1% than the optimum moisture content in the hearting zones may be permissible. The optimum moisture content shall be determined in accordance with IS:2720(Part0-VII)1973. The above compaction tests will be conducted by the contractor and the contractor shall ensure compaction till it is satisfied that 95% of the maximum dry density at OMC is obtained.

10.11 Special Precautions:

a) During the actual construction of any earth work, maximum use should be made of construction plant and routing of the plant should be carefully controlled to obtain uniform compaction over as wide an areas as possible. Care should also be taken during the compaction operation to shape the surface of the works to facilitate the shedding and to minimize the absorption of rain water, particular attention being given to the prevention of pending of water The contractor shall do this at the end of each day's work.

b) The earth moving machinery shall not be allowed to pass over a compacted portion of the embankment beyond certain limits by varying the hauling routes and rams, this ensuing that over compaction does not take place in any particular reach.

c) During the construction, a small transverse slope from centre towards the edges shall be given and further in the reach when back is being raised , the works shall be tackled in continuous horizontal layers to avoid pools of water and concentration of allow of water during rains, which will cause damages, scours and rain gullies.

d) Special precautions shall also be taken while rolling the spread soil near structures, conduit, sluice barrels, filters, rock toes at the junctions of bank connections with the structures, using hand or power tampers. It is essential that the compaction of filling should be carried, out in such a manner as to avoid an unbalanced thrust on walls etc. which might displace or damage it. The equipment shall be provided with suitably shaped heads to obtain the required density.

10.12 Embankment test section:

The embankment section shall be built as directed by the Engineer-in-charge prior to starting fill operations or at an early stage of embankment construction. The test section shall be used to establish.

i) Layer thickness of fill materials

ii) Optimum practicable moisture content

iii) No. of passes of sheep foot roller/ vibratory roller for effective compaction.

10.13 Refilling of key trench and consolidation:

a) Key trench shall be back filed with impervious material of the same specifications and in the same manner as for the impervious hearting zone of the embankment of the canal. The impervious soils shall be placed in continues and approximately horizontal layers not more than 25 sq.(loose) thick and compacted by 8 to 10 Tonne power roller under optimum moisture content.

b) Rolling shall be done along the key trench and the roller shall be taken close to the sides of the trench.

c) In cases where the compaction by rollers is not possible, compaction to the required density shall be achieved by such other means as specified by the executive engineer.

d) Each layer shall be compacted to achieve the required dry density of not less than 95% of the maximum dry density (Proctor's density) for the type of material at optimum moisture content.

e) Watering of material for its compaction shall have to be arranged by the contractor at his cost as the quoted rate for consolidation of Schedule 'A' is inclusive of watering.

f) During placing and compaction of impervious soils in the key trench where dewatering is involved, the sub soil water level at every point in the key trench shall be maintained below the bottom of the earth fill until the compacted fill in the key trench at that point has reached a height of 3m. after which water level shall be maintained at least 1.5m below the top of compacted fill.

g) The quantity for payment shall be the volume of key trench measured in cubic meters. The unit for payment shall be the cubic meters.

10.14 Compacting by other than Power Driven Equipment.

a) This shall conform to that of embankments compacted by power driven equipment except that instead of using power drive rollers ordinary rollers driven by tillers shall be adopted for compaction. If the work is of small magnitude,no manual compaction shall be allowed except through the use of pneumatic tampers and only very occasionally hand tampers shall be used.

b) Thickness of layer shall not exceed 150 mm before compaction (loose).

c) Each layer shall be compacted to not less than 95% dry density (Proctor's density) at optimum moisture unless otherwise specified.

d) Any loose soils shall be removed by trimming and bringing embankment and side slopes of canal to the section shown on the drawings. Slope compacting equipment and pneumatic equipment should be used.

e) Measurement and rate for payment shall conform to para 3.2.14 slope compacting equipment and pneumatic tamping equipment should be used.

10.15 DOWEL BANKS.

a) Dowel Banks shall be constructed to the dimensions, grades, slopes as shown on the drawings.

b) Payment will not be made for construction of Dowel Banks.

10.16 Water Conditions:

a) Embankment soils shall be placed only when the weather conditions are satisfactory to permit accurate control of the moisture content in the embankment material. Before closing work in embankment, in any continuous reach prior to setting of monsoon, the top surface shall be graded and rolled with a smooth wheeled roller to facilitate run-

off away from canal. Prior to resuming work, the top surface shall be scarified and moistened or allowed to dry as necessary.

b) The contractor shall provide suitable protection works protect the slope from erosion due to rain water. No payment whatsoever shall be made for providing such protection work and rectifying any monsoon damages.

10.17 Borrow Area Consideration:

a) The contractor shall use only the suitable soils for formation of embankment, out of the soils excavated if they are proved to be suitable, based on Laboratory test results, and if they are within the Economic lead. Otherwise the contractor shall borrow the soils from the borrow area after test checking the suitability of the soils for the embankments for particular embankment work.

b) The contractor shall be allowed to borrow the soils from the fore shore areas of Reservoirs/tanks, upto MWL contour and on the sides of the canal. Where the department is having provision to borrow or exploit the soils. The contractor can avail this provision. If, for any reason the contractor is not interested to borrow the soils, from the above said areas the contractor is free to borrow the soils from any other places of his choice.

c) The responsibility for arranging and obtaining the land for disposal of spoil and the land for borrowing or exploitation in any other way shall rest with the contractor, who shall ensure smooth and uninterrupted supply of materials/earth for the quantity required in construction during the construction period.

10.18 BORROW PITS:

1) The borrow pits shall not normally be more than 25M in length and 10M in width and 1m/2M depth. A clear spacing of one meter between each pit shall be left out. Each pit shall be clearly peg marked and number tags of the pits shall be maintained.

2) In the case of earth dams unless otherwise specified the borrow pits shall not be located within a distance of 10 times the height of the embankment on the upstream side and two times the height of the embankment on the downstream side.

3) The depth of the pits shall be so regulated that their bottom does not cut the hydraulic gradient line having a slope 4:1 from the top edge of the embankment.

4) In no case the pits shall be located within 5M from the toe of the embankment. If there are old pits in the borrow area the new pits shall be located one meter away from them.

5) If the contractor excavated the pits near to the toe against to the above clauses and the same is observed at any time during or after the execution of work, the contractor has

to fill the same pits with the soils suitable for hearting zone of embankment and compact to 95% proctor's density at the cost of contractor.

10.19 Stripping of borrow areas:

a) Borrow areas shall be stripped of top soil and any other objectionable materials to the required depths as ordered by the Executive Engineer (Stripping operations shall be limited only to designed borrow areas)materials from stripping shall be deposited of in exhausted borrow areas are in the approved adjacent area. Particular care shall be taken to exclude all organic matter from the borrow area. The cleared areas shall be maintained free of vegetable growth during the progress of work.

b) No payment shall be made for removal of top soil on borrow area.

10.20 Moisture Control at Borrow Areas:

a) Borrow area watering shall be done by the Contractor in the manner specified by the Engineer-in-charge.

b) No payment shall be made for watering the borrow area or drying the material in borrow area or on bank to reduce extra moisture content or for delay due to this.

c) The cost for such works shall be deemed to have been included in the price bid.

10.21 CLAY BLANKETS:

a) **Scope:** Clay blankets are made from impervious soils and are used on the beds of reservoirs or in channels or canals to reduce seepage.

b) Requirements: The materials used for these purpose, shall be impermeable, free from excessive shrinkage and swelling, shall resist erosion and have adequate stability. As far as possible, G.C or S.C materials shall be used when satisfactory soils are not available, the surface shall be protected with a blanket of stable gravelly soils if so instructed by the Engineer-in-charge.

c) Laying: The clay blankets shall be laid and compacted to 98% proctor density to a length and depth.

d) Measurement: Dimension shall be measured to be nearest 0.01m and volume worked out to the nearest 0.01 cum.

10.22 Back filling:-

Back filing with selected materials in foundation trenches around structures and above lining key.

1) General:

a) The type of material used for backfill, and the manner of depositing the material, shall be subject to approval of the Engineer-in-charge. As far as practicable, back fill material shall be obtained from the excavation for structures or from adjacent canal excavation or from the excavation of the other ancillary works. Back filling shall be done with approved materials after the concrete or masonry is fully set.

b) Backfill material shall not contain stone larger than 7.5cm. size.

c) The pervious materials (sand) with profuse watering used for back filling around the cut off wall shall be placed as shown on drawings or as directed by the Engineer-in-charge.

d) Backfill shall not be placed against retaining walls until the retaining wall is cured adequately and is strong enough to take lateral pressure of the backfill. Trimming of the sides of excavation against which the backfill is to be laid shall be delayed until immediately prior to back filling and any excessive drying of the surface shall be conditioned properly and made adequately moist to avoid potential description of the rock or partly compacted/consolidated materials.

e) The back fill material shall not be placed against retaining walls until the retaining wall cured adequately and is strong enough to take lateral pressure of the backfill, Trimming of the sides of excavation against which the backfill is to be laid shall be delayed until immediately prior to back filling and any excessive drying of the surface shall be conditioned providing adequate earth cover over pipe to prevent damaged due to loads of construction equipment.

f) If a haul road is built over a pipe, all back fill around and over the pipe shall be placed to a uniform surface and no lumps or depressions shall be permitted at the pipe crossing.

2) Compaction of Backfill

a) When compacting the soil against the steep rock, abutment walls of masonry or concrete structures, the construction surface of embankment shall be sloped away from the rock or masonry or concrete structure leaving a minimum distance of 0.6 metre and at an inclination of 3:1 . Roller shall not be used close to structures as structural damage is very likely more particularly when structures have not been fully cured. The size and weight of equipment will depend on nature of material, the height and load assumed in design of structure. The backfill close to the structure upto the rolled layer shall be compacted in suitable uniform layers, using pneumatic tampers as appropriate to obtain dry density of at least 95% of proctor density. The moisture content of the earth fill

placed against rock or the structure shall be on higher side of OMC by about 2% or so, to allow it to be compacted into all irregularities of the rock. Profuse watering shall be done to pervious materials (sand) before compaction as per instruction, shall be carried out with special care without claiming any extra cost.

b) Deployment of hand tampers be restricted to rare usage that too for very small jobs.

3) Structures on backfill:

Where the original ground surface is below the base of the structure or below the bottom of pipe, all fill required for the structure foundation and all fill upto the bottom in the pipe shall be placed as compacted embankment. The embankment over natural ground upto pipe bottom and over the pipe shall be laid in accordance with clause 9.2.4, 9.2.5 and 9.2.6 IS:783 of 1985. The compacted back fill shall be placed in horizontal layers not exceeding 15cm, after compaction. Heavy stones shall neither be dropped on top of pipes not shall be allowed to roll down the side of the embankment against the pipes.

10.23 Inspection and Tests:

1) General:

a) The contractor shall maintain and exercise through check on the quantity of fill material delivered to the embankment and shall arrange to obtain the data and in-situ properties of the material after compaction for comparison with design assumption. To achieve these objectives, a programme of field testing and inspection shall be planned to effect quality control

b) Scope of testing and inspection.

Field control of fill material shall be required by visual and laboratory checks. The checks on the effectiveness of placement and compaction procedures shall be made by field density tests at prescribed intervals by the Contractor.

2) Tests

The following tests shall be carried out for determining compaction.

a) Density moisture relation of the soil: In accordance with IS:2720(Part-VII(1980.

b) Density of the soil in field: In accordance with IS:2720 (Part.XXVII)1974 or IS:2720(part-XIX)1975.

c) Moisture Content: In accordance with IS:2720(Part-II) 1973. Before compaction Materials delivered to the fill shall be visually examined and their properties estimated by way of inspection.

3) Embankments.

I. Moisture content tests shall be carried out in the field laboratory while placing the fill materials.

II. Moisture content shall be controlled by adding water or allowing the soil to dry.

III. It shall be ensure that the methods of dumping, spreading and moisture conditions are such as will result in reducing segregation and/or variation of moisture content to a minimum.

4) Borrow Area.

i. Estimation of moisture content of materials by visual examination and feel.

iii. Different samples shall be taken for laboratory analysis in case the soil is of different characteristic.

These inspection checks shall be supplemented by sampling the materials at prescribed minimum intervals and by testing the samples in the laboratory for gradation and moisture content.

During Compaction:

It is intended that the checks in operations during compaction shall verify.

i. That the layer thickness of the material is as specified

ii. That the fill is compacted at least to 95% of standard proctor's Density or (Dry density at OMC) or 70% relative density as the case may be.

iii. That no excessive rutting, waving or scaling of the fill occurs during compaction.

5) After compaction:

The condition of the fill after compaction shall be observed and recorded particularly with respect to rutting or waving. However, the properties of materials after compaction shall be determined primarily by field density tests. Routine tests on samples taken from constructed embankment shall include besides density tests, grain size distribution and Permeability.

10.23.1 Frequency of Testing:

a) It will be necessary to carry out sampling and testing of materials before and after compaction at sufficient frequencies so that effective checks on the full operations are maintained. Testing frequencies proposed should correspond to the frequencies as mentioned in the relevant paragraphs. However, the actual frequencies shall be adjusted to suit the nature and variability of materials placed and the rate of fill placement.

b) Testing shall be performed at frequent interval than those specified in table during initial stages of placing in each zone in order to establish control on testing techniques and also testing should be conducted at higher rates in case of special problem of control caused by such factors such as material variation, equipment performance and weather.

c) Compaction:

Test location shall be chosen only through random sampling technique. Control shall not be based on the result of any other test but on the mean value of 5 to 10 density determinations. Generally these shall be at the locations indicated below or any other areas so determined by the Engineer-in-charge in addition to these tests shall be made at the following locations.

1) In areas where the degree of compaction is doubtful.

2) In areas where embankment operations are concentrated.

3) For record tests at the locations of all embedded instruments. Areas of doubtful density may be detected by the inspection by Engineer-in-charge and possible location of insufficient compaction include.

i) The junction between areas of mechanical tamping and rolled embankment along abutment or cutoff walls.

ii) Areas where rollers turn during rolling operations.

iii) Areas where too thick layer is being compacted.

iv) Areas where improper water content exists in material.

v) Areas where less than specified number of roller passes were made.

vi) Areas where dirt clogged rollers were used to compact the materials.

vii) Areas where compacted by rollers that have possibly lost part of their ballast.

viii) Areas where oversized rock which has been over looked is contained in the fill.

ix) Areas containing materials differing substantially from the average.

10.23.2 Record and Report:

Record of borrow area material and embankment placing operations shall be maintained in order to have a continuous check on the suitability and availability of full materials and quality of fill. Thus, shall be possible to have complete description of materials in any portion of embankments. The record shall be maintained on the form specified in ANNEXURE-1.

10.23.3 Field Test Data:

Records of field Test Data results should be presented in the form of statistical analysis sheets and summary sheets in order to provide control required for enforcement of statistical requirements of the specifications.

Test data summary sheets and inspection reports be used to form the basis of construction control report, which should be issued from the site at fortnightly intervals during construction season. The report would contain narrative accounts of the progress and problems of field constructions, statistical analysis of test data and photographs of the fill operations.

ANNEXURE-1

Earth work Daily Report:

Name of work:

_____

_____

Date _____ shift_____ weather _____Inspector _____Following Inspector_____ Type roller equipment used _____weight of roller

_____

(A) EXCAVATION

1. Type of Excavator:
2. Depth of Cut.
3. Type of soil
4. Borrow pit location
5. Weather water added at borrow pit
6. Percentage of moisture content

(B) FILL CONDITIONS

1. Location of fill.
2. Elevation
3. Whether water added at the fill
4. Moisture content before rolling
5. Roller passes.

(C)TEST DATA

1. Location of Sampling point

(a) Chainage

(b) Off-set

2. Serial Number
3. Moisture content
4. Dry density (G/)
5. Plasticity needle reading (Kg/Sq.cm)
6. Quality of Earth Work rolled.

LABORATORY CHECK

1. Serial Number
2. Optimum Moisture content percent
3. Maximum dry density (Gr./CC)
4. Plasticity needle reading (kg/sq.cm)

(D) COMPACTION EFFICIENCT

1. Field moisture deviation from optimum
2. Percentage Compaction.

10.24 Surface Drains

This work stall consist of constructing surface drains, schedule of work shall be so arranged that the drains are completed in proper sequence with canal excavation works as necessary subsequently or no damage is caused to these works due to lack of drainage.

a. Surface drains shall be excavated to the specified lines, grades, levels and dimensions. The excavated soils shall be removed from the area adjoining the drains and is found suitable utilized in embankment construction. All unsuitable soils shall be disposed off as directed.

b. The excavated bed and sides of drains shall be dressed to bring these in close conformity with the specified dimensions, levels and slopes.

c. All works on drain constructions shall be planned and executed in proper sequence with other works as approved by Executive Engineer with view to ensure adequate drainage for the area.

10.25 Rock fill in Toe of Embankments and filters:

Scope: This specification covers filters to be laid for internal drains, sandy filter blankets, filter below the riprap, horizontal and inclined filter drains, longitudinal and transverse filters around rock toe etc.

10.25.1 Filters:

i) Sand as filter materials:

Scope: Formation of sand filters of specified thickness using the sand of approved quality including cost and conveyance of sand sampling, testing and laying with all leads, lifts, delifts and compaction to 70% relative density including hire and operational charges of power roller seigniorage charges and all other incidental and operational charges necessary to complete the finished item of work for filter blanker, horizontal and inclined filter drains, longitudinal and transverse filters around rock toe etc. as per drawings and as directed by the Engineer-in-charge.

10.25.2 BASE FILTER BLANKETS:

a) As and where indicated in the approved drawings, filter blanket should be laid on the base, under the riprap, below the rock toe of the embankment, underneath the cement concrete blocks in between the R.C.C. apron and curtain wall, on the down stream side of barrage, in slopes of afflux and guide bundhs and in the location as indicated in the drawing.

Inverted filter shall be constructed to the specified thickness always measured normal to the slope. Filters shall be placed in at least two different layers. The filter materials shall be clean, sound, well graded sand and gravel or screened rock fragments manufactured by stone crushers.

The filter materials used are required to satisfy the following criteria:

Piping Criteria

Its void should not allow migration of particles. For this.

$$\frac{\text{D15 of Filter material}}{\text{D85 of base material}} \leq 5$$

D15, D85, D50 denote diameter of grain size, at which 15%, 85% and 50% respectively of material is smaller than the particular size, determined from the gradation curve.

Permeability criteria

The filter should be sufficiently more pervious than the base material so as to induce a rapid drop in gradient line or have easy drainage. For this---

$$\frac{\text{D15 of Filter material}}{\text{D15 base material}} \geq 5$$

This criteria ensures permeability of the filters to be greater than 25 times of the base material.

Gradation Criteria

The filter which satisfies the piping and permeability criteria as above may yet fail if it has excess or lack of certain sizes or is not uniformly graded. Hence the filter material should be well graded to satisfy the condition.

Co-efficient of Uniformity (CU)= $\frac{D.60}{D.10}$

> *4* (in case of aggregates)

> 6 (in case of coarse sand)

The gradation curve of the filter material should be approximately parallel with that of base material specially in the finer zone. To ensure it...

$$\frac{\text{D15 of Filter material}}{\text{D15 base material}} < 25$$

b) The base filter materials should be well graded so as to satisfy the above mentioned criteria. The grain size curve should be approximately parallel to that of base materials, especially in the fine range. Filter materials should not contain more than 5% of fines i.e materials finer than 0.075 mm. (Passing through sieve No.2000 IS sieve 75 micron) and fines should be cohesion less to ensure that filter does not sustain a crack. The filter should not have particles larger than 75mm so as to minimize the segregation.

c) D15 is the size at which 15% of the total soil particles are smaller, the percentage being by weight, to be determined by mechanical analysis. D.85 size is that at which 85% of the total soil particles are smaller. As more than one filter layer is required, similar criteria is followed in each case, viz. the finer filter is considered as base materials for the selection of the gradation of the coarser filter.

d) The requirement for grading of the filter shall be established by the tests conducted in the field laboratory on the basis of mechanical analysis of adjacent materials. Mechanical analysis shall be performed of all samples, which have been compacted by the methods equivalent to compaction by roller, so that the individual particles are broken to their field condition in the embankment.

e) The thickness of each filter layer shall be less than 150mm

10.25.3 Placing of Filter:

a) Filters shall be laid to the lines and grades and dimensions shown on the drawings.

b) The foundation shall be cleared and stripped in accordance with specification 2.0 before laying the bottom layer of filter material.

c) Filter material shall be laid in layer of 150mm adequately watered and compacted by required number of passes of crawler type tractor or any method approved by the Superintending Engineer to get dense and stable filter.

d) Care shall be taken to ensure that materials of different layers do not get mixed both at the time of placing and during compaction. Extreme care shall be taken when placing materials to obtain a fill free tenses, layers and streaks of segregated materials.

d. In case of horizontal filters after being compacted earth fill materials shall be laid over it in layers of 150mm and compacted as directed by the Engineer-in-charge sheep foot roller or DRR shall not be used till earth has been laid and compacted to a thickness of 600mm. Over the filter blanket. However, the construction of earth fill in the initial 600mm thickness shall be subject to the same quality control regarding moisture content and dry density as for the rest of the embankment.

e. In case of inclined filter, the filter shall be raised along the adjoining embankment layers and shall be properly compacted by suitable means. In order to avoid contamination of filter with adjoining earth fill material, the top of filter be kept slightly higher than the adjacent embankment level and any contaminated portion shall be scrapped and removed before adding the new layers.

10.25.4 Measurement

The measurement shall be in meters correct to 0.01 meter and volume shall be worked out to nearest 0.01 cubic meters.

10.26 STONE PITCHING.

Stone protection work for loose apron of the barrage bays beyond concrete cubes both in upstream and downstream and also below the cubes of upstream of barrage are to be provided as per relevant drawings. Rough stone pitching has lo be provided on the river side slope of the afflux and guide bunds. The launching apron for these bunds in continuation of the revetment lo abutment shall be constructed with random rubies.

10.26.1 Material for Stone pitching.

10.26.2 The pitching material shall consist of the most durable rock fragments of approved quality selected for the purpose. Stones shall be procured from the approved quarries and If required shall be subjected to Inspection and approval by the Engineer-in-charge. The quality of individual stone shall be dense. sound and free from conglomerate, bands and other defects that would tend to Increase their susceptibility to destruction by water and weathering action. Stones having thickness less than 50% of their maximum dimension shall not be used for pitching.

10.26.3 Size of Stone

No Stone shell be less than 0.03m3 in size. At least 15% of stones to be used for pitching shell have depth equal to the thickness of pitching. All stones to be used for apron shall have a minimum depth of 25 cm. No stones shall have any dimensions less than 20 cm.

10.27 Slope Cutting

The compacted embankment, the slope of which is to be protected with stone pitching, shell be trimmed to the lines and slopes as prescribed on the drawings or as directed by the Engineer-in charge from time to time. The earth obtained from this trimming shall be laid on top of the embankment lf required or as directed by the Engineer-in-Charge.

10.28 Thickness of pitching

(a) Pitching shall be hand placed on the water side slope of the embankment. The thickness of pitching shall be as indicated on the drawings. The thickness shall be measured normal to the slope of the embankment.

(b) Launching apron shall be hand placed in horizontal layers and its thickness shall be as indicated on the drawings. .

10.29 Method of Placement.

(a) Before laying the pitching or launching apron on level ground or on sides of the slope of afflux or guide bunds, the receiving surface shall be trimmed to the required slopes and profiles put by means of lines and pegs at regular intervals. Depressions shall be filled up and thoroughly compacted. Pitching on inverted filter, if any shall be started from the end and built in courses upwards. Stones shall be placed by derrick or by hand and so placed that the largest dimensions are perpendicular to the face of the slope. The large stones shall be placed in the bottom course and for use as headers for subsequent courses.

(b) All interests between adjacent stones shall be filled with spalls if proper sizes and wedged in with hammer to ensure tight packing.

10.30 Rock fill in Toe of embankment (Rock toe)

a) Scope:- Formation of Rock toe using approved quality of well graded metal & stone of size 75mm to 450m including cost and conveyance of metal, sampling, testing laying with all leads, lifts, delfts, and at least 225mm thick rough stone dry packing to the external face including labour charges for packing, seignior age charges and all other operations necessary to complete the finished item of work as per drawings and as directed by the Engineer-in-charge.

c) Rock fill shall consist of sound, durable and well graded broken rock obtained from approved excavation work and/or from quarries and shall be approve prior to being transported to the areas of deposition. The materials shall range in size from 75mm to 450 mm. However, no load shall contain more than 15 percent by volume of rock, fragments smaller than 75m in size. All brush roots, or other perishable materials shall be removed from rock fill during the spreading.

d) Placing:

i) The rock fill shall be constructed, true to the lines and grades as shown in the drawings.

ii) The rock fill shall be placed and packed to obtain a suitable well graded and free draining fill.

iii) The smaller rock fragments shall be placed adjacent to the filter of embankment and large rock fragments near the outer edge of the fill.

iv) The rock fill shall be placed and roughly leveled in layers not greater than one meter in thickness.

v) The stones shall be properly hand packed and the inter slices shall be well filed with spells and chips and tightly welded to ensure firm packing so as to have dense, well graded fill with no larger voids and cavities.

vi) Contamination of rock toe with finer material from any other zones shall be avoided.

vii) Suitable out fall for draining out the seepage water collected in rock toe shall be provided depending upon the site conditions.

10.31 Measurement

As liner measurement shall be in meters, correct to 0.01 volume shall be worked out to nearest 0.01 cum.

10.32 Protection:

The contractor shall take all precautions necessary for the protection of the work by diversion of stream local surface drainage, rain water etc. if these are likely, to damage the work. Any damage to earth work due to any reason what so ever shall be made good by the contractor at his cost till the work is certified as completed and takeover by the Executive Engineer.

10.33 Roads and Ramps.

The contractor shall construct, operation, and maintenance roads and earth ramps adjacent to the canal and structures at his own expenses. Suitable materials from excavation or borrow areas shall be placed as embankment for the roads and ramps. The width of the road shall be not less than 4.25M.

SECTION-XI

ROAD WORK

GENERAL

1. Road shall be constructed to the lines, level and grade with sand and moorum fill having desired parameters of density cohesion, etc. so as to ensure the designed stability and performances of the whole road. The Quality Control Organization of the project may carry out requisite test for the suitability of construction materials well in advance and the contractor shall ensure that only approved materials are brought to place of fill and used for construction of Road.
2. The difference in elevation of the approach road during construction within each working length of not less than 50M shall not exceed 1.0M anywhere in the cross section unless specifically permitted by the Engineer-in-Charge placing of the layers for the road portion programmed for construction in the season shall be continuous and approximately horizontal. In case the whole length of road is not constructed simultaneously, the incomplete end of the road shall be kept at slope not steeper than 1 in 4.
3. No materials shall be placed in any section of the road until the road seat for that section has been dewatered, suitably prepared and approved by the Engineer -in-Charge. All portions of excavation made for test pits or other sub-surface investigations, all holes, hollows, and all other existing cavities found within the area to be covered and which extend below the established lines of excavation for road seats, shall be filled with suitable earth fill of the corresponding zone of the road a12nd suitably compacted.
4. Pools of water shall not be permitted in the foundation for road and such water shall be drained and cleared prior to placing the first layer of road materials.
5. The contractor shall construct and maintain good diversion in case the existing communication are disturbed. Precautionary measures such as night lamp, danger fencing signals shall be provided by the contractor at his cost to avoid accidents on the communication lines because of contacts activities.

SETTING OUT OF THE WORK

1. In the vicinity of the road, there are permanent Bench Marks fixed by Survey of India. Temporary Bench Marks shall be set up by the department at every 1.0 km interval at convenient locations along the road to serve as control points. The contractor shall establish sufficient numbers of reference Bench Marks for facilitating the setting out and taking levels for measurement of work with the approval of the Engineer-in-Charge at his own cost.

The Bench Mark shall be 30cmX 30cm X 75cm with concrete pillar, which shall be embedded 55cm into firm ground and 20cm projecting above the ground. The Bench Marks shall be constructed in plain c.c. M-10. These pillars shall be well protected from being disturbed. The word B.M. showing value of R.L. shall be conspicuously carved and painted on the Bench Mark.

2. Before starting any work and during execution (if required) the contractor shall erect reference Bench Marks, reference lines and check profiles at convenient locations as per the direction of the Engineer- In-Charge. The centre line of the road and the reference line for all alignments for demarcation purpose shall be laid by properly dug-belled on the ground.

3. The Check profiles shall be located at 30M. apart or closer as directed by the Engineer-In-Charge so as to ensure execution of all slopes, steps and elevations, to the profile as indicated in the approved drawings. All important levels and all control points with respect to Bench Marks and reference lines shall be fixed and co-related by the Engineer-In-Charge.

4. To ensure correctness of execution the edges of cutting, the lines of the road and those of spoil bank shall be marked carefully with pegs at close enough intervals so as to obtain a layout in plan free from banks. The pegs shall then be connected by stretching string from peg to peg and dug belling into ground along the strings. The lines so connected shall be corrected whenever necessary to provide a stream lined plan of the features. Special care shall be taken at curves to ens':1re uniform curvature of the alignment. The layout of the structures shall have to be given in appropriate manner with pegs & pillars. ;

5. All materials and labour for settings out works including construction of reference Bench Marks, reference lines check profiles and surveys, as may be required at the various stages of the construction, shall be supplied by the contractor at his own cost. The cost of such works shall be deemed to have been included in the costs of items in schedule.

PREPARATION OF SITE

1 CLEARING THE SITE

a) The contractor shall clear the entire area required for setting out, of all tree stumps, bushes, jungles, roots, brushwood, rubbish of all kinds, loose stones and all other objectionable materials. The ownership of all the useful materials so removed from clearing site and or excavation shall rest with the department. The contractor shall have to remove all the stumps and roots of trees for which no additional payment will be made. The roots of the trees shall be grubbed to full depth. The contractor shall dispose off all such materials within 1 km. or as directed by the Engineer-in-Charge. All operations in connection with clearance of jungle and bushes shall be subject to provision of forest acts and rules.

b) No separate payment will be made to the contractor for the complying the requirements of this paragraph and all cost shall be deemed to have been included in the rates quoted in schedule for the items of excavation.

2 RECORDING OF CROSS SECTION

After clearing the site the area is to be stripped of objectionable materials after which the initial cross sections shall be taken at every 30 m interval or closer depending on nature of the ground upto sufficient distance outside the limit if work. Levels on these cross sections shall be taken at 5 m. or closer intervals as directed by the Engineer-in-Charge and recorded in the field and level books in the presence of the contractor or his authorised agent shall sign the field work/level book in the token of acceptance. These c.s. shall form the basis of all future measurement and payment. The original c.s. duly signed by contractor and the Engineer in charge shall be preserved. Such dimension shall be measured to the nearest 0.01 M. any dimension greater than 25 mm. shall be measured to 0.01 M. Area shall be computed to 0.01 M^2, volume shall be computed to 0.01 M^3.

FOUNDATION PREPARATION

1 SOIL FOUNDATION

Soil foundation under the seat of road shall be scarified and loosened by means of a plough, fipper or other means to a depth of about 15 cm .to 20 cm .to the satisfaction of the Engineer-in-Charge. Roots and other debris turned up during scarifying shall be removed from entire foundation area for the fill. Before placing of fill materials, the stripped slat of the road is to be initially compacted. The first few layers of fill for the road shall be of depth of 10 cm to 15 cm and shall be carefully placed, ensuring uniform compaction and a satisfactory intimate bond between the foundation soil and fill materials. Heavy rubber type rollers or vibratory rollers may be used for compaction because they will follow the irregular surface and not bridge over small low areas as other type of rolling equipments will do. Power Road Rollers shall be used for compaction of impervious soil and preferably vibratory type roller shall be used for compaction of all other soil and rock. Separate payment shall not be made for preparation of foundation as above and it shall be deemed to have been included in the unit rate quoted for respective item of road.

2 SAND FOUNDATION

Sand met with in foundation shall be tested for it's lateral relative density. In reaches where the relative density is less then 70% the foundation sand shall be compacted by any of the approved methods to obtain a minimum relative density of 70%. Until the foundation has been

tested and the relative density found to exceed 70%, fill shall not be allowed to be placed. This is necessary to minimize the effect of any structural readjustment in a loose foundation.

BORROW AREA

1 GENERAL

All materials required for the construction of road shall be obtained from borrow areas duly approved by the Engineer-in-Charge in consultation with quality control unit. The contractor has to arrange borrow area for necessary testing and approval of Engineer-in-Charge to borrow sand & moorum at his own cost and responsibility. No compensation whatsoever for change in limits and locations of the borrow areas and depth of cut for getting suitable road materials shall be paid to the contractor. No excavation is permitted within a distance of ten times the height of road from the outer toe. Borrow pits shall be operated so as not to impair the usefulness or mar, the appearance of any part of the work or any other property. The surface of wasted materials shall be left in a reasonably level and even condition. Adequate lighting arrangement should be provided by the contractor at the borrow area if required.

2 PREPARATION OF BORROW AREA

All areas required for borrowing sand for road shall be cleared of all tree stumps, roots, bushes, rubbish and other objectionable materials. Particular care shall be taken to exclude all organic matter from the materials to be placed in the approach road. All cleared organic materials shall be burnt to ashes or disposed off as directed. The cleared areas shall be maintained free of vegetable growth during the progress of the work. No payment shall be admissible for preparation of the borrow areas indicated above as this is deemed to have been included in unit bid price.

3 STRIPPING OF BORROW AREAS

Borrow areas shall be stripped of top soil, and any other objectionable materials to the required depth I as directed by the Engineer-in-Charge. The work may be done manually or with suitable machine. Stripping operations shall be limited only to designated borrow areas. Materials from stripping shall be disposed of in exhausted borrow areas or in the approved adjacent areas as directed. No extra payment shall be admissible for stripping the borrow areas as this is deemed to have been included in the unit bid price.

4 HAUL ROADS ANDAPPROACH ROADS

Construction and maintenance of approach roads and haulage roads will be the responsibility of the contractor. The department will have full right of way to those roads for inspection purposes. Proper road sign as directed have to be provided for safety. For haulage of road materials, the

contractor shall construct ramps and haulage and of sufficient width along the shortest but most practical route and shall maintain and illuminate them to a satisfactory manner. Watering of the haul road shall be done by the contractor as often as necessary to prevent raising of dust, formation of cuts and consequent deterioration of the surface. Whenever service roads meant for public thorough fare traverse through or run close to the borrow areas, the contractor shall direct his excavation and haulage operation in such manner as to ensure uninterrupted use of the service road and safety to the public. At the haul road and the service road crossing, the contractor shall install necessary check gates and road signs. No extra payment is admissible as this is deemed to have been included in the unit bid price for the earth work item being contingent to the main work.

5 WEATHERCONDITIONS

Road materials shall be placed only when the weather conditions are satisfactory to permit accurate control of the moisture content in the road materials. Before closing work on road, the top surface shall be graded and rolled with a smooth wheeled roller to facilitate run off. Prior to resuming work, the top surface shall be scarified and moistened or allowed to dry as necessary and approved by the Engineer-in-Charge for resumption. The contractor shall provide suitable protection works to protect the slope from erosion due to rainwater. No payment whatsoever shall be made for providing such protection work and rectifying of monsoon damages.

6. WATERING

1. Adequate watering to the sand fills it to be done to facilitate proper compaction. Similarly water content to moorum is to be controlled for proper compaction. No compensation will be made to the contractor due to held up of work for rain, fog and moisture content in the working process.

7. COMPACTION

1 GENERAL

a) Having decided on the filling materials to be used, standard compaction test shall be made on the materials proposed for road to indicate broadly which are the most suitable type of equipment to be used and the moisture content at which compaction should be undertaken and also to determine the effects of soil moisture content, thickness of layer and number of passes.

b) Having decided on the thickness of layer and range of moisture contents, tests should be made with different type of equipment available and the required number of passes should also be determined.
   (a) In all this work, the state of compaction should be measured in terms of dry density.
   (b) Density tests if felt necessary by Engineer-in-Charge shall be made after rolling in that case. Standard proctor density test shall be carried out at regular intervals to account for variations in the borrow area materials as well as that in situ excavated materials.
   (c) The contractor shall supply all materials labour machinery and equipment at his cost for the work.
   (d) No extra payment shall be made for these operations as this shall be deemed to have been included in the price bid in schedule of Quantities for the respective item of work.

8.ROLLING

When each layer of materials has been prepared so as to have the proper moisture, content uniformly distributed throughout the materials it shall be compacted by passing the vibrating roller or P. R .R .The exact number of passes for each layer to obtain specified density shall be designed by the field laboratory after necessary test, the layer shall be compacted in strips over tapping not less than 0.6 m. Rolling shall commence at edges and progress towards centre longitudinally. The rollers of loaded vehicle shall travel in a direction parallel to the axis of the road. Turns shall be made carefully to ensure uniform compaction. Rollers shall always be pulled. Density tests shall be made after rolling and dry density attained shall satisfy the compaction standards specified in relevant I.S. Codes.

9.COMPACTION OF COHESIONLESS MATERIALS

Where compaction of cohesion less free draining materials such as sand and gravel is required, the materials shall be deposited in horizontal layers and compacted to the relative density specified. The excavation and placing operations shall be such that the materials when compacted shall be blended sufficiently to secure the highest practicable unit weight and best stability. Water shall be added to the materials as may be required to obtain the specified density by method of compaction being used.

The thickness of the horizontal layers after compaction shall not be more than 10 cm, if compaction is performed by tampers and more than 15cm, if by rollers.

10.DRESSING SLOPES

The slopes of road shall be neatly dressed to lines and grade as shown on the drawing as the placing of fill progress, compaction shall extend over the full width of the road and materials in slopes shall be compacted as for the rest of the road. To ensure proper compaction of the edges, the cross section of the fill during construction shall be kept suitable wider as directed by the Engineer-in-Charge and cross section shall be dressed to the designed requirement after compaction for which no extra payment shall be made as it is deemed to have been included in unit bid price for item of schedule of Quantities. Materials used to fill depression shall be of same type as used in the road and shall be thoroughly compacted and bonded to the original surface. Slopes shall be maintained until final completion and acceptance. Any material that is lost by rains, weathering or other causes shall be replaced at the cost of the contractor till completion of the works and taking over by the department.

11.SETTLEMENT ALLOWANCES

(i) In the fill road, settlement allowances of 2% will be provided. Accordingly extra height shall be provided but payment for design height will be made. The base width of the road will not be increased to maintain the design slopes indicated in the drawing for the additional height as settlement allowances, but the following procedure will be adopted, settlement allowances will be calculated at various levels where the slopes is to be changed and the elevations including settlement allowances will be derived keeping the road widths of the designed levels unchanged. The edges of road at the increased elevations (including settlement) when joined with the point 1 where the slope has changed earlier bellow, shall give the slope to be adopted for constructions.

(ii) If the road is raised in more than one season, provision for settlement shall be made in the last season's construction as described above.

12.MEASUREMENT AND PAYMENT

a) All works shall be measured by levels.

b) For payments the level books, field books, the cross section sheets and calculations sheets shall be treated as adjuncts to the measurement books.

c) All linear measurements shall be in meters, correct to 0.01 meters, area worked out in square meter correct to 0.01 m2 and volume work-out in cubic meters correct to 0.01 m3.

d) The quantities between the levels taken after stripping and cross sectional levels taken after construction of consolidated road with the available useful excavation soils. It shall be clearly understood that construction of road to extra width as specified and extra height formed for settlement allowance as specified earlier will not include for payment. The measurement will be limited to within design section.

e) Final measurement and levels shall be taken at the cross sections of the completed compacted bank design section after the slopes dressed to ensure that work is completed as shown in the drawing plus settlement allowances. The measurements for computation of quantity shall not include the extra section provided for compaction of sand fill upto lines of finished slope and for settlement allowances.

13.RATE FOR PAYMENT

The rate for Construction of road under item provides all costs for labour, materials, tools and plants, machinery, excavation, transportation and incidental operations required for carrying out and completing the item of work in accordance with the specification, drawing and as directed by the Engineer-in-Charge including (i) Site clearance (ii) Setting out works (iii) Marking out, providing and forming model section, locks spitting, strings and stakes as may be considered necessary by the Engineer-in-Charge to guide the contractor in road construction (iv) compacting the original ground including preparation of seat under road (v) Scarifying and benching etc. (vi) Clearing trees stumps and bushes, stripping of the borrow area upto required depth (vii) Maintaining borrow area free from vegetation growth, drainage arrangement and moisture control including watering (viii) Loading, conveyance from designated borrow area, unloading and spreading of suitable materials including rehandling (ix) Construction and maintenance of approach roads and haul roads (x) Cutting and trimming as specified in dressing of slopes (xi) Restricted working near sites of structures (xii) Settlement allowance (xiii) Spreading in thinner layers at required places (xiv) Compaction with suitable compactors (xv) Removal of materials like bushes, roots, sods, other perishable materials and pebbles etc. from the fill materials (xvi) Providing labour and testing charge for testing of samples (xvii) All drainage and dewatering as required (xviii) The section of all work to be maintained in good order during execution and also in rainy season (xix) All safety measures.

14.SCOPE OF WORK

This specification covers items for construction of road work starting from sub-base preparation to pre- coated seal coat over premix asphalt carpeting including earth work in excavation or trimming for laying sub base, preparation of sub-base with moo rum and sand mix laying and compacting I.R.C. Gr .I (40mm to 90mm. size) and I.R.C. Gr. III (25 to 40mm size) metaling with hard granite hand broken metal premix; asphalt carpeting and precoated seal coat. The work covers providing all materials, labour, conveyance of materials with all leads, lifts and delifts, stacking at site, spreading, rolling, watering including royalty and all taxes.

15.GENERAL

(i) All works performed shall conform to lines, grade, cross sections, levels and dimensions shown in the drawing with necessary super elevation and extra width at curves for roads and as directed by the Engineer-in-Charge.

(ii) Proper care shall be taken to avoid any interference with or damage to works of other discipline such as water supply, sewerage, electricity etc.

(iii) The Contractor shall submit sequence of operation which he proposes to follow to the Engineer- in-Charge and shall obtain approval to it prior to commencing work and shall adhere to the agreed sequence after modification if any by the Engineer-in-Charge.

(iv) The methods and plants and equipments to be used by Contractor is subject to approval of Engineer-in-Charge.

(v) Sign boards for construction activities, overtaking signals, diversion of road etc. is to be displayed by Contractor at his own cost.

(vi) The Contractor shall at all time carry out work in a manner creating least interference to the traffic during execution. The Contractor shall provide and maintain during execution a passage for traffic either along or as part of existing way under construction or a separate diversion road at his own cost.

(vii) Quality of all materials should be approved by Engineer-in-Charge prior to collection at site.

(viii) Construction traffic shall not be allowed to use the newly prepared surface without prior permission from Engineer-in-Charge. Any damage arising out of such use shall however be made good by the Contractor at his own cost.

(ix) All measurement a 00 computations unless otherwise indicated shall be carried out to the following limit

(i) Length and breadth –10 mm .

(ii) Height, depth or thickness of earthwork, Sub base and base course-5mm.

(iii) Areas - 0.01 sqm.

(iv) Cubic content - 0.01 cum.

(x) Materials found inferior and rejected shall be removed from site immediately by the Contractor at his own cost.

(xi) Works rejected by the Engineer-in-Charge on ground of poor quality or workmanship shall be dismantled and redone by the Contractor at his own cost.

(xii) Complete stacking of materials like sand, moorum, H.G. chips: as per requirement shall be carried out in 2Km. length before spreading, The collection shall always commence at one end and be carried continuously towards the other unless the Engineer-in-Charge directs otherwise.

(xiii) Till utilization, the Contractor will be responsible to protect the materials collected at the work site at his own cost.

(xiv) The unit rates for different items of work shall be for payment in full for completing the work to the requirement of specification including full compensation for all the operations detailed in relevant section of specification and in schedule. The rates are considered for finished work covering all labour, tools, equipment, wastage, Temporary works, hire and running maintenance of plant and equipments, watch and ward, overhead charges and profit as well as general liabilities, obligations and risk arising out of the contract for the work.

EXCAVATION (OR) TRIMMING FOR LAYING SUB-GRADE

(i) The road or surface to the full width of the pavement is to be excavated or trimmed to designed level for laying the sub-grade.

(ii) The excavated material to be disposed off by laying on the berms or slope of road finished smooth or as directed by Engineer-in-Charge.

(iii) Measurement for payment shall be made on cubic meter basis. The volume will be measured by level section limited to designed sections, lines and grade.

MATERIALS

1 MOORUM

The moorum shall have plasticity index not less than 6 as determined in accordance with I.S. 2720 (part v) .It shall be free from all rubbish, dust and organic materials as well as clods of clay / black cotton soil. The moorum should be granular and gritty.

2 SAND

Sand shall consist of hard, dense, durable and uncoated silicious gritty materials. Sand to be used shall be natural as obtained from river bed from specified quarries. It shall be free from all rubbish, dust and organic materials as well as clods of earth loam and other deleterious substances.

3. STONE AGGREGATE

3.1 METAL

a) The hard granite crusher broken stone metal shall be obtained from rock excavation if available or quarries as approved by the Engineer-in-Charge prior to collection. The metal shall be obtained from hard, tough, sound, durable stone of close texture as is locally available and reasonably free from decay and weathering. Pieces of the stone shall be angular and roughly cubical in shape, round, elongated or flaky materials shall be rejected. No round or along pebbles or angular chips, longer or smaller than the specified size shall be allowed. The size of the metal shall be 40mm to 90mm for I.R.C. Grade-I and 25mm to 40mm, for I.R.C. Grade-III and it shall be machine crushed.

(b) Samples metals, collected from the approved quarries shall be get tested by the Contractor at his cost in the laboratory. The test results shall conform to the standard requirement laid down for metal to be used for this work.

(c) The physical requirement for standard size metal shall conform to the test results in the Table in next page.

Type of construction	Test	IS for test method	Requirement
Base	(i) Los Angels abrasion value	IS: 2386 (Part iv)	50% Maximum
	(ii) Aggregate impact value	IS: 2386 (Part iv) or IS: 5640	40% Maximum
	(iii) Flakiness	IS: 2386 (Part-l)	15% Maximum.
	(iv) Water absorption	IS: 2386 (Part iii)	2% Maximum.

(d) Grading requirement of coarse aggregates :

The coarse aggregate shall conform to one of the gradings as given in table below provided, however the use of grading No. I shall be restricted to sub-base coarse only.

Table: Grading requirement of coarse aggregates.

Grading No.	Size Range.	Sieve Designation	Percentage by weight passing
I.R.C.-II	63 mm to 45 mm		

CONSTRUCTION PROCEDURE

1 SUB-BASE BELOW PAVEMENT

(i) Moorum and sand stacked separately shall be conveyed and mixed properly to make an admixture of moorum and sand in proportion as per direction of Engineer-in-charge.

(ii) The formation after excavation or trimming shall be dressed to required camber and grade.

(iii) The admixture of moorum shall be spread in subbase and also side shoulders in layers not exceeding 15cm. in thickness and should be adequately watered.

(iv) Immediately following spreading of spreading of admixture moorum rolling will be started with three wheeled roller of 8 to 10 tones capacity or equivalent vibratory roller. The rolling shall begin from edges firmly compacted and then progress gradually from edges to centre, parallel to the centre line of the road and over lapping uniformly each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. In case of superlevated portions rolling shall proceed from inner edge to the outer edge. Rolling to continue till the admixture of moorum is thoroughly keyed. During rolling sprinkling of water is to be done as required for a dense compacted mix layer .

(v) The rolled surface to be checked transversely and longitudinally and any irregularities, ruts and soft yielding places be corrected by loosening surface, adding or removing amount of admixture moorum and rolling entire surface to conform desired grade and camber of 1 in 50 (not flater than 1 in 72).

2 I.R.C. GRADE-II METAILING

2.1 SPREADING OF COARSE AGGREGATE

(i) The quality and grading of I.R.C. Grade-II metal (size 63mm to 45mm) shall satisfy criteria described under sub-head criteria —materials" (Chapter 11.6.3).

(ii) The surface to receive I.R.C. Gr-II water bound macadam course (metaling) shall be made free from dust and other extraneous material.

(iii) The respective grade metals shall be spread uniformly to specified nominal thickness of 10 cm for

(iv) The spreading shall be done from stacks along the side of the roadways or approved stock yards. In no case shall aggregates be dumped in heaps directly on the surface prepared for the metaling nor shall hauling over un compacted or partially completed base be permitted. No segregation of large or fine particles shall be allowed.

The surface of the aggregates shall be carefully checked with Templates and all high or low spots remedied by removing or adding aggregates as may be required by hand packing the same to proper grade and camber.

(v) The bunds of earth or moorum one on either side shall be made along the outer edge of metaling prior to or simultaneously with spreading of metal. In addition where over required turf edging are to be provided. These bunds and turf edging are required to prevent loose metal from spreading out beyond width of road to be metaled.

No extra payment will be made for the bunding or turf edging as the same are deemed to be / included in the unit rate of respective items.

(vii) The course aggregate shall normally be spread more than 3 days in advance of the subsequent / operation.

(viii) Spreading of metal shall proceed only 200m. in advance of rolling operation.

2.2 CONSOLIDATION

(a) Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power roller of 8 to 10 tonne capacity or equivalent vibratory roller. The weight of the roller shall depend upon the type of the aggregate and shall be as indicated by Engineer-in-charge.

(b) Except on superlevated portions where the rolling shall proceed from inner edge to outer rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller moving forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half wheel width.

(c) Rolling shall continue until the aggregate is thoroughly keyed and the creeping of the aggregate ahead of the roller is no longer visible. During, rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave like motion in the sub-grade or sub-base course.

(d) The rolled surface shall be checked transversely and longitudinally with Templates and any irregularities corrected by loosening the surface, addition or removing necessary amounts of aggregates and re rolling till the entire surface conforms to desired camber and grade. In no case shall use of screenings be permitted to make up depression.

(e) Moorum as blinding material shall be applied, successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly, and rolled, during which water shall be applied to the wheels of the rollers, if necessary to wash down the blinding materials sticking to them. These operations shall continue until the resulting slurry after filling the voids, forms a wave ahead of the wheels of the moving roller.

(f) After final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding materials as directed, lightly sprinkled with water, if necessary & rolled .No traffic shall be allowed on the road until the macadam has set. The Engineer-in-charge shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause damage to the surface.

(g) Material which crushed excessively during compaction or becomes segregated shall be removed & replaced with suitable aggregate.

(h) It shall be ensured that shoulders are built up simultaneously along with water bound macadam courses.

2.3 CONSUMPTION OF MATERIALS

Consumption of material for specified thickness of pavement in case of both I.R.C. Gr.II:

I.R.C. Gr.II

Over all (Nominal) thickness of layer laid	100mm.
Compacted thickness	75 mm
Consumption of metal	0.090 cum/sqm
Consumption of moorum as blinding	0.022 cum/sqm

ROAD DIVERSION

(a) The Contractor shall Construct and maintain the road diversion for the traffic with necessary sign boards working signal during construction period as approved by the Engineer-in-charge at his own cost.

(a) The Contractor shall take all necessary measures for the safety of traffic during construction and provide, direct and maintain such barricades including sign, marking, light and flagmen as may be required by the Engineer-in-charge for the information and protection of traffic approaching and passing through the section of the road or highway under construction. Before taking up any construction, phased programme for the Control of traffic on the road or highway shall be drawn up in consolation with the Engineer-in-charge.

(b) The barricades erected on either side of the portion of the carriage way closed to traffic shall be strong to resist violation and painted with alternate black and white strips. Red lantern or warning lights of similar type shall be mounted on the barricades at night and kept there through out from sunset to sunrise. At the points where traffic is to deviate from its normal path, the channel for traffic shall be clearly marked with the aid of pavement marking and painted drums are to be kept through out the channel. At night the passage shall be lighted with lanterns or other suitable light sources.

(c) One way traffic operation shall be established whenever the traffic is to be passed of the carriage way inadequate for two lane traffic. This shall be done with the help of flagmen kept positioned on opposite sides during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns lights on both sides, suitable regulatory/warning signs shall be installed for the guidance for the road users on each approach at least two sign shall be put up one close to the point where transition of carriage way begins and the other 120 meters away. The sign shall be of approved design and of reflector type, if so directed.

MEASUREMENT AND PAYMENT

(i) Providing and stacking moorum, H.G. metal (I.R.C. Gr.II), Moorum, metal and Chips shall be stacked in standard box heaps of 1.5 M.x1.5M.xO.44M.to be measured as 1 Cum.Sand shall be stacked in regular stacks or box heaps of 1.5Mx 1.5Mx 0.44 M as per direction of engineer-in-charge.

The unit rate for respective items includes excavating, collecting procurement, conveying to work site including loading, unloading, stacking the same at approved stack yard beyond trafficable berm in regular box heaps or stacks as directed by the Engineer-in-charge with all leads, lifts and delifts, including royalty, all taxes and incidental charges like watch and ward till utilization.

(ii) Subbase preparation with moorum

Measurement for conveying from stacks, laying moorum and watering and rolling for subbase below pavement shall be based on cubic meter content of moorum based on premeasurement of items as actually utilized in the work after deduction of void.

The rate shall include Labour and T & P required for conveying moorum from stacks measured previously collection paid separately) spreading the moorum to required thickness, watering, rolling, turfedging with all leads, lifts and delifts, hire and running charges of P.R.R., cost, conveyance of turf

and water including royalty, cess and all other taxes, incidental charges etc .complete for finished item of work to lines and grade as per drawing, specification and as directed by the Engineer-in-charge.

(iii) I.R .C Gr. II metaling courses will be based on cubic meter content of metals utilized in work after deduction of void from stacked measurement. Volume of moorum used as binding material will not be added to the cubic meter content of I.R.C.Gr.II metaling for payment. The rates shall be for finished items of work to lines and grade (excluding cost of H.G. stone, metal and moorum measured and paid separately) including labour and T & P. required for conveying from stacks and spreading hard granite crusher broken metal to specific thickness, packing voids with small size metals uniformly, hand packing to proper camber, conveying from stacks and spreading of moorum of specified grade and quantity over the metal surface to fill of interstices, watering and consolidation with P.R.R. including hire and running charges of P.R.R. and other equipments, turf edging, cost and conveyance of turf and water with all leads, lifts and delifts including royalty, cess and all other taxes, incidental charges etc. Complete as per specification and as directed by the Engineer-in-charge.

(iv) Shoulder construction

Measurement for conveying moo rum from stacks and spreading to required thickness, watering and rolling shall be based on cubic meter content of moorum, after deduction of void, actually utilized in the work.

The rate shall be for finished items of work including labour charges with all leads, lifts, delifts, hire and running charges of P.R.R. and other equipments, turf edging, cost and conveyance of turf and water but excluding cost of moorum measured and paid separately.

SECTION - XII

POWER SYSTEM CONNECTIVITY

IMPORTANT INSTUCTION TO BIDDERS

- **This Section comprises of two parts:**
  - **A. Technical Specification on construction of over head lines (Sub-transmission, HT & LT) and Construction Practices for MSDSS and DSS.**
  - **B. Technical Specifications for supply of equipment's & materials & respective Guaranteed Technical Particulars (GTP).**
- **Above shall be read in conjunction with Technical Specification Volume-II, Section II A "survey & Investigation, Planning, Design and Drawing" as they are integral parts of Technical Specification.**
- **Bidders are advised to follow Bureau of Indian standards, REC construction standards, approved manufacture specifications & other relevant manuals and construction standards that complies with relevant Regulations of CEA/CERC/ OERC, for those items not provided specifically in this document, but required for turnkey completion of Sub-Stations and associated Sub-Transmission, HT & LT lines.**
- **SLD for system networking, drawings & physical scopes where ever mentioned in the Bid document give indicative scope of work. Drawings are complementary to specifications and shall be referred to for better understanding as well as for estimation of quantities for arising at lump sum bid price on turnkey basis. System connectivity & related equipments are on turnkey basis. The successful bidder shall be liable to abide by the specific requirements of DoWR at detailing stage with no financial liability to Owner.**
- **Bidders shall comply with the submittal list & duly fill up the required formats in complete shape including GTPs. For Bid purpose, only GTPs of important system elements like Power Transformers 33/6.9 KV (rating 630 KVA & 1.6 MVA), Distribution transformers (rating 100 KVA & 315 KVA), 33 KV Vacuum Circuit breakers, Conductors (AAAC) shall be submitted along with Technical Bid.**
- **Bidders are advised to ensure that all documents/ drawings are legible copies & drawings should be of size not less than A3.**
- **Non compliance with any of listed submittals or incomplete submittals shall be treated as "Non-responsive" Bid.**

[Conventions: The following conventions are used throughout this document;

a) The word "shall" donate a mandatory requirement.

b) Italics are used to indicate titles of acts or publication.]

A. CONSTRUCTION OF

33 KV SUB-TRANSMISSION

AND

6.6 KV, LT SUB-SYSTEM

Index

1.0 Broad Scope: Scope includes but is not limited to;

Planning, Design, Testing, Supply, Erection & Commissioning of:

a. **Main Step-Down Distribution Sub-Station (MSDSS) [33/6.6 kV in relation to the projected load, voltage regulation & shall meet the basic requirements indicated in the attached single Line Diagram (SLD)]**
b. **Lay-out of above outdoor switch yard.**
c. **33 kV Sub-Transmission networking/ System Connectivity with identified EHT Grid Sub-Stations and/or identified DISCOMs network topology as shown in attached SLD.**
d. **HT Line (6.6 kV) and LT over head lines.**
e. **Distribution sub-stations DSS (6.6/0.433 kV, 33/0.433 kV) as per the requirements, including conductor/cable and supporting structures.**
f. **Metering, Protection & control for 33 kV, 6.6 kV & LV systems.**
g. **Earthing system & earth mat design**

GENERAL

2.0 Project Information:-

- 'Project Synopsis' [enclosed with volume-1] provides details of identified Mega Lift Schemes with their Identification Number (ID) under each cluster.
- Each project and/or pool of projects needs physical connectivity with the distribution networks of concerned area distribution licensee, to effect power supply in terms of the provisions contained under *'ODISHA ELECTRICITY REGULATORY COMMISSION DISTRIBUTION (CONDITIONS OF SUPPLY) CODE, 2004'*.
- Odisha Power Sector is characterized by (i) four area Distribution Licensees, namely CESU, NESCO, WESCO & SOUTHCO (ii) State Transmission Utility, OPTCL and (iii) GRIDCO, the Intra State Trader, the sole bulk supplier of power to DISCOMs in Odisha.
- To meet the additional projected load on account of Mega Lift Projects, physical assessment of System augmentations at EHT level has been worked out & funds placed with OPTCL for execution. Augmentation covers up-rating of Power Transformers, installation of 3rd Transformer with associated 132kV bays and 33 kV feeder bays for the projects. Thus EHT back up for power supply to Mega- Lift Project rests with OPTCL (Transmission Utility).
- The project conceives connectivity at voltage level at 33 kV. Thus connectivity may be a direct interface with Transmission Utility's Grid Sub-stations or inter-connection with DISCOM's 33 kV network to be decided as per techno-economic analysis. Schemes, where dedicated Grid connectivity would not be feasible or not cost effective, solution like connectivity with local distribution 33 KV systems, may be considered, subject to technical feasibility. General practices adopted by concerned area distribution licensee (DISCOM) will be taken in to consideration so that infrastructure developed is compatible to their system.
- Intervening 33kV dedicated new lines linking nearest/identified Grid Sub-station & Point of supply of the beneficiaries [here 33/6.6 kV Main Distribution Sub-Station (MSDSS) and/ or DSS (33/.433 KV) to feed MLIPs] and other 33kV new lines, that may be required for integrating beneficiary's installation with DISCOM's existing and/ or ongoing (schemes like CAPEX Program/ ODSSP etc.) infrastructures, will be part of the bidder's scope.
- 33 KV new feeder bay, if any required at DISCOM's 33/11 KV existing and/ or ongoing schemes for power supply to Mega-Lift Scheme including augmentation (up rating of conductors) / rehabilitations (replacement of missing/damaged structures,

any missing accessories etc.) of existing sub-transmission system shall be assigned to DISCOM..

- 33kV infrastructure, so developed, will be handed over to area distribution Licensee for Operation & maintenance, with effect from *"date of commencement of supply"*. Modalities for handing over for O&M shall be decided by DoWR.
- Downstream electrical composite unit including 33/6.6 kV Main Step down Distribution Sub-Station (MSDSS) , Distribution S/S (6.6/.433 kV) and/ or (33/0.433 kV), apparatus (indoor, outdoor), 6.6 kV & LV lines, electrical motors, and underground cables, erected and wired by or on behalf of beneficiary, shall be termed as *"consumer installation".* Planning, design, testing, supply, erection & commissioning of all related *"Consumer Installation"* shall be part of the bidder's scope including operation & maintenance of the installation for a specified period as detailed in the bid document. .
- DISCLAIMER: This Document includes statements, which reflect various assumptions. Each Bidder should conduct its own estimation and analysis and should check the accuracy, reliability and completeness of the information in this Document and obtain independent advice from appropriate sources in their own interest. DoWR will have no liability whatsoever to any Bidder or any other person under the law or contract, the principle of restitution or unjust enrichment or otherwise for any loss, expense or damage whatsoever which may arise from or be incurred or suffered in connection with anything contained in this Documents and mater deemed to form part of this document.

  Though adequate care has been take while issuing the Bid document, the Bidder should satisfy itself that documents are complete in all respects. **Intimation for any discrepancy shall be given to this DoWR immediately.**

3.0 Scope of Proposal:-

Scope of proposal shall be on the basis of single bidder's responsibility, completely on turnkey basis, covering supply, erection, testing & commissioning of all equipments and new OH (33 KV & 11 KV) line as specified under the accompanying Technical Specifications/ SLD including other services. It would include the followings;

- Planning & development of suitable system connectivity: - Network planning shall be through consultation process with DISCOMs and STU (OPTCL). Owner's indicative network enclosed in the Bid document is based on interaction/ consent with concerned DISCOMs & STU (OPTCL). Any modification to SLD needs to pass through similar process and approval. Network planning shall be duly supported by

appropriate computer aided network analysis through software package, preferably with Mi-Power package (being used by OPTCL). System impact study (LFA) by the EPC contactor shall be submitted to OPTCL for their review.

EPC developer shall provide Block diagram for System connectivity both for 33 KV & 6.6 KV based an SLD (as agreed in the Joint meeting of OPTCL/GRIDCO/DISCOMs & PMU (Mega Lift).

- Preliminary route survey, finalization of route alignment, detailed survey, structure (tower/pole) spotting, geo-technical investigation, optimization of structure location and check survey of Line, substation and preparation of SLD/BOQ;
- Design, selection and installation of foundation for structures, poles for single/double circuit over head line.
- The design, testing, supply and erecting of 33kV, HT (11 KV lines to be charged at 6.6 KV) and associated LT lines with single/double circuit support structures [low based tower structure/M.S rail pole/ GI RS Joist/ H poles/PSC poles (for lines other than 33 KV line)], associated cross arms, nuts, bolts & washers, D-shackles, support stays and accessories like danger plates, anti-climbing devices, structure identification plate and earthing devices;
- Supply of supports, conductors, insulators, insulator hardware, earth wire, joints, clamps for conductors, earth wire clamps and accessories including stringing;
- Design, manufacture, supply, erecting and stringing of special structures/towers including design and construction of foundations for crossings like Railways, Rivers, power lines etc;
- The slack span connections of conductors from terminal structures to the sub-station gantry structure at Transmission and/or Distribution licensees interface (i.e. point of supply).
- Planning, design, testing, supply, erection & commissioning of MSDSS (33/6.6 kV), Distribution sub-stations (6.6 /0.433 kV and/or 33/0.433 kV) and all related *"Consumer Installation"* and operation & maintenance of the installation for a specified period as detailed in the bid document.
- Providing Engineering drawing, data including calculation sheets (both hard and soft copies in XL form), operational manual, etc for Owner's approval.
- Relevant drawings pertaining to safety aspect (General Lay-out with important elevations & sectional views of MSDSS/DSS including SLD, Earthing details, OH Lines including important crossings, shall be approved by statutory Authority, prior to field executions.

- Getting the relevant drawings for the substations and lines approved before execution & installation inspected after completion of work by Electrical Inspector.
- O&M of substation/installation for specified period as detailed in Bid document.
- Supply of testing instruments & maintenance kit for carrying out testing and measurement at MSDSS & DSS for O&M purposes.
- Supply of contingency reserve stocks for system elements, Transformer, Transformer oil, CBs, Insulators, Supports/ conductor, conductor hardware, Cables for O&M.

4.0 SYSTEM CONDITIONS (Design Parameters):

The equipments/lines to be installed for altitude up to 1000 m above MSL shall be compatible to the system characteristics:

i) System Parameters for HV System shall be as flows:

Parameter	33 kV	6.6 kV
Rated System Frequency(HZ)	50	50
Nominal System Voltage(kV)	33	6.6
Maximum System Voltage(kV)	36	7.2
Three Phase symmetrical short circuit rating for switch gear (KA)	25	25
Duration of short circuit fault current (Second)	3	
Dynamic short circuit current rating(KA_P)	62.5	62.5 (Rated making current=1.8*√2* rated short circuit breaking current)
Insulation Level:		
1.2/50 µs Impulse with stand (kV_{peak})	170	60
Power frequency one minute withstand in dry condition(kV_{rms})	70	20
Design ambient temperature (^0C)	50	
Wind Pressure	As per IS 802 (Part. I/ Sec.I)	
System earthing	Solidly earthed	Solidly earthed

ii) System parameters for LT system shall be as follows:

Nominal system voltage (V)	415
Highest system voltage (V)	433
Voltage variation (%)	± 10%
Frequency variation (%)	+3 to-5%
Maximum System fault level (KA)	50(for 1 sec)
System earthing	Solidly grounded

5.0 SYSTEM CONNECTIVITY:

- System networking should be planned & developed suitably, that shall be capable of providing reliable, economic and efficient power supply in terms of the provisions contained under ***CEA (Technical Standards for connectivity to Grid) Regulations 2007, CEA (Technical standard for construction of plant and lines) Regulations, 2010, CEA (Measures relating to safety and Electric Supply) Regulations, 2010, Odisha Grid Code and "Distribution System Planning And Security Standards, Operating standards –1999" or its latest amendments, if any*** *issued by OERC,* ***ODSSP*** *Technical specifications, Document and their relevant drawings,* ***CBIP*** *Manuals,* ***IEEE/IEC/IS****.*
- Independent 33 kV feeder from nearby EHT Grid Substation shall be provided for loads of 5 MVA and above. Service area for each MSDSS (33/6.6kV sub-station) shall be identified by pooling a set of nearby Schemes and such sub-distribution station can be fed by independent 33kV feeder from nearby EHT Grid Sub-stations in an integrated manner, with an overall objective of quality, reliability in supply & reducing 33 kV inventory. Such schemes should be based on Techno-economic study/ analysis.
- Schemes, where dedicated Grid connectivity would not be feasible or not cost effective, solution like connectivity with local distribution 33 KV systems, may be considered, subject to technical feasibility by concerned area distributor (DISCOM).
- For isolated Schemes (that are out of above supply zone of MSDSS) may be fed by spur lines to be extended from existing/ ongoing (CAPEX Program/ ODSSP) 33 kV infrastructure of distribution licensee, subject to permissible ***KVA-KM Loading.***
- 6.6 kV sub-distribution networks shall either over head or by cable & preferably in ring configuration.
- 6.6 KV over head line shall be 11 kV designed line.
- Comprehensive Sub-Transmission Planning & 6.6 kV distributions networking along with methodology, assumptions, ***load flow study*** and analysis thereof need to be submitted to OPTCL & for approval by DoWR**.**
- Earthing design (Earth mate) with relevant studies for MSDSS/DSS need to be submitted for approval.

6.0 General particulars of System:

Substation Philosophy:

- MSDSS: 33 KV side will be AIS (outdoor) & indoor switchgear panels for both 33 & 6.6 KV systems.

- Vacuum type circuit breakers shall be used for voltage level of 33 KV and below [i.e. Outdoor type with its GI Supporting structure & indoor control panel for 33 KV & indoor type for voltage 6.6 KV].
- It will have at least two power transformers of adequate capacity to meet the projected load and operate at 80% of their rated capacity. Station supply (LV system) will be from a station transformer connected to 33 KV systems.
- Capacities of Power Transformers shall be selected as per the following guidelines:
  - MD of individual Scheme shall be calculated as per the guidelines given in clause 9.1.2 of Section-V-B, Vol-II.
  - Diversity factor of 1.0 shall be used on summation of MDs of Schemes to be fed from MSDSS& efficiency of transformer shall be as per the data from the manufacture (GTP data sheet).
  - There shall be at least two transformers that shall be able to operate in parallel operation & be selected from standard ratings of 630 KVA, 1 MVA, 1.6 MVA, 3.15 MVA & 5 MVA.
  - Loading of transformer shall not exceed 80% of rated capacity.
- DSS (33/.433 KV): 33 KV side will be AIS & indoor switchgear panels for both 33 KV & LT systems. It will have at least two distribution transformers of adequate capacity to meet the projected load and shall sustain the starting impact of largest LV motor. The 33/.433 KV distribution transformers shall normally have standard rating of 100, 160, 200, 315, 400, 500, 630, 1000, 1250, 1600, 2000 or 2500 KVA depending on requirement and shall be mandatory BIS certification (minimum of Energy efficiency level 2) complying to IS 1180(Part-1):2014.
- DSS (6.6/.433 KV): Location of DSS is preferred to be within 6.0 KM radius with stipulation to satisfy permissible KVA-KM for AAAC 100^2 mm. 6.6 KV side will be AIS & indoor switchgear panels for both 6.6 KV & LT systems. It will have at least two distribution transformers of adequate capacity to meet the projected load and reserve capacity to sustain the starting impact of largest LV motor. Distribution transformers shall normally have standard rating of 100, 160, 200, 250, 315, 400, 500, 630, 1000, 1250, 1600 KVA depending on requirement and shall be mandatory BIS certification (minimum of Energy efficiency level 2) complying to IS 1180 (Part-1):2014.
- In case of contingency failure in or any transformers load interrupted shall not exceed 20% of the total demand on the substation. This shall be applicable to MSDSS/DSS. There would be at least one station transformer to meet the auxiliary load of MSDSS (33/6.6 KV).
- Formation level for Substation shall be at minimum 1.0 m above HFL. Adequate provisions in layout shall be made for protection of main control room against

flooding & shall be located at floor higher than that of main Pump- motor floor. DSS shall be either a ground AIS or on raised concrete platform, close to pumping station & well writhen permissible KVA-KM for conductor used for voltage grade of 33 KV/6.6 KV/LV system. DSS shall be easily approachable in all the seasons.

- Bay lay out & structural part for MSDSS/DSS shall be in lines with ODSSP structural model and control room should be in lines with existing arrangements of Mega Lift Projects & approved by PMU.
- Solar roof top shall be installed for both MSDSS and Pump-site to meet the emergency load/street lights with change over mechanism to main supply in case of battery are not charged.

Line Philosophy:

- 33 KV Lines may be single circuit and/or double circuit based on site requirements & as per the present practices adopted by respective DISCOM. Connectivity shall be from the identified EHT Substation and/or from identified 33 KV DISCOM network as per the attached SLD.
- Lines shall be designed/constructed with due consideration the area wind pressure zone & as per the general practices adopted by concerned area distribution licensee (DISCOM) so that infrastructure developed is compatible to their system.
- 33 KV lines will be Low based tower structure / GI RS Joist as per the practices adopted under DISCOM (under ODSSP).
- 11 KV out going lines (to be charged at 6.6 KV) will be with 10 mtr (300 Kg type) PSC poles for pin points up to 100 Deviation, 10 mtr PSC Pole with guy wire for more than100 but up to 600 deviation and DP structure using GI RS Joist for deviation of more than 600 up to 900.
- 33 KV trunk lines with be with 148 sq mm or 232 sq mm (AAAC) and 11 kV lines with 100 sq mm AAAC. Sizing of conductors will be based on findings of LFA.
- Relevant drawings shall be submitted to respective DISCOM for their views & vetting by Electrical Inspector.

7.0 Owners Study:

The Owner has developed an indicative system networking (enclosed) based on cited objectives & in consultation with State Transmission Utility (OPTCL)/GRIDCO & Concerned area DISCOM. Developer may like to submit at bid stage, any other, networking scheme with duly supported system studies ***(Load flow analysis),*** that ensures improvement on savings in technical loss & maintain permissible VR [Owner's Comfort zone for 33 kV < (-) 7%]. Physical projections, if any, mentioned under Owner's studies are indicative only.

7.1 over view of Sub transmission and Distribution Planning: Methodology, the planning criteria and guide lines that are used in planning and design of integrated system connectivity has been out lined in brief but not limited to;

A. Planning standard & criteria:

1) *Planning standard & criteria as specified in OERC Distribution Planning Standard & security Standard.*

2) *Over all approach to system planning is based on risk based deterministic approach: under which all the load cannot be supplied with a network element out of service (hence N-1 criteria are not met) but with due regard to acceptable degree of adequacy and security.*

3) *Risk based network planning aims to strike an economic balance between;*

   - *Cost of providing additional network capacity to remove any constraint and*
   - *Potential cost and other impacts that may be associated with low probability events*

4) *Augmentation criteria that would cover network augmentation and non-network alternatives to augmentation which take account to minimizes distribution losses & maintain voltage at permissible limit.*

B. Sub-Station Planning Criteria:

5) *Primary 33 KV sub-station (Less than 10 MVA) shall comply with Para 4.3.2.3 of DISTRIBUTION SYSTEM PLANNING AND SECURITY STANDARDS, OPERATING STANDARDS, issued by OERC; The layout shall generally conform to relevant Construction Standards of Rural Electrification Corporation Ltd / any other improved standards and provisions in Indian Electricity Rules, 1956 subject to the requirements mentioned in sub paragraph (a) below.*

   a. *The layout adopted shall include the following :*

- *Group circuit Breaker control of Transformers.*
- *Independent control of 11KV Feeders.*
- *Single Bus.*

6) *Above stipulations shall be applicable to all transformers having capacity less than 1000 KVA. However, in lines with the provisions contained U/S 35(3)(i) (b) of CEA(Measures relating to safety and Electric Supply) Regulations.2010, a circuit breaker shall be provided on primary side of every transformer having capacity 1000 KVA and above installed in or after the year 2000.*
7) *Loading in any current carrying component of the Distribution System (e.g. Conductors, Joints, Transformer, Switchgear, Cables, other apparatus etc.) shall not exceed 80% of the respective thermal limit.[U/S 4.4 of Security Standards issued by OERC]*
8) *There shall be 33 KV incoming breaker (at Connection Point) having a minimum of over current and earth fault protection with or without directional features so that fault occurred at their end will not be reflected towards grid sub-station end. (U/S 9.8 of Odisha Grid Code)*

9) *Primary Distribution (MSDSS) sub-station shall normally have two or more transformers ([U/S 48 (6) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010].* Model of banked transformer zone substation configuration has been adopted, where in multiple transformers are used but not segregated for system disturbances. For contingency loss of a transformer customer supply is interrupted prior to restoration. Considering to above stipulation & acceptable degree of adequacy & security, in DSS (that

Feeds main pumping motors) shall have at least two distribution transformers.

10) *While sizing of transformers in MSDSS/ DSS, due consideration with regard to adequacy & security have been taken in lines with OERC "Distribution system planning & security standard. "Annual energy at risk" shall not exceed "N-1" station output capability rating of the substation. Capability of a zone substation with one transformer out of service is referred to as its (N-1) rating. & "N" being the capacity of substation with all transformers in service.* Load interrupted shall be limited to not generally exceed 50 percentile of the total demand on the sub-station with rider that developer will ultimately bring down to 20% in span of three years. There is also 50% chance that actual demand during off season will be lower than projected demand in any one year. More over probability of a major transformer outage occurring over the duration of year is a low event (about 1% per transformer).
11) *Preferred rating of power transformers shall be 1, 1.6, 3.15, 5, 6.3, 8, 10, 16 and 20 MVA. [U/S 54 (3) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010]*
12) *A Transformer with off-circuit tap changer shall have taps ranging from (+) 2.5% to (-)10% each on high voltage winding.[U/S 54(9) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010]*
13) *On load tap changing (OLTC) device tap ranging from (+) 5% to (-) 15% in step of 2.5% shall be provided with Transformers of 3.15 MVA and higher rating [U/S 54(10) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010].*
14) *Normally vacuum type circuit breakers shall be used for voltage level of 33 KV and below [U/S 59(1) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010].*
15) *Distribution Transformer can be oil filled or dry type depending on requirement [U/S 54(10) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010]*
16) *Distribution transformers shall normally have standard rating as specified U/S 75 (7) of CEA (Technical Standard for Construction of Plant & Lines) Regulations, 2010.*

7.2. Reference Drawings: Drawings relating to Main Step-down Sub-Station (MSDSS) and Distribution Sub-Station (DSS) showing indicating scope of work are enclosed. Drawings are complimentary to the specifications and will be referred to for better understanding as well as for bidding purpose.

8.0 SUBMITTALS:

I. **Methodology:** A brief write up on methodology, design & planning criteria on development of integrated system networking, Sub-Stations including O&M practices to be followed for *"User installation"*.

II. ***Single line diagrams for system connectivity (SLD):*** *Showing 33 KV lines from points of connection with Transmission utility interface point (EHT sub-station), MSDSS (33/6.6 KV substation), DSS (33/.43 KV and/ or 6.6/.43KV), HT lines (11 KV to be charged at 6.6 KV) and location of schemes (with ID number). Projected distance of lines should be clearly mentioned in SLD.*

[*SLD is mandatory requirement under proviso 4.16 of Odisha Grid Code;* the Bidder must submit either SLD of their own planning study or statement to the effect that they may like to follow Owner's indicative model.]

III. **SLD of MSDSS [Covering HT (6.6 KV & LT)].**
This submittal is optional. Owner's Conceptual SLD has been given in this document for reference of the Bidder.

IV. **SLD of DSS [33/.43 KV and/or 6.6/.433 KV].**
This submittal is optional. Owner's Conceptual SLD has been given in this document for reference of the Bidder.

V. **Details of 33 KV feeders emanating from EHV sub-station- (Format ESC-1):**
This submittal is applicable to those who would like to propose alternate connectivity configuration other than owner's indicative model. *VR & system loss may be calculated by long hand method as per REC standard and/ or submit the Load flow study in support of their proposed SLD.*

VI. **Details of Proposed Primary 33/6.6 KV (MSDSS) and 33/0.433 KV Substations and HT Feeders (6.6 KV) emanating from these Substations - (Format ESC-2):**
This submittal is optional & may be submitted at detailed engineering stage.

VII. **Details of augmentation of existing 33 KV Feeders- (Format ESC-3):**
This submittal is optional & it is to be submitted at detailed engineering stage.

VIII. **Deviation schedules- (Format ESC-4):**

- Statement on deviations, if any, from the Bid technical stipulations/ specifications along with reasons & supporting documents, shall be submitted.
- For supply of materials/ equipments- GTPs for major items like Power Transformer (rating 630 KVA & 1.6 MVA), Distribution transformers (315 KVA & 100 KVA), AAAC & 33 KV VCB shall be submitted along with Bid offer. Others shall be submitted at detailed engineering stage.

IX. **Details of spares & maintenance kit for O&M:**

Bidder shall submit a list of spares for major system elements i.e. Conductors, insulators & hard wares, LAs, HT & LT Power cables, Cable jointing kits, Ststion transformer, Transformer oil etc. for the contingency events (forced outage and/or planned outages) and Testing instruments and Maintenance kits & other tools & plants. Above list shall be over & above the mandatory spare items that are supplied along with the equipments by manufactures.
Reserve stock for maintenance shall be limited to 10% of respective population (considering Project as whole) for each of above cited critical system elements.
The schedule of testing instruments & maintenance kit given here are generally meant for carrying out testing and measurement at primary (MSDSS) & distribution substations (DSS) for O&M purposes. These kits shall be of reputed make; type tested and shall be subjected to acceptance as per approved specification of DoWR.

Item of testing kit	Unit	MSDSS/DSS
100 KV transformer oil break down voltage test set	Nos	1 per MSDSS
Insulation resistance tester (Megger); Voltage range (1 - 5 KV DC)	Nos	1 per MSDSS
Oil sample bottle	Nos	4 per MSDSS
LCD Clamp on meter	Nos	1 per MSDSS
Line tester	Nos	1 per MSDSS
Digital earth tester	Nos	1 (for Cluster)
Discharge rod as per standard for carrying out the switch yard maintenance work	Nos	6 per MSDSS
Relay tools kit	Sets	1 (for Cluster)

In addition to above, list of other tool & and Plants (T&P's) like set of "D" and" Ring " spanners, socket wrench with socket, insulated cutting pliers, nose pliers, monkey pliers,

Pipe wrench, Sly wrench, insulated screw drivers of different sizes, L-N keys set, hammers with handle etc as per requirements for O&M shall be given in the offer list.

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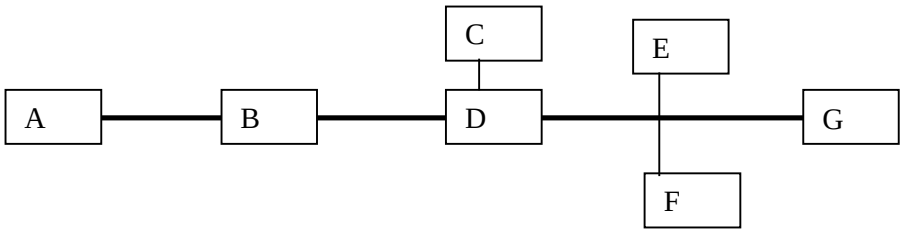
ESC-1

DETAILS OF 33 KV FEEDERS EMANATING FROM EHV GRID SUB-STATIONS:

Name of Grid Sub-Station and Voltage Level (220 or 132 KV: ----------

Sl. No	Name of 33KV Feeder	33 KV Line Section							
		Line Section	Name of Originating substation	Name of Terminating station	Type & size of condr.	Length of section	Max. Projected demand on section	% Voltage regulation at pf 0.8	System Loss
						(Km)	(KVA)	(%)	(LU)
1	*2*	*3*	*4*	*5*	*6*	7	8	9	10
1	FEEDER-1	A-B	A	B					
		B-D	B	D					
		D-G	D	G					
		Sub-Total (FEEDER-1)							
2	FEEDER-2								
		Sub-Total (FEEDER-2)							
		Grand Total (All FEEDERS)							



1. Voltage regulation may be calculated by Long hand method using KVA-Km method or through Load flow analysis (LFA).
2. Regulation constant for conductor shall be as per the data given in REC construction Manual.
3. Diversity factor (DF) shall be based on pattern of consumption as proposed in Bid document. All the Pumps under the each scheme, are supposed to run continuously during working season. Owner recommends DF of 1.37 for VR calculation (For WESCO Zone).
4. Owner's comfort zone for VR is (-) 7% for sub-transmission lines.
5. Peak Loss (Watt) can be calculated based on KVA^2Km method as per REC manual.

(This submittal is applicable to those who would like to propose alternate system connectivity configuration as per their own planning study and/or Load flow study- Ref: Para 6.0 of this Chapter)

ESC-2

DETAILS OF PROPOSED PRIMARY 33/6.6 KV (MSDSS) AND 33/0.43 KV SUBSTATIONS AND PROPOSED FEEDERS (6.6 KV, LT) FROM THESE SUBSTATIONS:

No	Sl.No of Substation	Power Transformer capacity (No x KVA) with respect to Projected load			Total anticipated Max projected Demand including aux.	6.6 KV Feeders					
		Voltage ratio (KV)	(No x MVA)	Total capacity (MVA)		Feeder No.	Feeding to Scheme ID	Projected Length of the feeder (Km)	Condr. type & size	Projected demand on feeder (MVA)	Voltage regulation (%)
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*		*9*	*10*	*11*
	MSDSS-1	33/6.6				1					
						2					
	MSDSS-2					1					
						2					

- Voltage regulation may be calculated by Long hand method using KVA-Km method or through Load flow analysis (LFA).
- Regulation constant for conductor shall be as per the data given in REC construction Manual.
- It is recommended to use unity diversity factor (DF) for radial feeder.
- Sizing of TRFs shall be in lines with Bid document.
- Owner's comfort zone for VR is (-) 7% for HT line.

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ESC-3

AGUMENTATION OF CONDUCTOR SIZE OF EXISTING 33 KV FEEDERS (PROPOSED UNDER THE SCHEME)

(Applicable to those Schemes that need connectivity with DISCOM network topology.)

Sl. No	Name of new line/section		Source Substation	Connecting Substation	Conductor size		Length (Km)	Remarks
	From (Location)	To (Location)			Existing	Proposed		
1	2	3	3	4	5	6	7	8
Sub Total								

(Note: This information is optional - Ref: Para 6.0 of this chapter. It is to be submitted at detailed engineering stage

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ESC-4

Deviation Schedule: (section VII)

A. Construction of 33 KV sub-Transmission & 6.6 KV, LT Sub-System

Sl. No.	Reference to Bid document: (Para no & Page)	Subject matter	Deviation proposed by the Bidder	Remarks

B. Technical Specification on Supply Of Materials-GTPs

[Note: Relevant supporting documents (Provisions of Acts, Regulations, Standards & any other technical publications) in support of the proposals shall be enclosed.]

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CHAPTER-1

SPECIFICATION FOR CONSTRUCTION OF OVERHEAD LINE

A. (Sub-Transmission & HT):

1.0 STANDARDS:

Except where modified by this specification, the sub-transmission and distribution line, associated equipments shall be designed, manufacture, tested and erected in accordance with the *REC Constructions standards* with latest version of the following standards and associated specifications and practices adopted by DISCOMs under ODSSP;

IEC/ISO	***Indian standard***	***Subject***
IEC:826 *IEC:652*	*IS:802 Part 1/1 (1995)* *Part 1/1 (1977)* *Part 1/2 (1992)* *Parts 2and3(1978)*	*Use of structural steel in Over Head Transmission Line Tower- Code of Practice*
	IS:5613 Parts 1 and 2 (1985) *Part 3 (1989)*	*Code of Practice for Design Installation and Maintenance of Over Head Power lines*
	IS: 4091(1979)	*Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles*
IEC:1089	*IS:398*	*Round wire concentric lay overhead electrical conductor*
	IS:1498	*Classification and Identification of soil for general Engineering purposes*
	IS: 1888	*Method of Load test in soil*
	IS: 1892	*Code of Practice for sub-surface investigation of foundation*
IEC:1089	*IS: 2141*	*Galvanized steel wire*
	IS: 9708	*Stock Bridge Vibration Damper*
ISO: 1460	*IS: 2629*	*Hot deep galvanizing of steel and iron*
	IS:2121	*Conductor and earth wire accessories*
ISO: 9000		*Quality Management systems*
ISO: 8501-1		*Shot blasting*
	IS: 6005	*Phosphating of iron and steel*
	IS: 2633	*Test on galvanized steel*
	IS:4043	*Code of practice- earthing*

2.0 SURVEY AND MARKING: As detailed under Volume-II, section-II (Survey, Investigation, Design and Drawing).

3.0 Supports (Poles and Towers):

3.1 General:

The supports will be poles or narrow based lattice towers with fully galvanized structure as per the site requirements. Type of supports shall be as per the prevailing practices adopted by respective DISCOM.

- LBS/ GI RS joist will be used for 33kV line as per the requirement. For 11 KV lines, poles will be PSC and GI RS Joist as required, provided PSC poles shall not be used at cut points and as end poles. Supports shall be designed based on wind pressure of concerned zone and general practices adopted by concerned area Distribution licensee (DISCOM) and comply with Line Philosophy guide lines specified at para 6.0 above .
- Poles shall confirm to the specification as detailed in the schedule.
- PSC poles/ GI RS Joist preferred in plain area. For angle of deviation of more than 10^0-60^0 Double poles structure and four poles (FP) for 60^0 - 90^0 deviation, shall be used.
- For locations involving long spans or higher clearances on account of crossing of power line or communication lines or a railway line, special designed poles/lattice tower/ cables may be used. Relevant drawings & data shall be furnished to the appropriate authorities and obtain statutory clearance.
- The height of the pole above the ground level , length of the pole below ground and working load shall be decided taking into consideration wind zone, terrain, topography, and the statutory clearances required to be maintained and shall confirm to the relevant IS
- The average span length for 100 sq mm Conductor shall be 80 to 100 Mtrs & for 148 sq mm & 232 sq mm condr shall be 50-55 Mtrs. Span length shall be, where possible, no longer than 64% of normal span & depend on site conditions.
- One cut point in every 1km in rural area. But however, this can vey as per the site requirement.
- Provisional quantities/numbers of different types of tower structures/Joist poles/PSC poles shall be estimated and indicated in the BOQ Schedule. However final quantities for work shall be as determined by the successful bidder, on completion of the detail survey,

preparation of route profile drawing and designing of the different types of tower structures/Joist poles/PSC poles as elaborated in the specification.

3.2 Optimization of Pole Location:

3.2.1 Pole Spotting

To optimize the line length, the contractor shall spot the poles in such a way so that the line is as close as possible to the straight line drawn between the start & end point of the line.

3.2.2 Crossings

a) Road Crossings: - Road crossing will be with DP structure with 13 mtr long GI Joist pole. Where the clearance will not be sufficient, it will be with PC or PC+6 mtr lattice GI tower. At all road crossings, double tension HW fittings should be used. There should absolutely no joints in the conductors in all roads, power line and all other major crossing. The crossing angle shall be near possible to 90^0 but in any case shall not be less than 60^0. The ground clearance from the road surfaces under maximum sag condition shall be not less than 7.1 Mtrs over roads. In National High way the minimum height of guarding at the maximum sagging point should be less than 8.5 Mtrs.

b) Railway Crossings: - The railway crossing overhead or underground shall be carried out in the manner as approved & prescribed by the railway authorities from time to time. The crossing shall normally be at right angle to the railway track. In case crossing is required to be done through underground cable, cost of the cable including laying and other accessories shall be in the scope of the contractor. During detailed engineering, the contractor shall submit his proposed arrangement for each railway crossing to the owner. The approval for crossing railway track shall be obtained by the owner from the Railway Authority.

c) Power Line Crossings: - Where the line is to cross over another line of the same voltage or lower voltage, provisions to prevent the possibility of their coming into contact with each shall be made in accordance with the *Indian Electricity Rules/ CEA Safety Regulations, 2010*. At all the crossing described above the contractor shall use protective guarding as per *REC Construction Standard A-1* to fulfill statutory requirements.

d) River Crossings: - For crossing crossings over major rivers, the clearance to be provided as per stipulations of Navigation authority. For non-navigable rivers the clearance shall be measured over highest flood level. The crossing angle shall be as near as possible to 90^0 but in any case shall not be less than 60^0.

For river crossing of 33KV & 11KV line,

- For span length from 100mtr- 450 mtr shall be with PC+6 Tower & 11mtr H pole DP as anchoring with ACSR,

- For span length more than 450 mtr shall be with UR+6 Tower & 11mtr H pole DP as anchoring with ACRS.
- For span length from 70mtr to 100mtr, it shall be with 14mtr H pole DP & 11mtr H pole DP as anchoring.

For longer spans special crossing structures shall be required & the developer shall propose an appropriate solution for each situation as it arises (developer may adopt the standard designs of OPTCL for structure used for 132 KV/ 200 KV Lines). In such cases, the developer shall carry out sub-soil investigation, to ascertain soil parameters in locations where higher tower will be required to get adequate ground clearance.

No mid span joints shall be allowed in the crossing span.

3.2.3 Line Clearances: - Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the *Indian Electricity Rules, 1956/ CEA Safety Regulations, 2010* as amended up to date. The vendor shall select the height of the poles in order to achieve the prescribed electrical clearances.

Situation	***Min Clearance (Mtrs)***	
	33 Kv	***6.6 Kv***
Over open country	*5.2*	*4.6*
Over Road	*7.10*	*7.10*
Along Road	*5.8*	*5.2*
Over Telecom. Line	*2.44*	*2.44*
Over railways	*14.10*	*14.10*
Over 11 Kv or LV line	*2.44*	*2.44*

3.2.4 Support Structure Design and fabrication for over head lines: - The support structure shall comply with technical specification for line support structures and cross arms. IS: 5613(Part1/sect1) :(1985) shall be taken into consideration for wind pressure to be applied to conductors, insulators and support structures.

3.2.5 ***Factor of safety:-***

- *For metal supports : 2.0*
- *For mechanically processed concrete supports: 2.5*
- *For stay wires, guard wires or bearer wires shall be 2.5 based on ultimate tensile strength of the wire*
- *For conductor, shall be 2.0 based on their ultimate tensile strength.*

3.2.6 Excavating Pits for erection of Poles:

Pole pit should be of size 600x900x1500mm or circular with 600 mm dia and base padding of 200mm thick with 1:3:6 cement concrete be done before erection of pole. The earthing coil

should also be grounded 800mm below ground level in a separate pit & filling the pit with soil. The earthing coil is jointed with the earth wire provided in the base of the PCC pole and metallic fittings should be earthed with the embedded wire in the PCC pole at the top. In case of RS Joist Pole/H Pole, the earthing coil is bolted with the same. PCC pole should be in vertical position & the pit is filled with 1:3:6 cement concrete mixture for size 450x600x1500mm and rest filled with boulders. The poles should be erected with maximum span of 100 meters.

3.2.7 Earthing of Poles:

In Sub-Transmission line & HT lines, each pole shall be earthed with coil type earthing as per *REC Construction Standard J-1.*

All DP & FP structure & the poles on both sides of railway, Telecommunication, road, drain & river crossing shall be earthed by pipe earthing as per REC Construction Standard J-2.

3.2.8 Providing of Guys/ Strut Poles to Support:

The arrangement for guys shall be as per *REC Construction Standard* for PSC Poles. Strut poles/ flying guys wherever required shall be installed on various pole locations as per *REC Construction Standard.* In case of 5 feet centre DP, six stays should be provided on the DP. The location of pit for embedding the anchor plate and stay rod shall carefully be determined either in true alignment.

The pit 0.4x0.6x1.6 Mtr. shall be excavated and anchor plate with stay rod shall be suitably aligned in such a manner that the stay wire when binded with anchor rod & stay clamp at pole, the same should make an angle of 30 degree to 45 degree from the pole in the tightened position. Cement concrete mix 1:3:6 shall be poured (about 0.3 cmt) in the pit, well packed with ramming adequately & cured properly. The stay clamp shall be located near and below the DC Cross arm to counter balance the tensile load of the line conductor. Stay wire shall be bound at both ends i.e. at the box and the stay rod. Fly guy/storm guy, as per the site conditions should be used after getting approval from DoWR. The stay set consisting of Anchor Rod, Anchor plate, turn buckle bow, thimble should be used at the tension locations.

3.2.9 Fixing of 'V' Cross-Arm, Top clamps, DC Channels etc. On Poles:

- The fitting such as V cross arm, top clamps, D.C. channel etc. should be fixed on poles as per *REC standard*. The fabrication of above fittings should also be got done as per the standard indicated in the schedule.
- The general specification of steel sections is given below:

Cross arm should be made out of M.S. Angle of size 75x75x6mm. The weight of one V cross arm is approximately 25.70 Kg/Cross Arm. Top clamp should be made of M.S. Angle of size 75x75x6mm. The weight of clamp should be approximate 4.08 Kg/Top clamp.

D.C. cross arm 5' centre should be made out of the M.S. channel of size 100x50x6.0 mm. The weight of one DC cross arm comes out 62.3 Kg D.C. and length 3245 mm.

Other special fittings if required may be got fabricated as per the drawings approved by DoWR.

The clamps for holdings the fittings should be fabricated out of M.S. flat 65x8 mm size.

All nuts & bolts used shall be of M.S. with combination of plain and spring washer and machine made.

3.2.10 Fixation of Insulators and Hardware fittings:

Insulator shall be handled carefully in all stages of loading and the individually checked for cracks, damages, loss of glaze etc. before assembling and erection of at site.

a) The 33KV & 11KV galvanized steel pins made by process of forging suitable for 33KV pin/11KV pin insulators having maximum failing load of 10 K.N & 5 KN respectively with small steel head as per *IS 2486 (ii)/1974* shall be used. The dimension of pin shall conform to ref L-306N fig *69IS-2486 (ii)/1974*. The pin shall be provided with nut (hot dip galvanized) one plain washer and one spring washer (electro galvanized).

b) The disc insulators should be fitted with respective voltage grade hardware for tensioning the conductor. Hardware should be fixed in the disc insulators as per the standard practice and in the correct position to bear the tension of conductor. The strain hardware fitting of aluminium alloy suitable for Dog Conductor (100 mm^2) should be used conforming to *IS-2486 (Part-II) 1989.*

c) Insulator Strings:

Sl. No.	Particulars	Single suspension string	Double suspension string	Single tension string	Double tension string
	(No. of standard Disc)	(Nos)	(Nos)	(Nos)	(Nos)
1	33KV	1x3	2x3	1x4	2x4
	11 KV	1x2	2x2	1x3	2x3
2	Size of Disc	Mm			
	33 KV, 11 KV	255x145	255x145	280x170	280x170

3.2.11 Final Schedule

The final schedule including Bill of quantity indicating location of poles specifically marking locations of failure containment pole/structure, line sectionalizes, line tapping points; angle of deviation at various tension pole locations, all type of crossings and other details shall be submitted for the approval of the owner. After approval, the contractor shall submit six more sets of the approved documents along with one set in reproducible form to purchaser for record purpose.

3.3 Conductor:

In normal practice ACSR / AAA conductors of 100 Sq mm will be used in 11 KV lines and that of 148 Sq mm (AAAC) & 232 sq. mm AAAC (Trunk line) will be used in 33 KV lines, as per the Line philosophy given at Para 6.0.

3.3.1 Stringing of conductor:

Conductor should be laid out from a rotating wheel supported on jacks for easy unwinding of the conductor snatch blocks shall be used for stringing the conductor and shall have groves of a shape and size to allow early flow of conductor and ensure damage free operation. Come along clamps should be used to grip the conductor at the time of stringing.

3.3.2 Sagging of conductor:

All conductors sagging shall be preferred in accordance with the sag and tension tables. After the conductors have been pulled to the required sag, intermediate spans shall be checked to determine the correct sag. The conductor shall be installed on insulators secured to it by means of 6 SWG aluminum binding wire. The jumpers at the tension locations should also be bound by 6 SWG aluminum binding wire. Before fixing the conductor on insulator and strain hardware, aluminum tape should be wrapped on the conductor.

3.4 Guarding:

Guarding cross arm is to be fitted on the pole as per the drawing for guarding the line with 6 SWG GI wire as guard wire and 8 SWG GI wire for lacing. Guarding cross arm made of 75x75x6 mm angle 8 feet long should be clamped at 300mm below the bottom arm of 'V' cross arm.

3.5 Anti-climbing device:

Barbed wire weighing 35 Kg per pole should be wrapped at a height of 3000 mm above ground level stretching in 900 mm length. Both ends of barbed should be clamped suitably to avoid Coming down from its location.

3.6 Danger board: Danger Board for 33KV or 11KV voltage and danger mark conforming to *IS: 2551-1963* should be fixed on each location.

3.7 Pole Numbering System:

Each feeder support structure shall be uniquely identified along the route. Identification number to be painted on PSC and steel pole using stencils at a distance of 1.6 m from the ground, as per the approved scheme.

4.0 Project License: The eligible Contractor has to obtain project license from the competent authority *(ELBO)* in respect of the mentioned works prior to commencement of the works. All the expenses towards the project license and inspection thereof have to be borne by the contractor.

5.0 FINAL CHECKING, TESTING AND COMMISSIONING: After completion of the work, final checking of the line shall be carried out by the contractor to ensure that all foundation works, pole erection and stringing have been done strictly accordingly to the specification and as approved by DoWR. All the works shall be thoroughly inspected in order to ensure that:

i. Sufficient backfilled earth covers each foundation pit and is adequately compacted.
ii. All poles are used strictly according to final approved drawing and are free of any defect or damage whatsoever.
iii. Stringing of conductors has been done as per desired clearances.
iv. All conductor accessories are properly installed.
v. All other requirements for completion of works such as fixing of danger plates, anti climbing devices etc have been fulfilled.
vi. The insulation of the line as a whole is tested by the contractor through provision of his own equipments, labour, etc to the satisfaction of DoWR.
vii. All poles are properly grounded.
viii. The line is tested satisfactorily for commissioning purpose.

B. LT (Over head Lines):

1. **SCOPE**: Planning, supply, installation, testing and commissioning of 415 Volt over-head low tension line on 140 Kg. 8 meter long PCC Pole and necessary iron fitting etc. complete. All relevant supports fittings and fixtures, conductors shall conform to their respective *IS specifications and REC standard.* The physical layout of the work has to be got approved by DoWR before start of work.
2. **POLE:** The overhead LT line shall be supported on 140 Kg. 8 meter long PCC pole as specified in the schedule of item conforming to ISS. Normally one sixth of the pole length shall be buried in the ground. The supports shall suitable be spaced depending on the number and size of the conductors, road crossings etc. in general, the spacing of supports shall be approximately 50-60 meters depending upon road crossing, telephone crossing etc, and in no case the inter-distance between two consecutive support shall exceed 65 meters *as per rule 85 of the Indian Electricity Rules, 1956.* For erection of pole, a pit size of 600x900x1500 mm should be done and base padding of 200 mm thick should provided and back filling of pole pit with boulders. Suitable time of at least seven days shall be allowed for setting the base concrete with proper curing etc. Then the pole shall be laid in the center of the pit and shall attain vertical position & pit shall then be refilled with excavated soil and well consolidated.
3. **CROSS ARMS AND BRACKETS:** The LT cross arm shall be made up of M.S. Angle as follows: i) LT 3 Pin Cross Arm: 50x50x6 mm size 4.5 Kg/meter, 680 mm long ii) LT 4 Pin Cross Arm: 50x50x6 mm size 4.5 Kg/meter, 980 mm long The minimum clearance between holes for U clamps shall be 300mm. A minimum space of 40mm along the length of the bracket shall be kept spare from top hole and bottom hole of the bracket the length of cross arm and bracket shall be suitable for spacing of conductors, earth wire and guarding in accordance with the minimum spacing specified in relevant ISS and in accordance to *Indian Electricity Rules.* The width of the bracket shall be not less than 50 Cms.
4. **INSULATORS**: L.T. Porcelain shackle insulators of size 90x75mm conforming to IS: 1445-1977 shall be provided and fixed in 'U' clamps for holding the conductors. LT shackle hardware galvanizing shall conform to *ISL 2633-1964* for 4 dip tests. For holding neutral conductor Aluminium bobbin insulators of size 60x50mm size with nuts bolts shall be provided.
5. **CONDUCTORS:** AAAC 7/3.15mm (55 sq mm)/7/2.5 mm (34 sq mm) & 7/2.00 mm (22 mm sq. mm) may be used for phase conductors based on technical requirement. The conductors shall be laid out in such a manner that there is no damage to the conductors in any form. While stringing overhead conductors, there should not be any kinking. Reels of conductor should be handled carefully, so that there is no cutting, nicking or fraying of the conductor strands. 'D' loops shall be provided on each conductor on both sides of each LT pole and all jumpers of LT line.
6. **CLAMPS:** Back clamps and stay clamps for LT line should be made up of 50x6mm MS flats.
7. **GUARDING:** Suitable guarding shall be provided as per provision of Rules 88 of *Indian Electricity Rules.* The spacing between the outermost conductor and the guard wires shall not be less than 30 Cm. both vertically and horizontally. The guard wire shall be GI and shall in no case be less than 8 SWG in size and shall have a breaking strength of not less than 635 Kg.
8. EARTHING OF PCC POLE: Every *third pole should be suitably earthed as per REC Standards.*

CHAPTER -2

CONSTRUCTION PRACTICE FOR 33/6.6 KV SUB-STATION (MSDSS)

1.0 General Consideration:-

a) The Sub-Station shall be designed and constructed complying with requirements of the Project, applicable Indian Standards (IS), as well as other rules and Regulations as per the latest amendments. The design and construction of Sub-Station including civil works shall be such that they perform their intended functions. In case of conflict, more stringent provisions shall prevail. The civil scope generally covers Construction of Control room-cum-Switch gear room along with foundations. cable trenches along with covers, marshalling box/control cubicle foundations, switchyard dressing and leveling, site clearance, soil investigation, roads, drains, fencing/ compound wall, gravel filling and, transformer foundations, firewalls, PH facilities. .

b) The Sub-Station shall be outdoor type. The bus bars may be of either rigid type or flexible strain type depending upon the choice of the designer conserving the overall suitability and economy of the substation to be installed.

c) The Sub-Station should have the provision for data acquisition system for monitoring.

d) *Each Sub-Station shall normally have two or more power transformers.* Each Sub-Station will have incoming feeders preferable from two different sources.

e) *All Sub-Stations shall have independent circuit breaker control of 33 KV incoming feeders and all the incoming feeders feeding the Sub-Stations shall have independent circuit breaker at source end.*

f) The 415 V AC Station load would be met from a 33KV/.433 KV Auxiliary TRF of appropriate capacity. Station Transformer may be conventional oil type (3 star rated by BEE) or dry type (capacity less than 200 KVA).

g) DC system comprising of adequate capacity of 110 V DC battery and its chargers shall be provided for protection and monitoring system of the various panels, circuit breakers, isolators, lightings etc. of the entire switchyard system. DC power supply from maintenance free rechargeable seal lead acid batteries i.e. VRLA battery would be preferred.

The system parameters of 110 V DC systems shall be as follows:

Nominal system voltage (V)	110
Highest system voltage (V)	121
Voltage variation (V)	99-121
Ambient temperature (^{0}C)	50
System earthing	Unearthed
Maximum system fault level (KA)	25 (1 sec)

The ampere-hour capacity of DC storage battery shall be based on the three hour supply. The battery duty cycle:

Load	Duration	Type of Loads
Continuous load	3 hours	Relays, IEDs, HMIs, CB spring charging, isolator interlock loads & other miscellaneous permanently connected loads, etc.
Emergency load	1 hour	Emergency lighting loads

h) Any other items, not specifically mentioned here but required for commissioning of substation shall be deemed to be included in the scope.

i) Prior to commencement of supply/ works all relevant drawings, designs must be got approved by respective Statutory authorities/ Agencies and DoWR.

1.1 **Selection of site**:- The main points to bear in mind while selecting site for MSDS shall be as follows:-

a) Selection shall be made after taking into consideration the capacity and location of the feeding Grid Sub-Station, the projected load, the existing network configuration, etc. and the economic, and environment consideration.

b) As near to the load centre as feasible.

c) Far away from obstruction to permit easy and safe approach of high voltage over head line transmission line.

d) Easily accessible to the road to facilitate transport of plant & equipments in all the seasons.

e) Formation level shall be 1 m above HFL.

f) The land shall be reasonably leveled and shall not have any open drain/ nallah or road crossing it.

g) The developer shall carry out detailed survey and Geo- technical Investigation of the area as per the specification given elsewhere in this document for finalization of the lay out approved *Single Line Diagram,* location of 33 kV and 6.6 kV bays, control room, incoming and outgoing 33 kV lines.

2.0 Lay out of Sub-station:- It may follow the standard lay out for 33/11kV Sub-Station, as standardized by REC/ CAPEX programme of DISCOMS. 33kV switch yard shall be out-dooring type with indoor 6.6 kV switch gear. SLD is shown at Exhibit- ELEC/5-2014 is only for reference purpose only.

3.0 Control room Building:-

i. Control room shall preferably be located to oversee the entire switch yard from control room. The minimum floor area requirement shall be 10 x 8 sq. m. The size which may vary at the time of detailed engineering to suit the actual site requirements. The layout and orientation of the control room shall be finalized as per the detailed engineering based on individual scheme and/ or pool of schemes under the Cluster and line corridor & future requirements.

ii. The different rooms required for Control room would; Main Control room, JE's room, Battery room, Store room and WC/Bath/WB.

iii. An open space of minimum 1 meter shall be provided on periphery of the rows of the Panel board and equipments in order to allow easy operator movements and access as well for maintenance. Working clearances should comply with provisions of ***CEA (Measures relating to safety and Electric Supply) Regulations, 2010***.

iv. Contractor shall comply with all applicable statutory *Acts, Rules & relevant Regulations,* while developing the Control Room.

4.0 Installation:- The physical layout of entire sub-station with positions of equipment, bus bar, structures and outgoing feeders shall be marked at site and drawings have to be got approved by Electrical Inspector & concerned competent officer of DoWR before start of works.

5.0 Structural:

i. Switchyard structure to support buses, electrical equipments and terminals of line conductors shall be made of fabricated steel structure, 150 x150 GI RS joist Pole & GI Channels & angles as per the ODSSP drawings of suitable cross section for 33/6.6 KV (MSDSS) and 33/0.433 KV & 6.6/0.433 KV DSS. Steel structure shall normally be hot dip galvanized or painted.

ii. All Pole mounted stations (for station supply) shall be as per *REC standard.*

iii. Minimum strength of structural foundation concrete shall be M20 confirming to *IS: 456* as per drawing.

iv. Blinding concrete below foundations, cable trenches, shall be PCC of minimum grade M-7.5.

X. **Erection of structure & Equipments:**

XI. Supports shall not be guyed but may be suitably concreted. For erection of bus bar structure supports, normally one sixth of the support shall be buried in ground. A pit of size 0.6 Mtr. x 0.9 Mtr. of required 1.5 Mtr. depths shall be excavated. A layer of 20 cm thick of 1:3:6 cement concrete poured for base pad concreting of post is to be done by 1:3:6 ratio cement concrete of size 0.45 M x 0.60 M x 1.5 M. Suitable time shall be allowed for setting the cement concrete before removal of holding ropes. Proper curing of cement concrete by means of wet gunny bag for at least seven days shall be done. All precautions shall be taken to avoid any chance of injury or damage to labors working at site.

XII. After the columns/supporting structures are erected respective equipments of 33/6.6 KV is to be erected carefully by suitable crane. The breaker and isolators are to be erected as 3 phase unit basis. Control relay panels are to be mounted inside the control room in the same order as in the switchyard. After the earth mat design is finalized, the earth mats with 50x6 mm GI flat are to be put for each equipment. Then flats are to be interconnected with each other. The bus bars are to be strung after all the columns and beams are fitted. Control and power cables should be laid in consultation with Engineer-in-Charge for safe and easy maintenance. All the equipments of each 33 bays are to be connected by suitable jumpers and clamps.

XIII. **Muffing**: A layer of 1:3:6 mix cement concrete 45 cm x 45 cm on all sides of the pole up to a height of 45 cm and tapered on top shall be coasted and adequately cured for seven days. One finishing coat of cement paste shall be applied on outer surfaces of the muffing.

XIV. **GI Iron Fittings:** All channels used shall not be less than 100x50x 6 mm. All angle used shall not be less than 50 x 50 x 6 mm corresponding to *ISI 6565*. MS flats used shall be of sections as directed by Engineer-in-Charge. All nut-bolts used shall be GI with a combination of plain and spring washer.

XV. **Painting of Pole:** - All steel poles, brackets, cross arms and all steel fittings shall be first painted with two coat of red oxide paint. The portion of the pole to be buried inside the ground shall be painted with two coats of bitumen tar. After erection of pole, the external

surface of pole and all steel items shall be painted with two coats of aluminium paint in an approved manner.

6.0 Transformers: The transformers and fittings and accessories shall comply with the Owner's technical specification and relevant IS. *The preferred rating standards for 33/6.6 KV transformers shall be 0.630, 1.0, 1.6, 3.15, 5.0 MVA and shall be three- phase, outdoor type.*

7.0 Protection:

7.1 *All 33 kV lines at Connection Points shall be provided with breakers having a minimum of over current and earth fault protection with or without directional features so that fault occurred at their end will not be reflected towards grid sub-station end.*

7.2 The life expectancy of power transformer is much dependant on right type of protection provided with a transformer. *One 33 kV breaker should be provided for group control when there are two transformers of capacity less than 1000 KVA each. A circuit breaker shall be provided on primary side of every transformer having capacity 1000 KVA and above installed in compliance with CEA (Measures relating to safety and Electric Supply) Regulations, 2010.*

7.3 In addition to basic protections, *transformers shall have O/C (three elements) & E/F numerical relays. For TRF of 5 MVA & above capacity, differential or REF relays may be provided. In addition all transformers 1.6 MVA and above shall be provided with gas-operated relays, temperature protection and winding temperature protection and oil temperature protection. Guidelines mentioned in protection manuals of Central Bureau of Irrigation & Power (CBI & P) may be kept in view. The contractor shall provide protection schemes in lines with proviso 9.8 of Odisha Grid Code,* for approval by DoWR.

7.4 The Intelligence Electronic Device (IEDs) shall provide numerical electrical protection of feeders/ equipments. Each numerical protection scheme shall have a serial interface on the front for communication on open protocol like MODBUS or IEC: 60870-5-10 for remote communication, data transfer etc.

7.5 Necessary auxiliary relays, timers, trip relays, etc. required for interlocking, alarm, logging, etc. and completeness of the scheme shall be provided.

8.0 Disconnectors (Isolators) and earth switches (applicable for AIS):

Disconnectors shall be of outdoor horizontal central break/ double break/ vertical break/ without earth switch as per IEC 62271-102. Type of disconnector shall be as per layout

requirement. 33 KV system disconnectors shall be manual operated type. Disconnectors/ earth switches shall be provided with pad-locking arrangement to prevent operation in case of emergency.

The earth switches shall be capable of discharging trapped charges associated with lines. Earth switches shall be locally operated. Mechanical and electrical safety interlocking shall be provided to prevent closing of disconnector when main earth switch is closed and vice-versa.

9.0 Bus Bar Conductor: Conductor used should be able to take the short circuit current corresponding to the fault level as notified in technical specification. Minimum Aluminum conductor steel reinforced of size 100/232 Sq.mm conforming to *IS: 398-1961* as specified in the schedule of item and directed by Engineer-in-Charge shall be used for 3 phase 3 wire 33 KV over head bus bars based on site fault level. Tension should then be adjusted until correct sag is obtained in spacing near the pulling end. Stringing chart should be used for proper stretching of conductor. The sag shall then be checked either by sighting method or by stopwatch reflected method. The conductor shall be installed on insulators secured to it by means of 6 SWG aluminium binding wire and aluminum tape on it maintaining proper tension and sag.

10. Cable and Earthing:

a. Cables: The cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications relevant standard specifications and cable manufacturer's instructions. The MV cable shall be PVC insulated PVC sheathed alluminium conductor armoured cable of 1100 volts grade & FRLS type. The sizing of the power cable shall be based on current rating & fault level; however rating factors corresponding to temperature and grouping of cable shall be considered. All cable shall be inspected upon receipt at site and checked for any damage during transit by the Engineer-in-Charge before it lay down to trenches, walls etc.

b. Laying of Cables: Cable lying in general shall follow;

a) Switch yard area: - In concrete cable troughs (cable trench having cable trays)

b) Control room: - On cable racks consisting of slotted type and ladder type cable trays. Cable trays shall have standard width of 150 mm, 300 mm and 600 mm and standard lengths of 2.5 meters. Minimum thickness of mild steel sheets used for

fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.

c) Buildings: Conduits directly buried cables shall be used wherever necessary with the approval of DoWR.

Minimum vertical separation between layers of cable tray shall not be less than 300 mm.

Cables shall be laid by skilled and experienced workman using adequate rollers to minimize stretching of the cable. Great care shall be exercised in laying cables to avoid forming kinks. The relative position of cables shall be first marked to avoid the cables crossing each other. At all points of changes in direction in horizontal as well as in and vertical planes, the cables shall be bent smooth with a radius of bend not less than 12 times the diameter of the cables. For laying cables under-ground a trench of at least 750 mm deep of required width shall be excavated for entire length of cable route. The trench shall be brick masonry made. A bed of fine sand of 100mm thickness shall be dressed and well dressed. The cable shall be laid on the bed of sand with full precautions to avoid any kinking, twisting and damage of cable. Fine sand shall be spread over the cable and shall be flushed with top surface RCC Slab are to be placed at suitable size to cover cable trenches. For cables to run along the wall proper and accurate verticality shall be maintained. Before fixing the cables on walls vertical plumbed arcing shall first be made. Parallel cables shall be spaced at least 50 mm apart maintaining their relative position over the entire length. Saddles for gripping the cables shall be spaced not more than 1 meter apart in order to avoid undue stress on the cables due to its own weight.

Suitable routed cable trenches shall be provided to accommodate power and control cables from marshalling box in the yard to the respective panels in the control room building. The cable entering the control room building will be laid in pipes with suitable sealing at wall opening to prevent entry of water and rodents in to the building through cable trench opening.

b. **Earthing:**

To meet the requirements, an earthed system comprising of an earthing mat buried at suitable depth below ground and supplemented with ground rods at suitable points is provided in the substations. The impedance to ground should be as low as possible but it should not exceed 1.0 (one) ohm.

i. All the non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits trucking, cable sheaths, switch gear, distribution fuse boards, light fittings and all other parts made of metal shall be banded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing shall be in conformity with the *Indian Electricity Rules/ CEA (Measures relating to safety and Electric Supply) Regulations, 2010* and in accordance to *IS: 3043-1987/ IEEE80*. The Step and touch potentials shall be within safe limit. Design of earth mate shall be duly supported by computer based soft ware study.

ii. All equipments, structures etc. shall be connected to the grounding mat as per IE Rules/ CEA Safety Regulations, 2010, code of practices for earthing and IEEE80 at two separate and distinct locations.

iii. A grounding mat shall be provided at minimum depth of 600mm in the Substation/switchyard to provide low impedance path for lightning surges/ system fault current to earth.

iv. The earthing conductor size shall be designed for life expentancy of minimum (forty) 40 years and system fault time of 1.0 Sec. whichever is higher. Minimum rate of corrosion of steel used for earthing conductor shall be considered as 0.12 mm per year for designing its size.

v. All earthing conductors shall be of GI plate, GI pipe or earthing coil of specified size and shall be protected against mechanical injury or corrosion.

vi. Under no circumstances the cross sectional area of earthing conductor shall be less than half of the largest current carrying conductor subject to an upper limit of 80 Sq mm. If the area of the largest current carrying conductor or bus bar exceeds 160 Sqmm. then two or more earthing conductor shall be used in parallel to provide at least half one cross sectional area of the largest current carrying conductor.

vii. **Connections to Earth**: All sub-station equipment shall be earthed on a grid system. The grid around the substation connecting earthing stations shall be of bare GI conductor of size not less than 7/3.15mm.

- The transformer neutral shall be directly connected to two pipe electrodes in treaded earth pits, which intern and shall be connected to station earth grid. All the electrodes shall be buried in cement pit

with cast iron cover hinged to cast iron frame to have an access to the joints.

- Earthing terminal of each lighting arrester and lighting down conductors shall be directly connected to rod electrode which in turn shall be connected to station earthing grid.
- All other sub-station equipment shall be earthed with separate and independent GI strip of required section or bare GI conductor of size 6 SWG connected to grid. The earthing conductors inside the buildings shall be properly supported with clamps and brass screws. GI strips outside the building shall be laid at-least 450 mm below the finished ground level.
- Over lapping in strips at joints where required shall be minimum 75 mm. The joints shall be reverted with rivets and brazed in approved manner. Sheathed lugs of adequate capacity and size shall be used for all termination of connection. Lugs shall be fitted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance and properly tinned.

11. Lightning Protection:

i. Lightening protection system installation shall be in strict accordance with latest edition of *Indian Electricity Rules, Indian Standards and Code of practice and Regulations* existing in the locality where the system is installed.

ii. Direct stroke lightening protection (DSL) shall be provided in the switch yard by electrodes mounted in the Joist pole structure.

iii. 25 mm dia 1000 mm long MS solid rod electrode shall be provided with each lighting mast.

iv. Lighting protection system down conductors shall not be connected to conductors of earthing grid above ground level. Also no intermediate earthing connection shall be made to lighting arrestor, transformer earthing leads, which shall be directly connected to rod electrode.

v. Connection between each down conductor and rod electrode shall be made via joints located approximately 1500 mm from ground level. The joints shall be directly connected to earthing system.

vi. Down conductors shall be cleated at the structure at 1000 mm interval.

12.0 Fire Protection: Firefighting equipment of adequate capacity shall be provided in the sub-station to deal with fires likely to be encountered. The layout of the Sub-Station itself shall be such that the fire shall not spread from one to other equipment and areas as far as possible. Fire hydrant, carbon dioxide (Co_2) type fire extinguisher or dry chemical power type fire extinguisher conforming to latest IS shall be provided as per site requirement. All fire fighting equipments shall conveniently be located and conspicuously marked.

A fire wall shall be erected between the transformers if the free distance between the various pieces of equipment is less than 10 m, to protect each one from the effects of fire on another.

Fire walls shall also be erected between the power transformers if the free distance is less than ten meters. Fire walls shall extend at least two metres on each side of the power transformers and at least one metre above the conservator tank or safety vent. These dimensions might be reduced in special cases where there is lack of space.

13.0 Switch yard lighting: 50 lux on main equipment at first level (equipment connection level), 20 lux on balance switchyard & road etc. Details shall be supplied by Engr-In- Charge.

14.0 Chain Link Fencing, Gate etc: The outdoor switchyard shall compound wall or be enclosed by GI wire mesh chain link fencing over masonry works (0.78 meter height of brick work and 1.22 meter of chain link). The fencing shall be supported by adequate angle iron frame work of minimum size 50 x 50 x 6 mm and shall have iron bracings of the angle iron frames. Framework of gates of the switchyard shall be made up of M.S. flat and M.S. bars. The design of Compound wall for MSDSS and/or fencing arrangement for switch yard shall be as per the approved drawing by the Engineer-in-Charge. Switch yard area shall be filled with 150/100 mm thick gravels to restrict the growth of grass in the outdoor switchyard. Before laying the gravel fill, top layer of the soil shall be treated for anti-weed considering type of weeds found in the vicinity. It should be covered with granite metal jelly 15 to 20 mm size for purpose of effectively discouraging the growth of grass and weeds and to prevent the spreading of dust. All the areas adjacent to oil filled equipments such as breakers, transformers etc should be surfaced for additional purpose of absorbing leaking oil.

CHAPTER -3

SPECIFICATION FOR DSS, (TRANSFORMER CAPACITY UP TO & BELOW 250 KVA) ON DOUBLE POLE STRUCTURE

1. SCOPE:

Design, planning, supply, installation, testing for commissioning of double pole structure (D.P.Structure) for pole mounting transformer Sub-station with all allied equipments etc. complete. The Sub-station plan shall be got approved by the competent authority of DoWR prior to erection work.

2. SUPPORTS:

The D.P. structure will be either with GI RS Joist supports or have two numbers 140 Kg. 8 meter long PCC Pole for 250 KVA Sub-station as specified in the schedule of items. Normally one sixth of the pole shall be buried in the ground. The support shall be placed at a distance of 2400 mm. For erection of pole, a pit digging of size 600x900x1500 mm should be done and base padding of 200 mm thick should be provided and concreting with 0.3 Cmt per pole with 1:3:6 cement concrete mixture for size 450x600x1500 mm.

Suitable time for at least seven days shall be allowed for setting the base concrete with proper curing etc. the pole shall than be laid in the center of the pit and tied with ropes of adequate strength of four side of the pole by means of suitable clamps fixed at right angles to each other. Loose ends of two sides of ropes forming straight line shall be tied firmly with deep driven iron pigs located equidistant from the center of the pole pit. One of the remaining two ends of remaining ropes shall be connected to turfer and the end of opposite rope shall be kept loose and ready to be tied with deep driven iron pigs shall be manned by skilled worker to control the unwanted deflection of pole while pulling it by turfer. The pole shall then be pulled by turfer and correctly aligned to its truly vertical position and then set in 1:3:6 cement concrete poured up to ground level. Suitable time shall be allowed for setting the cement concrete before removing the ropes. Proper curing of cement concrete for at least seven days shall be done. All precautions shall be taken to avoid any chance of injury or damage to labour and technicians working at site.

3. FITTINGS:

6.6 KV "V" cross arms shall be made up of MS Channel 65x65x6 mm size having phase to phase clearance of 1070 mm. 6.6KV top clamps shall be made up of MS angle 65x65x6 mm size 405 mm long. DC cross arms, single pole cut point DC, transformer mounting DC, AB Switch mounting DC, DO and LA mounting channel shall be made up of MS Channel 100x50x6 mm size of required length.

Back clamps and stay clamps shall be made up of 65x8 mm size.

MS Nut and Bolts conforming to IS: 1363-1902 shall be used of 5/8" (16mm) for fitting works and for earthing arrangements GI nut-bolts must be used.

4. AB Switch:

AB switches and DO Fuses should be supplied with base steel structure, terminal bi-metallic connectors / PG clamps / earth connector. They should be checked for proper alignment and free & smooth operation. The insulators should be cleaned before commissioning. The linkage of contacts should be checked for free and adequate grip. The AB switch should be checked for fully OPEN/CLOSED positions. Contact between two movable points should be checked and recorded. The contacts should be adequately lubricated before commissioning. Connection of terminal connectors shall be checked for proper tightness. Operating handle should be separately grounded. Equipments should be supplied with detail technical specifications enclosed. The associated mounting / connection accessories items shall not be considered for measurement under any head of Price Schedule even if they happen to be appearing in Price Schedule.

5. LIGHTENING ARRESTOR:

The 6.6 KV lightening arrestor shall be valve type arrestor consisting of an outer ceramic body containing 9 Set of resistance (Valves) and spark gaps in series. The resistance shall be made of special silicon carbide ceramic, which offer high resistance to power frequency voltages and low resistance to surge voltages. Arrestor should be installed as close as possible, to the HT line. The arrestor should be solidly earthed. The lightening arrestor shall be mounted on 100x50x6 mm MS Channel fixed approximately 1500mm below the 6.6KV tapping point.

6. D.O. FUSE UNIT:

The 6.6 KV drop out fuse unit shall have current carrying capacity of 200 Amps having 2 Nos 11KV post insulators fitted on bakelite base with fuse barrel as per BSS-1314. The DO fuse should be got checked and test certificate from CPRI Bangalore/Bhopal as per IS: 5792-1970 should be obtained and produced.

7. TRANSFORMERS:

The 6.6/0.4KV step-down distribution transformer shall be supplied and installed as per the specifications mentioned in the Transformer Section.

8. DISTRIBUTION BOX:

The distribution box suitable for 250 KVA transformers with isolator on incoming side and SPMCCB on outgoing side will be used. All sheet steel work shall undergo a process of digressing, pickling in acid, cold rinsing, phosphating, possivating and then sprayed with a high corrosive

resistant primer and then backed in oven. The finishing treatment shall be by application of two coats of synthetic enamel gray paint in an approved manner.

9. DANGER CAUTION BOARDS:

The danger of caution boards shall have to be displayed on pole, Transformer and LT distribution panel. The danger signboards should conform to *IS: 2551-1963.*

10. ANTI-CLIMBING DEVICE:

Anti-climbing device consisting of barbed wire extending to a minimum length of 900mm shall be provided on poles. Both ends of the barbed wire shall be secured to poles by means of suitable iron clamps as per the direction of Engineer-In-Charge.

11. PAINTING OF DP STRUCTURES:

All metallic parts except transformer and LT distribution box of D.P. structure and PCC Pole shall be painted in an approved manner.

12. EARTHING OF SUB-STATION:

Three numbers pipe earthing with 2.5 meter long GI Pipe 40mm dia used connecting pipe earthing with 4mm GI wire with LA transformer neutral, transformer body, DO earthing, Channel earthing. Pole pit is filled with soil.

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