VOLUME-II
SECTION 6A
GENERAL SPECIFICATIONS

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A SUMMARY

1 GENERAL

1.1 Application

1.1.1 The Specifications shall apply to all Works as are required to be executed under the Contract and in its absence the work shall be executed as directed by the Employer.

1.1.2 The Specifications must be read in conjunction with the Conditions of Contract, Bills of Quantities, Drawings and other documents forming the Contract documents. Notwithstanding the subdivision of the Specification under different headings, every part of it shall be deemed supplementary to and complementary of every other part. The heading in these Specifications shall not be deemed to be part thereof or be taken into consideration in the interpretation or construction thereof, or of the Contract.

1.2 Abbreviations and Acronyms

1.2.1 The following abbreviations shall have the meaning as set forth below:

ASTM	American Society for Testing and Materials
BS	British Standard published by British Standards Institution
CD	Chart Datum for the Cochin Port Trust
CEMP	Construction Environmental Management Plan
CWMS	Construction Work Method Statement
COPT	COCHIN PORT TRUST
EMP	Environmental Management Plan
HAT	Highest Astronomical Tide
HAZID	Hazard Identification
SHE	Safety, Health and Environment
IS	Indian Standard published by the Bureau of Indian Standards
ISO	International Standards Organization
ITP	Inspection and Test Plan
LAT	Lowest Astronomical Tide
NCR	Non-Conformance Report
TPR	Third Party Review
PQP	Project Quality Plan
QA	Quality Assurance
QC	Quality Control
RL	Reduced Level

PIMT	Project Implementation and Monitoring Team
PMP	Project Management Plan
CPCB	Central Pollution Control Board
KSPCB	Kerala State Pollution Control Board

1.2.2 The Contractor shall use the above abbreviations and nomenclature on its documentation.

1.3 Definitions

1.3.1 Words including Contract, Contractor, Employer, Drawings, Employer, Government, Works and Site used in this Specification shall be considered to have the meaning as understood from the definitions of these terms given in the Conditions of Contract.

1.4 Reference Standards

1.4.1 The Work covered by this Specification shall comply with the latest editions and revision notes of Indian, British and other recognized International Standards as may be specified elsewhere in the Contract Documents.

1.4.2 The latest edition of all Standards till 30 (thirty) days before the final date of submission of the tender, shall be adopted. The Contractor shall maintain a copy of the latest editions of the Standards, Laws and Codes applicable to the work to be undertaken on site.

1.4.3 The Contract Documents reference to a number of codes, standards and guidelines. In some cases, these documents may be in disagreement or conflict. Where conflicts or omissions are identified, the Contractor shall notify the Employer who shall make a determination and advise the Contractor accordingly. The Employer's determination will generally adopt the most conservative or stringent requirement.

1.5 Working Drawings

1.5.1 Six hard copies of the Working Drawings (Good for Construction), on the basis of which actual execution of the Works is to proceed along with soft copy in dwg format, shall be furnished free of cost by the Contractor.

1.5.2 The Drawings provided for tendering purposes in the Tender Documents shall be used as a reference only. For Tender Drawings refer Volume-2 Section -7C.

2 WORK COVERED UNDER CONTRACT

2.1.1 The Works under this Contract are design, supply, installation and commissioning of Main Jetty and Approach Trestle along with other services and utilities. The details are covered in Section-7A(Scope of Works) of the Contract Documents.

3 SITE LOCATION

3.1.1 The site location for the Works is as shown on the drawing provided in Section 7C of Volume 2. The Contractor shall submit details of any temporary works associated with the Works.

3.1.2 The Contractor's local office, his own working area and all of the Contractors Works shall be subject to compliance with CoPT established guidelines and applicable local authorities Rules and Regulations.

3.2 Permissions and Permits

3.2.1 The Contractor shall at all times comply with the latest requirements of:

(a) Navigation, Shipping and Kerala Inland Vessel (KIV) Rules;

(b) Port Authority Acts;

(c) Marine Oil Pollution Management Plan;

(d) Marine Oil Pollution Contingency Plan;

(e) Emergency Response Plan;

(f) Cyclone Contingency Plan;

(g) State and National Environment Regulations.

3.2.2 The Contractor shall ensure that all plans and procedures developed in accordance with the requirements of the Contract are integrated with those of the Port /Kerala inland Navigation rules and or other statuary Regulations.

3.2.3 The Contractor shall obtain advance approvals from the required authorities prior to executing the Works.

3.2.4 The Contractor shall make all arrangements with and obtain the necessary approvals from the Relevant Authorities for temporary marine traffic arrangements and control.

3.3 Existing and Temporary Aids to Navigation

3.3.1 The Contractor shall be responsible that existing aids to navigation are not damaged or otherwise made unserviceable as a result of any marine construction work or collision by any vessel. The cost of repair of any damage to existing aids to navigation, including replacement of the damaged aids, if necessary, which has occurred as a direct or indirect result of the Contractor's operations, shall be at the Contractor's cost.

3.3.2 The Contractor shall install and commission temporary structures, with the prior approval of the Employer, to ensure the safety of the Contractor's marine plant and the continued safe operation of the navigation channel or waterfront.

3.3.3 All such Works are to be coordinated with the relevant authorities to minimise disruption to navigation channel/waterfront operations.

3.4 Marking of Landside Works, as applicable.

3.4.1 The Contractor shall exhibit such marks and keep illuminated during the darkness hours near the various parts of the Works as the relevant authorities or the Employer may from time to time require or approve.

B ADMINISTRATIVE REQUIREMENTS

1 PROJECT MANAGEMENT AND COORDINATION

1.1 Project Coordination Meetings for Interfacing Contracts

1.1.1 The Contractor's Authorized Representative(s) shall attend regular meetings as required by the Employer to coordinate and manage the interface between the Works under this Contract. The frequency of such meetings may vary depending on the nature of the interface and associated Works. However, the Contractor should anticipate that meetings will be held at least fortnightly throughout the duration of the Contract.

1.1.2 The Contractor shall be responsible for establishing and maintaining direct lines of communication, as coordinated with the Employer, with the relevant parties for the day to day coordination of his activities.

1.2 Weekly Meetings

1.2.1 The Contractor's Representative(s) shall attend Weekly Meetings to be chaired by the Employer to discuss the progress of the Works and other relevant matters. The Weekly Meeting Agenda will typically include, but not be limited to:

(a) Action taken on the decisions of the Previous Minutes.
(b) Outstanding Matters.
(c) Health and Safety.
(d) Quality Assurance.
(e) Interface Coordination with adjacent works.
(f) Progress of the Works.
(g) Programme Milestones, Achievements and Slips.
(h) Resources (i.e. Plant and Equipment, etc.)
(i) Survey and Clearance of the Works.
(j) Contractual Matters.
(k) Progress Payment Claims and Payments.
(l) Environment Compliance Issues.
(m) Other points, as necessary.

1.2.2 When required by the Employer, separate meetings covering occupational health and safety; environmental management, quality etc. shall be held independently of the weekly meetings with the Contractor's specialist personnel in attendance and other Contractor's Safety Representatives also in attendance when, and if, deemed necessary, by the Employer or the Employer's Safety representative. Any unresolved issues arising from these supplementary meetings can be included and form part of the weekly site meetings. Joint (Contractor and Employer) site quality walks and safety walks shall be carried out at regular intervals.

1.2.3 Informal routine discussions shall also be held each day and/or as/when necessary, between the Employer's and the Contractor's representatives.

1.3 Contractor's Project Management Plan

1.3.1 The Contractor shall submit, within thirty (30) days from the issue of Letter of Award, for the Employer's review and acceptance, a detailed Contractor's Project Management Plan (PMP) that provides specific details as to the execution process, methods and procedures which the Contractor will adopt for the Project.

1.3.2 The PMP shall include methodology, policies, organization and resources to manage scope, change, schedule/ programme, security, interface, budget and cost, quality, human resources, communication, risk, procurement, environment, labour management plan, taking over plan, workmen's accommodation/villages, etc. Detailed requirements for some of these plans are included in this specification.

1.3.3 The PMP should reflect the holistic thinking process of the Contractor for the successful completion of Works from the commencement until completion

1.4 Contractor's Project Organization and Staffing

1.4.1 The Contractor shall employ on this Project, a competent team of managers, technical staff, etc. so as to complete the Works satisfactorily as per the various requirements of the Contract. The Contractor shall submit his proposed staffing plan and organization to the Employer for review and approval within thirty (30) days from the issue of Letter of Award, which shall include:

(a) The Contractor's proposed Staff Organization in chart form showing the names of his proposed staff for each position;

(b) CVs of the Contractor's proposed Key Staff with adequate details and copies of documentary proof for the individual's qualifications and experience (with contract titles, position(s) held) and dates to substantiate that he/she is competent for undertaking the proposed position;

(c) The scope of responsibilities of each staff member and the reporting lines between individual staff;

(d) The documents that each Key Personnel staff is authorized to sign on behalf of the Contractor.

1.4.2 The Staff Organization shall cover the Contractor's Key Staff, as well as other working-level staff, with a narrative of the authorities and responsibilities of each staff member in execution of the Works, whether on site or in office locations, or in deciding technical details of the Contractor's submittals.

1.4.3 Each member in the Contractor's Staffing Proposal, including the Key Staff, shall be allocated to this Contract on a full-time basis on site until the activities that he is responsible for, have already been completed. Should it be necessary to replace Key Staff, before the activities he is responsible for have been

completed, the Contractor shall submit the CV of the proposed substitute to obtain the Notice of No Objection from the Employer, at least 30 days before the proposed change. The substitute shall not be less qualified or experienced than the person he is replacing.

1.5 Project Controls Execution

1.5.1 The Contractor shall employ the appropriate level of suitably qualified and experienced personnel, having competencies in preparing integrated project programme, cost, resource allocation, and establishment of a baseline plan for monitoring and performance measurement.

1.5.2 The Contractor's Project Controls will be executed on the Employer's programme through integration of the following:

(a) Time Management;

(b) Cost Management;

(c) Resource Management;

(d) Change Management;

(e) Performance Measurement;

(f) Reporting.

1.5.3 The Contractor's Project Controls must include work breakdown structures, organizational breakdown structures, milestones, cost and programme information, risk, scope and deliverables in sufficient detail to allow a schedule baseline to be set at a level that facilitates visibility of performance and ease of reporting.

1.5.4 The Contractor shall develop the Contract Price into the budget baseline and define the resources (labour, plant/equipment, material, subcontract and overhead) required to deliver the Contract Scope at the lowest level of Work Breakdown Structure (WBS). Individual WBS elements are broken down to align with the integrated schedule activities and each activity is broken down and coded by cost elements.

1.5.5 The Contractor is required to ensure that schedule and execution risks are supported with mitigation measures. The Contractor shall establish and use quantifiable performance measurement tools and Key Performance Indicators (KPI) for each stage of the Contractor's Project Management process. KPIs are to be reported on a weekly and monthly basis in accordance with the Employer's requirement and must address all foreseeable contract risks and give early warning of Project performance.

1.6 Contractors Emergency Contact Details

1.6.1 Prior to commencement of construction Works, the Contractor shall provide to the Employer, and all other relevant government agencies, the 24-hour contact telephone number of two (02) persons with authority over the Works during the

construction period. The persons shall have authority to take immediate action to shut down any activity, or to affect any emergency measures as directed by the Employer or any other relevant government agencies.

2 WORK PROGRESS DOCUMENTATION

2.1 Detailed Work Sequence and Methodology

2.1.1 The Contractor shall be responsible for scheduling, actions, personnel, materials and all other aspects of the works (for design and construction) necessary to achieve completion of the whole of the Works within the approved programme/ schedule and subject to the restrictions contained in this contract, including granting of Right of Access to the site areas and use as specified earlier.

2.1.2 Along with the submission of the detailed programme/ schedule (in accordance with Conditions of Contract), the Contractor shall submit to the Employer for approval, the detailed design and construction work sequence and Methodology (including mechanical equipment proposed to be used), sequence of various activities, key milestones (including priority works) and the overall programme from Contract start to completion of all works.

2.1.3 The detailed Works Programme and Methodology shall be consistent with the overall sequencing of the Work Methodology submitted in the Contractor's Tender and shall provide additional details of the Contractor's proposed method of design and construction and sequence of work, with particular attention to priority works. The Works shall be planned such that proper site safety, drainage and free flow of traffic are maintained at all times. The Contractor's works sequence and scheduling shall conform with any additional construction sequence or phasing requirements and shall include due allowance for all inspection, testing and document review requirements nominated on the drawings and/or elsewhere in this specification.

2.2 Contract Programme

2.2.1 General

(a) The required time for completion of the works is stated in the Appendix to Tender.

(b) The Contractor shall submit a Detailed Time Programme (DTP) to the Employer for acceptance as required under this Contract.

(c) All programmes submitted to the Employer (including: the 120 days Preliminary Programme; the DTP and including any subsequent updates or revisions to the aforementioned documents), must be prepared and maintained using Primavera P6 version 7.0. Evidence of the Contractor's Planner's ability in the use of P6 shall be required to be submitted prior to submittal of the programme.

(d) The DTP prepared by the Contractor is to have a WBS based on information provided by the Employer. The logic and activity sequence of the DTP should

also follow the Critical Path Method (CPM) standard. The WBS shall be used for design submissions, shop drawings, procurement, subcontractors, and construction, inspection, commissioning and Taking-Over operations.

(e) The DTP shall identify submission dates of Work Method Statements (WMS), various interfaces and other key deliverables as identified in the specifications.

(f) The Contractor shall allow for thirty (30) days review time by the Employer of all submittals within the DTP.

(g) The DTP shall at all times accurately reflect the Contractor's current plan for the work and shall be the primary tool utilized by the Contractor to document the progress of the works and to communicate the timely completion of the Works.

(h) The Contractor's monthly progress reports (Monthly Reports) and applications for Interim Payment Certificates must incorporate an updated DTP indicating work activities and status in accordance with the requirements of this specification.

120-day Preliminary Programme

2.2.2 The Contractor shall submit a 120-day Preliminary Programme within 20 calendar days from the issue of Letter of Award. The Preliminary Programme shall show in adequate detail, to the satisfaction of the Employer, all the activities that the Contractor will undertake during the first 120 days from the Commencement Date. The Contractor shall update and maintain the Preliminary Programme on a weekly basis. The Contractor shall extend the duration of the Preliminary Programme and maintain the weekly updates until the Contractor's DTP (Baseline) is accepted by the Employer.

Contractor's Detailed Time Programme (DTP)

2.2.3 The Contractor shall submit the detailed time programme to the Employer in accordance with the requirements of the Contract and subject to the additional requirements of this Specification.

2.2.4 The work programme shall be submitted in both A1 hard copy (six copies) and Primavera P6 latest version electronic format or other form approved by the Employer. Electronic copy shall be either on CD-ROM or on DVD or via Project Management Information System (PMIS) as instructed by the Employer.

2.2.5 The work programme shall be consistent with the overall sequencing of the programme submitted in the Contractor's Tender and shall provide additional details of the Contractor's proposed design timelines and method of construction and sequence of work including but not limited to the following:

(a) All design phases with review time and re-submissions.

(b) All physical work to be undertaken in the performance of the Contract obligations, including Temporary Works.

(c) All major activities including design.

(d) The requested date for issue of any information by the Employer.

(e) Incorporation of principal aspects of design programme and design submission programme.

(f) Due time allowance for review by the Employer of the Contractor's submissions, as well as the subsequent amendment and re-submission by the Contractor in the design review and comment process.

(g) Time required for gaining any permits, permissions or approvals from government or statutory authorities as may be required under the Contract.

(h) Time required for the submission and approval of materials, procurement of critical materials and equipment, fabrication of special products/equipment etc.

(i) All activities of the Employer that are likely to affect the progress of the Works etc.

(j) Completion of priority works (Section I).

(k) The Contractor shall provide a manpower histogram, which shall be extracted or based on the cost/resource loaded programme.

(l) Off-site procurement and delivery activity durations shall not exceed 60 calendar days.

(m) Manufacturing, inspection and shipping activities, if any, shall be broken down into sufficient detail to allow adequate progress reporting.

(n) Sufficient allowance shall be made for preparation, submission and review of submittals. Allowance shall be made for reworking and resubmitting major submittals that may not receive an "Accepted" status at the first submission.

(o) All logical dependencies between the major activities.

(p) The time and sequence required for executing the Works broken down into activities not exceeding one month.

(q) Dependencies between items of work as normally identified in Critical Path Analysis methods in precedence GANTT form.

(r) The minimum duration of each item of work.

(s) All relevant time, site or other restraints including those imposed by the Tender Documents.

(t) Milestones, including priority milestones, with their dates.

(u) The sequence of activities that form the critical path for the completion of the Project.

(v) The proposed human resources and plant for each item of work on the Critical Path.

(w) Interface requirements and/or dependencies with Works to be accomplished by other adjacent contractors.

(x) Any work to be subcontracted with the name of the subcontractor identified.

(y) Points of interface between the Contractor and the Employer.

(z) All contract milestones, including inspections, Taking-Over, and testing.

(aa) Each separable portion of the Works if applicable.

(bb) Total float on all activities and the Critical Path.

(cc) Projected impacts due to severe weather including annual monsoon season.

2.2.6 The Contractor shall submit a narrative report with the DTP (Baseline). The Contractor shall submit a proposed narrative format to the Employer for acceptance which shall include, as a minimum, the following:

(a) Description of the Scope of the Works, including design and construction phases.

(b) Detailed description of the Contractor's approach to design and construction, including the sequencing and the execution of the Works (including any Phasing or Staging as required by Contract).

(c) Description of the Critical Path.

(d) Any adjustments made to the Baseline since the issue of any previous issue of a DTP report, and the date of the associated Employer's confirmation of acceptance.

(e) Potential or anticipated issues that may affect progress.

(f) Lists of:

(i) Calendars used.

(ii) Lags used (only lags previously confirmed by the Employer can be included).

(iii) Constraints used (only constraints previously confirmed by the Employer can be included).

(g) Graphs, histograms or lists indicating anticipated use of the following resources and work shifts:

(i) Labour resources (design and construction (by site)) break up by major competencies and/or trades.

(ii) Equipment resources (by site).

(iii) Principal Quantities (by site), (i.e. volume of excavation, volume of concrete, tonnage of steelwork/reinforcement, area of formwork, length of pipe work, etc.).

(h) Work shifts (e.g. single, double, or triple shifts).

(i) Work weeks (5, 6, or 7-day work week).

(j) Production rates.

(k) Holidays and special non-working days.

(l) Other details as appropriate or required by Employer.

2.2.7 The overall programme duration shall take into account all statutory holidays and any other applicable construction industry or corporate holidays. It shall also show the impact of seasonal monsoon periods.

2.2.8 The base unit of measurement of activity duration will be one calendar day. The Contractor shall specify the normal weekly hours to be worked for all labour and major items of plant.

2.2.9 The Contractor shall indicate on the Activity/Time Chart, the critical path, and shall indicate which activities (related to design and construction as appropriate) shall be undertaken on a twenty-four (24) hour per day basis (if approved by the Employer) and show the time for each activity in sufficient detail to enable an assessment to be made of the progress of the activities toward completion of the Works.

2.2.10 If the Employer is of the opinion that the detailed time programme (DTP) submitted by the Contractor does not enable the Employer to readily evaluate the Contractor's progress, the Contractor shall, upon being so notified by the Employer, continue to submit amendments (within seven days) of the DTP until the said programme is approved by the Employer. If so required by the Employer, the Contractor shall amplify or further breakdown any part of the design and/or construction phases of the programme.

2.2.11 The Employer shall review the programme for its adherence to Contract and scope of works but shall not be responsible to ensure that the programme will result in the required timely completion of the Works.

2.2.12 At such time that the DTP is approved in writing by the Employer, it shall become and, thereafter, be referred to as the approved Contract Programme. The Contractor shall adhere to and perform the Works in accordance with the approved Contract Programme unless otherwise agreed in writing by the Employer.

2.2.13 The Contractor acknowledges that the Employer will rely upon the approved Contract Programme in co-ordinating other works within site.

Updates of Contract Programme

2.2.14 The Employer may, from time to time, direct the Contractor to supply to the Employer with an updated contract programme. The Contractor shall within seven (07) days after the receipt of such a direction supply to the Employer an updated contract programme and shall continue to submit amendments of the contract programme until it is approved by the Employer. The Contractor shall comply with the approved updated contract programme when so approved by the Employer.

2.2.15 Once the first Contract Programme (Baseline) has been accepted by the Employer, the Baseline version as included within this document (the 'Original

Accepted Baseline',) must be incorporated (un-amended), within all of the Contractor's future Contract Programme (DTP) updates and revisions.

2.2.16 If it is considered necessary to prepare, at a later date, any DTP revised baseline(s) each revision must be submitted together with any substantiating information, to the Employer for review and comment. The Contractor must not incorporate a revised baseline into any DTP updates or any DTP revisions unless the Employer has provided written acceptance for the revised baseline's incorporation. All DTP updates and DTP revisions must incorporate the original accepted baseline, in addition to any subsequently accepted revised baselines.

2.2.17 In the event of the Employer notifying his acceptance for the incorporation of a revised baseline, then the Contractor must, as part of his next submitted DTP revision or DTP update, identify each amended activity as part of the accompanying DTP narrative report.

Revision of Contract Programme

2.2.18 The Contractor may from time to time submit a revised Contract Programme with the purpose of re-organization of the execution of the works so as to enable the Contractor to complete the works in the shortest practicable time. The revised Contract Programme must first be approved by the Employer and, if and when, such approval in writing is given, the Contractor shall comply with the revised Contract Programme.

Effect of Acceptance or Approval of Contract Programme

2.2.19 The acceptance or approval by the Employer of a Contract Programme, or revision thereof, shall not relieve the Contractor of its obligation to complete the works within the contracted time for completion and will not give rise to a variation under the contract.

2.3 Work Progress Reporting

2.3.1 During the performance of the design and construction Works, the Contractor shall submit to the Employer, progress reports as defined in this specification and in the format required by the Employer in both hard copy and in a digital format. These submissions will continue until the Contractor has completed all work known to be outstanding at the completion date stated in the Taking-Over Certificate for the works.

Daily Site Records

2.3.2 The Contractor shall maintain daily records of the number of each class of the Contractor's Personnel and of each type of Contractors Equipment on the site along with brief description of the actual construction activities undertaken each day at site, safety mishaps (including all injuries) and any environmental issues/mishaps, coordination issues, and any other noteworthy activities or events.

2.3.3 These records shall be kept in the form of separate pro-forma Daily Site Record Forms corresponding to each day throughout the Works. The Contractor shall finalize the format of the Daily Site Record Form with the Employer prior to the commencement of the design works and construction works on site.

2.3.4 The Contractor shall present the Daily Site Record Form to the Employer (or delegated representative) each day for acceptance. Once agreed, the Contractor and the Employer shall both sign the Daily Site Record Form and each shall retain hardcopy of the signed form for record purposes.

2.3.5 The Contractor shall note that the requirements of this Clause are separate from and additional to the requirements of the Conditions of Contract regarding records of the Contractors Personnel and Equipment.

Weekly Progress Reports

2.3.6 The Contractor shall submit at the end of each week to the Employer a Weekly Progress Report summarizing significant progress or problems encountered during the preceding week in respect to all parts/phases of the works (design and construction) under the contract.

2.3.7 The Contractor shall finalize the format and content of the Weekly Progress Reports with the Employer prior to the commencement of design works and construction works on site.

2.3.8 The Weekly Progress Report shall also include but not be limited to:

(a) Progress for that week in terms of all activities including design and construction. Construction progress will include quantities and production rates also.

(b) Key decisions required from the Employer in the next week.

(c) Key design and construction milestones and progress towards each.

(d) Major events for the upcoming week.

(e) Three-week look-ahead programme indicating progress in the previous week and the activities planned for the next two weeks.

(f) Measurement of KPIs (S-curves for Actual vs Planned).

(g) Submittal and RFI logs.

(h) Safety Health and Environment(SHE) report with photographs.

(i) Records of manpower and equipment compared to programmed requirements.

(j) Approved Daily Site Record Forms applicable to that week as a separate appendix.

Monthly Progress Reports

2.3.9 In addition to the Weekly Progress Reports, the Contractor shall submit each month within seven (7) days of the last day of the period or the agreed cut-off

date with the Employer, an overall Monthly Progress Report summarizing the contents of the submitted Weekly Progress Reports for that month in respect to all parts/phases of the Works under the contract. The submission of the Monthly Progress Report shall be subject to the requirements of the Conditions of Contract and the additional requirements of this Specification. The Report shall indicate the progress and financial status of the works of the previous month. The Report shall accurately estimate the work completed on each activity, including design, procurement, engineering and construction activities on the approved DTP.

2.3.10 The Contractor shall finalize the format and content of the Monthly Progress Reports with the Employer prior to the commencement of design works and prior to commencement of works on site. In addition to information from the Weekly Progress Reports, the Monthly Progress Report shall also include, but not be limited to:

(a) Executive Summary of previous month's events including a clear summary statement of the current progress position.

(b) Describe DTP current Critical Path.

(c) Details of design progress including design interface coordination, started or completed during the month as related to the Temporary Works, Permanent Works and Shop Drawings.

(d) Updated drawing register.

(e) Total work progress at the end of the previous month with progress chart showing progress achieved as a percentage against planned progress.

(f) State existing status, rate of progress, estimated time of completion and cause of delays (if any).

(g) Description of work accomplished since submission of previous progress Programme.

(h) Programme Update: Compare actual work (design and construction) status against the Contractor's Baseline Programme submitted in electronic format, indicating the following:

(i) Activity Description.

(ii) Original Duration.

(iii) Remaining Duration.

(iv) Current Early Start.

(v) Current Early Finish.

(vi) Planned Percent Complete.

(vii) Target Early Start.

(viii) Target Early Finish.

(ix) Actual Percent Complete.

(x) Date Variance.

(xi) Percent Variance.

(i) S-curves for physical progress against planned.

(j) Details of work for the next month (by site).

(k) Safety and health performance reporting.

(l) Information regarding any design changes.

(m) Information regarding any variations.

(n) Details of inspections and approvals required to proceed with Work.

(o) Records of manpower, equipment etc. (compared to programmed requirements.

(p) Information required from the Employer.

(q) Environmental Monitoring reporting, including separate Waste Management reporting.

(r) Weather records.

(s) Records of delays and stoppages with supporting reasons.

(t) Value of work done.

(u) Actual and anticipated cash flow.

(v) Changes or additions to Contractors supervisory personnel since the preceding progress report.

(w) Causes of any delays.

(x) Proposed actions by the Contractor to restore the programme, including what is being done or what is planned to be done in each problem area.

(y) Identify anticipated problems or changes and present plan to deal with them so as to minimize or prevent delays.

(z) Status of equipment and material deliveries.

(aa) Request for Information (RFI) status.

(bb) Submittals summary and status.

(cc) Instructions summary and status.

(dd) Defects summary and status.

(ee) Schedule of warranties and guarantees.

(ff) Schedule of insurances and insurance claims.

(gg) Subcontracts awarded in the previous month.

(hh) Photography of salient activities pertaining to work progress in the month

2.3.11 Updates and revisions to required programme and reports shall not modify or limit in any way, the Contractor's obligations to meet the Time for Completion.

2.3.12 Copies of the site progress photos for the month shall be provided in a separate appendix.

2.4 Notice to the Employer

2.4.1 Unless specified otherwise or elsewhere in this Specification, the Contractor shall give the Employer not less than 24 hours' notice in writing of the intended time for commencement of any construction activities at site to enable the Employer to make his arrangements for the inspection of operations on the site.

2.4.2 The Contractor shall also give the Employer not less than 7 days' notice in writing of the commencement of any preparation, construction or manufacturing activity occurring at the manufacturer's or supplier's site, or at a location not within the manufacturer's or supplier's site, of any article or material to be used in the works, whether by the Contractor or any Subcontractor, stating the time and place of the works such that the Employer may make his arrangements for the supervision or inspection of such works at the manufacturer's or supplier's site. The Contractor shall bear the costs for Employer costs for inspections at manufacturers/supplier's sites.

2.5 Photographic and Video graphic Documentation

2.5.1 The Contractor shall arrange to take colour photographs throughout the works for the purposes of recording the overall progress of the works and recording details of each aspect of the Works or as otherwise directed by the Employer. The photographs shall be of acceptable quality and shall be taken by a professionally competent person with a digital camera having resolution in excess of 10 Megapixels and able to record the date of photographs taken in the prints. Salient activities and corresponding photography pertaining to work progress are to be attached to the corresponding monthly progress reports. Further, the Contractor shall arrange for videography (HD quality) of important events of the Works or as otherwise directed by the Employer.

2.5.2 The Contractor shall submit to the Employer weekly six sets of CD/DVDs each containing the electronic files of each photograph/video taken as both, a) uncompressed, full resolution files and, b) compressed, reduced resolution files suitable for attachment to email (i.e. <1MB per file). The Employer shall select the photographs to be retained and the Contractor shall mount two hardcopy prints of each selected photograph in albums of acceptable quality. The albums shall be kept by the Contractor and produced to the Employer upon request and shall be handed over to the Employer at the completion of the Works. A compact disc containing the electronic files for the selected photographs shall be supplied each week. Each photograph in the album shall be suitably captioned and the electronic files appropriately named.

2.6 Six Monthly Report

2.6.1 The contractor shall submit draft reports on six monthly returns to be sent to Central Pollution Control Board, Bengaluru within 7 days of the last day of the period in hard and soft copies, in consultation with the employer.

3 Contractor's Design Work

3.1 General

3.1.1 It is the Employer's intent that the Contractor will analyses the Employer's Requirements thoroughly and use their full creativity to complete the design. The Employer intends to allow the Contractor maximum flexibility to design and produce a set of full, thorough and state-of-the-art, sustainable facilities and infrastructure.

3.1.2 The Employer has provided the Employer's Requirements in Section 7 of these documents. These documents are intended to provide the Contractor with sufficient information so as to clearly understand the Employer's intent, goals and objectives in execution of the works. The Contractor will be required to adopt the general concepts, as provided, and expand and develop the same to produce complete, thorough, comprehensive and high-quality designs, working drawings, and specifications for review and approval by the Employer. While developing the complete and final designs and specifications, the Contractor shall review the concepts design and planning for betterments or improvements which may be incorporated to better achieve the Employer's goals and objectives and which may result in overall improved functionality. These betterments, if any, shall be submitted by the Contractor to the Employer for review and for the approval by the before the final design is completed.

3.2 General Design Obligations

3.2.1 The Contractor shall prepare the full and complete design and drawings for the Works as per the Contract.

3.3 Design Method Statement

3.3.1 Prior to the commencement of any design works, the Contractor shall submit to the Employer for approval, as part of the 120-day Preliminary Program, a Design Method Statement as outlined below describing how he intends to manage, control, programme and carry out the necessary design work in accordance with his obligations under the Contract. It will include:

(a) The proposed design organisation.

(b) Programme of the design work.

(c) A Design QA/QC plan, certification and procedures.

(d) An integrated schedule of staged/segmented, sequential design, construction and supporting activities that results in the earliest possible completion and Employer's Taking-Over of Section I (complete and usable) and the complete Works (Section II).

3.3.2 For each stage, the Contractor will submit a design package that has all of the elements/components required for 100% design of the stage. All planning documents, calculations, applicable codes and specifications, design guidance

and ready-for-construction drawings with complete construction details, must be included.

3.4 Design Requirements

3.4.1 Design requirements are contained in multiple parts of the Contract Documents. The Contractor shall scrutinize all of the documents to ascertain all of the design, design process, design quality and design management requirements for inclusion in the Design Method Statement.

3.4.2 The Contractor shall be deemed to have scrutinized, prior to the Commencement Date, the Design Criteria, Specifications and Drawings and all subordinate and supporting documents. The Tender Documents contain concept design drawings and specifications provided by the Employer. The Contractor shall use these concept drawings and specifications provided and develop them further in parts and in the whole to full and final design, ready for construction purposes. The Contractor shall be responsible for the design and specifications of the whole of the Works. They are also responsible for the redesign and re-specification of all parts of the Works described in the Tender issued by the Employer that are affected in any way by the designs of the Contractor, and for the accuracy of that part of the Specifications and the Drawings relating to such design (including design criteria and calculations).

3.4.3 The Employer shall not be responsible for any error, inaccuracy or omission of any kind in the Design Criteria, Concept, Specifications or the Drawings as originally included in the Contract and shall not be deemed to have given any representation of accuracy or completeness of any data or information, except as stated specifically. In the event of, if finding a discrepancy, difference or conflict between documents, then the resolution, thereof, shall be interpreted and applied to the benefit and in favour of the Employer. Any data or information received by the Contractor, from the Employer or otherwise, shall not relieve the Contractor from his responsibility for the full, thorough and complete design of that part of the Works to be designed by the Contractor as required under the Contract and for the execution of the Works.

3.5 Contractor's Designer(s)

3.5.1 The Contractor shall carry out, and be responsible for, the full and complete design of the Works. Design shall be prepared by a qualified design firm or a consortium of design firms jointly complying with the following criteria:

(a) Successfully completed detailed design pertaining to Piled Jetty over the past 7 (seven) years ending last day of month previous to the Tender Due Date.

3.5.2 The Contractor shall submit to the Employer for review and approval the name and particulars of the design firm and the key personnel proposed to be involved in design along with his technical proposal.

3.5.3 Within 30 days of Commencement Date, the Contractor shall re-submit the credentials of design firm, who shall carry out the design works for this contract. The following shall be submitted for the approval of the Employer;

(a) Profile, details and experience of the design organisation.

(b) Completion certificates confirming that the design firm meets the qualification criteria as mentioned in 3.5.1

(c) Full and detailed CVs of persons proposed to be deployed.

3.5.4 Approval of the design firmshall be subject to the specific written approval of the Employer.

3.5.5 The Contractor warrants that he, his design firm, designers and design Subcontractors, if any, have the experience and capability necessary for producing a complete, thorough and quality design that meets or exceeds all Employers Requirements and complies with all applicable codes. The Contractor is required to ensure that the key personnel of the design firm shall be available to attend meetings and/or discussions with the Employer, as may be required by the Employer, until the expiry of date of the relevant Defects Notification Period.

3.6 Contractor's Documents

3.6.1 All Contractors' Documents shall be submitted to the Employer for review in accordance with the procedures outlined herein and in accordance with the requirements of the Conditions of Contract.

3.6.2 The Contractor shall prepare all and any Contractor's Documents and shall also prepare any other documents necessary for successful completion of the Works with required quality and within established and approved schedules. Such preparation shall include review (including Third Party Review, detailed below), verification and warranting of the Contractor's Documents by Designer(s), approved by the Employer as specified above. The Employer shall have the right to inspect the preparation of these documents, wherever they are being prepared.

3.6.3 Contractor's Documents shall comprise the following items and any other documents that may be requested by the Employer:

(a) Design Basis

(i) This document shall provide all information which the Contractor intends to use as the basis for preparation of approvals, construction drawings, monitoring and construction specifications.

(ii) This document shall also detail the design parameters for each Material to be used in the work, and shall include preliminary testing results which verify that the available Material is in accordance with the proposed design parameters.

(b) Detailed Design, Construction Drawings and Specifications

(i) The design shall include full design calculations and drawings and shall provide the full and detailed design of the Works showing the Contractor's application of the Employer's Requirements and any other data the Contractor reviewed or obtained, including details of any proprietary products to be used.

(ii) The design shall include clear details of any acceptance criteria and settlement triggers to be used when assessing the removal of preload or the completion of ground improvement works.

(iii) The drawings shall be the drawings which the Contractor intends to use for the construction of the Works.

(iv) The specifications shall be the specifications which, when read in conjunction with the drawings, shall describe the materials and workmanship to be used for the construction of the Works.

(c) Testing and Monitoring Regime

(i) The Contractor shall submit with each part of his design, details of the testing regimes that he will implement to demonstrate that the As-Built Works comply with his design.

3.6.4 All Contractors' Documents shall include revision numbering and issue dates.

3.6.5 As part of the Contractor's 120-day Preliminary Programme, and the subsequently detailed and maintained DTP, the Contractor shall submit all Contractor's documents required as per Employer's Requirements, the DMP and other documents as required or directed by the Employer. All design submissions will have been identified and contained in the Design Method Statement.

3.7 Design Review

3.7.1 The Employer, if required through PMC,will provide a high level review of the design works and will also perform a structural review of the design of critical structures performed by contractor's designer(s), If on structural review by the Employer the design is found to be acceptable, then the Employer will issue a notice of no objection. The contractor will submit the structural review of critical structures segments to the TPR (below) for review prior to submitting to the Employer.

3.7.2 The Employer's high-level review is for general compliance with the criteria, scope of work and intent of the Contract in accordance with the Specifications and the Drawings. The Employer's high-level review may not cover the technical or engineering part of the Contractor's Documents. The Contractor remains solely and totally responsible for the thoroughness and quality of the Contractor's Documents.

3.8 Classification of Contractor's Documents

3.8.1 Following review of the Contractor's Documents, the Employer shall reply to the Contractor with a classification of the Contractor's documents as follows:

Classification Category	Definition	Action by Contractor
1	The Contractor's Documents acceptable without comment.	Contractor may proceed with construction.
2	The Contractor's Documents acceptable subject to changes or clarification requested by the Employer.	The Contractor shall make the changes requested prior to commencement of construction.
3	The Contractor's Document is unacceptable for the reasons given by the Employer. Construction work shall not commence.	The Contractors hall revise the document and re-submit to the Employer for further review.

3.8.2 The scope, roles and responsibilities of the TPR shall be submitted by the Contractor and approved by the Employer. These primary roles and responsibilities should include, but not be limited to:

(a) Thorough review of all design, technical and specification documents provided from the Contractor design team. The Contractor, at his own discretion, can determine how best to utilise the services of the TPR to maximize efficiency and completeness while maintaining schedule integrity.

(b) The TPR shall endeavour to ensure that the proposed designs and specifications meet the goals and objectives of the Project. The review will also include detailed review for functionality, quality, form and fit, safety, efficiencies, interfaces, technical adequacy and solutions, relationships to adjacent systems and structures, cost effectiveness, sizing, sustainability, etc. Additionally, improvements, if any, shall be noted.

(c) Specifications review to ensure that the technical specifications are properly coordinated with the design, properly describe the components and material to be incorporated into the design and facilities, provide enough and proper detail for the bidders to understand the requirements, and are otherwise thorough and complete.

(d) Identify, review and validate all applicable technical, regulatory and referenced codes and specifications to ensure compliance.

3.8.3 The Contractor shall ensure proper and effective coordination of the TPR including related review conferences which may include some combination of the following:

(a) Traditional review - Contractor submits design documents to the TPR and stops work while the review process occurs for each segment/phase of the Contractor's design submission.

(b) In-progress review - Same as traditional review except the Contractor continues design effort while the TPR reviews.

(c) On-board review – TPR and the Contractor visit the activity to review the design documents submitted by Contractor; designated on board/ in progress, or on board/ traditional depending on whether or not the Contractor continues or stops work while the TPR reviews.

3.8.4 If through TPR or other means, it is determined by the Employer that the design is inadequate and deficient and not meeting project goals and objectives, the Employer, will require the Contractor to immediately provide a resolution and correction plan, that will ensure mitigation of the deficiencies and achieve the design quality and standard as required by contract.

3.8.5 The Contractor will account for all TPR reviews and follow-ups in the Contract Programme.

3.8.6 It will be the responsibility of the Contractor, acting in a professional capacity, to ensure accuracy, completeness, and correctness of the design, cost estimate and all engineering concepts and details of the work, including coordination of the various architectural, civil, structural, mechanical, electrical, and other subdivisions thereof with each other and with the specifications.

3.8.7 The Contractor shall establish a review comment capture, tracking, status, responsibility, and resolution tool software (such as MS Excel) that will be used by the TPR, but in any case, TPR shall input all required details (timely and accurately) into the PMIS.

Design Review Process

3.8.8 The Contractor shall submit to the TPR all elements of the Contractor's Documents prior to commencing any work on Site.

3.8.9 Submissions shall be made in stages to the TPR/Employer appropriate to the Contractor's design development and in accordance with the agreed programme.

3.8.10 After the TPR's review achieves a category "2" status, the Contractor's Documents shall be subject to review by the Employer, in accordance with the requirements stated above.

3.8.11 Unless otherwise stated in the Employer's Requirements, each review period shall not exceed 21 days, calculated from the date on which the Employer receives a Contractor's Document and the Contractor's notice. This notice shall state that the Contractor's Document is considered ready, both for review (and approval, if so specified) in accordance with this sub-clause and for use. The notice shall also state that the Contractor's Document complies with the Contract, or the extent to which it does not comply. No extension of time shall be considered for any delay related to this review. No work shall start on site until the TPR/Employer's reviews achieve category "2" status.

3.8.12 If at any time, the Contractor makes a change to any Contractor's Documents, the Contractor shall re-submit the Contractor's Document for further review and the above procedure shall again be adhered to.

3.8.13 The Contractor shall acknowledge and accept any designs which were not prepared by the Contractor and which form part of the Contractor's Documents and takes responsibility for such designs as if they were prepared by the Contractor.

3.8.14 All submissions shall be in electronic format (AutoCAD + working calculation files plus record copy in PDF format) and hardcopy. The design submission shall include detailed design calculations, results / recordings of all investigation work, and detailed drawings.

3.8.15 The Employer may, within the review period, give notice to the Contractor that a Contractor's Document fails (to the extent stated) to comply with the Contract. If a Contractor's Document so fails to comply, it shall be rectified, resubmitted and reviewed again (and, if specified, approved), at the Contractor's cost and time.

3.9 Quality Review

3.9.1 The Contractor is required to implement a highly effective and thorough QA/QC program as stated in subsequent paragraph. The Contractor will ensure that the final design is complete and thorough and meets all quality standards as contained in the Contractors Quality Management Plan and meets the Employer's Requirements.

3.9.2 Examination and/or approval by the Employer of any drawings or other documents submitted by the Contractor shall not relieve the Contractor of his obligations, responsibilities or liabilities under the Contract.

3.9.3 If the Employer instructs that further Contractor's Documents are required, the Contractor shall prepare them promptly.

3.9.4 Nothing done or omitted by the Employer shall relieve the Contractor of his duty or responsibilities or liabilities under the Contract.

3.10 Contractor's Undertaking

3.10.1 The contractor shall undertake that the design of that part of the Works to be designed by the contractor will be in accordance with:

(a) The Laws, Regulations and Codes of the Country;

(b) All documents forming the Contract; and

(c) All MoEF&CC requirements and obligations.

3.10.2 The Contractor shall be responsible for the completion of the design of the Works, and when the Works are completed for ensuring, that they arefit for such purposes for which the part or whole is intended as are specified in, or implied by, the Contract. Nothing done or omitted by the Employer shall relieve the Contractor of his duty or responsibilities or liabilities under the Contract.

3.11 Technical Standards and Regulations

3.11.1 The design of the Works to be designed by the Contractor shall comply with the country's technical standards, building, construction and environmental laws, laws applicable to the product being produced from the Works and other standards specified in the Employer's Requirements, applicable to the works, or defined by the applicable laws.

3.11.2 If changed or new applicable standards come into force in the Country after the prescribed dates mentioned in Employer's Requirements, the Contractor shall give notice to the Employer and (if appropriate) submit proposals for compliance. In the event that:

(a) The Employer determines that compliance is required,

(b) The proposals for compliance constitute a Variation, and

(c) Then the Employer shall initiate a Variation in accordance with relevant Clause.

3.12 Design Error

3.12.1 If errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the Contractor's Documents, they and that part of the Works to be designed by the Contractor shall, subject to the approval of the Employer, be corrected at the Contractor's cost and time, notwithstanding any consent or approval under this Clause.

4 SUBMITTAL PROCEDURES

4.1 General

4.1.1 All Communications submitted by the Contractor as defined in the Conditions of Contract shall have a unique sequential reference number to facilitate tracking of the Contractors submissions and correspondence by the Employer.

4.1.2 Contractor's submission shall be made in both hard and native soft copy format to the Employer, as specified or requested by the Employer. The cost of submissions to the Employer in all formats shall be deemed to have been included in the Contract Price.

4.2 Requests for Information

4.2.1 Where the Contractor requires additional information or clarification in order to carry out the Works, or where he identifies any ambiguity or inconsistency in the Contract Documents he shall immediately submit to the Employer a Request for Information (RFI). The response for RFI shall normally be given within seven(7) days after receiving the same.

4.2.2 The Request for Information forms shall be provided with a sequential number or reference to facilitate tracking by the Employer.

5 NOTICE TO THE EMPLOYER

5.1.1 Unless specified otherwise elsewhere in this Specification, the Contractor shall give the Employer not less than 24 hours' notice in writing of the intended time for commencement of any construction activities to enable the Employer to make his arrangements for the inspection of operations on the Site.

5.1.2 The Contractor shall also give the Employer not less than seven (07) days' notice in writing of the commencement of any preparation, construction or manufacturing activity occurring at the manufacturer's or supplier's site, or at a location not within the manufacturer's or supplier's site, of any article or material to be used in the works, whether by the Contractor or any Subcontractor, stating the time and place of the works such that the Employer may make his arrangements for the supervision or inspection of such works at the manufacturer's or supplier's site.

C REGULATORY REQUIREMENTS

1 PERMITS, PERMISSIONS AND STATUTORY APPROVALS

1.1.1 The Contractor shall comply with all statutory obligations and regulations of relevant Authorities or services or utility providers, or any other relevant body or organization with authority or jurisdiction in India relating to the execution of the Works.

1.1.2 Where any conflict arises between the requirements of the various relevant authorities, the more stringent provision shall apply subject to the agreement of the relevant authorities.

1.1.3 The Contractor shall allow sufficient time in his programme for the issue of any statutory notices by the relevant Authorities which may be required prior to the commencement of the relevant Works. The Contractor shall provide the Employer with documents of evidence that the relevant Authorities have been notified of the proposed Works in accordance with relevant regulations and ordinances.

1.1.4 The Contractor shall give notice to the relevant Authorities at least one month or as appropriate to get the necessary approvals in advance of commencement of any new activity and shall keep the relevant Authorities regularly informed of the Works. The Contractor shall liaise with the relevant Authorities to give all information on working areas, types of plant and durations of activities, deemed necessary by the Authorities. The Contractor shall if required, also advice the Authorities on completion of each and every separate activity. In particular, at least one months' notice shall be given to the Authorities for the removal or relocation of any navigation affected by the Works.

1.1.5 The Contractor shall identify the permissions and submissions that are required by the regulatory Authorities for the performance of the Works. Where required, the Contractor shall prepare and submit to the relevant Authorities for their endorsement details of the proposed construction sequence and methods to be employed on the Works and an action plan as required in the Contract. No construction work shall be commenced prior to the endorsement and approval of the relevant submissions by Authorities. In this respect the Contractor shall note that the Authorities' requirements may include the submission of the following for their approval at least one month in advance of the commencement date of the Works.

- Detailed plans of the landside and marine Works showing the proposed overall limits of the working area(s) and the space requirements of each of the operations.
- List of all personnel who would be working at site.
- Name of the person(s) in charge of the Works who can be contacted by the relevant Authorities on a 24-hour basis and means and procedures to contact them.

- Proposed schedule of all Works carried out under the Contract indicating different types of operations, their number, duration, space requirements and phasing.
- Afull description of the method for all work activities including the number and type of plant / craft to be employed, together with a complete list of vessels and craft to be used for all types of marine Works.
- Details of weather conditions in which operations would cease and all working marine craft would be removed from the working area; Other as may be required.

1.1.6 Health Safety &Environment permits and all related issues are the responsibility of the Contractor. All correspondence between the Contractor and relevant Authorities including all submissions shall be copied to the Employer. All environmental permitting issues will be dealt through Employer.

2 HEALTH AND SAFETY REQUIREMENTS

2.1 General

2.1.1 The Contractor shall comply with all health and safety requirements of the Contract including statutory requirements, requirements of Kerala State Government Department, requirements stipulated, and any reasonable direction issued by the Employer's safety department or authorized personnel of the Employer from time to time. The Contractor shall document, implement and maintain a safety system complying with international standards acceptable to Employer.

2.1.2 All works shall be carried out in a safe manner and free from any danger and shall comply with the relevant Laws regarding safety of the Works.

2.1.3 The Contractor shall take all precautions necessary to protect the health and safety of persons where works may expose workmen and other persons on, or within the vicinity of the site, to conditions which are dangerous or potentially dangerous to health, including the noxious effects of dust, fumes, liquids, infection, fire, explosion, or other hazards. Any identified hazard posing risk of bodily harm to personnel or property damage shall be rectified immediately.

2.2 Health and Safety Management Plan

2.2.1 The Contractor shall prepare and submit for approval a Health and Safety Management Plan (HSMP) complying with the requirements of the Contract, the Employer's HSE Plan, and international best practice and with Indian and local laws and regulations and which shall be implemented throughout the Works. The plan shall describe the responsibilities and procedures for all aspects of the safety management on the Works and shall be capable of regular audit throughout the course of the Works.

2.2.2 The Contractor shall submit the HSMP to the Employer within 28 days of the Contract Commencement Date or at least 14 days prior to the intended commencement of any permanent Works under the Contract, whichever is the

earlier. The Employer will take maximum 14 days for issuing comments (if any) to be incorporated by the Contractor.

2.2.3 The resolution of such comments on the HSMP submission to the satisfaction of the Employer and the subsequent acceptance of the HSMP by the Employer shall constitute a Hold Point on the commencement of any permanent Works under the Contract.

2.2.4 The Contractor shall ensure its HSMP include:

(a) Safety Policy Statement of Senior Management and a project responsibility matrix;

(b) Normal protocols for personnel requiring access into and out of working areas;

(c) Emergency plans (in line with existing Emergency and Disaster Management Plans for the project) for all identifiable potential incidents such as fires, foundering, oil spills and the like;

(d) Requirements for routine internal safety audits;

(e) Drills frequency and type. Drills shall be separated into those required for statutory or insurance purposes and additional drills proposed for the Works. Vessels and crew training shall meet the safety requirements of the Contract and all applicable regulatory requirements or as indicated by Central, State or Local Government statutory authorities and bodies;

(f) Emergency evacuation procedures, lifeboat and evacuation drills and other emergency response equipment;

(g) Certification of crane drivers/vessel operators, in full compliance with Indian requirements;

(h) Job Hazard Analysis. The Contractor shall provide written working procedures, directions including Job Hazard Analysis or Job Safety Analysis (JHA/JSA) and undertake drills on all equipment in order to ensure the safe and timely execution of the Works. JHA/JSA, procedure revisions and drills shall be ongoing during the course of the Works according to a programme approved by the Employer and set out in the Health and Safety Management Plan; Based on JSA and anticipated risks, mitigation measures for activities planned, based on hierarchy of control will be developed and submitted to Employer for approval;

(i) Work over and on water specific risks and mitigations;

(j) Fire fighting and emergency breathing apparatus;

(k) Hazardous and explosive materials register and storage;

(l) Project specific Contractor's site safety instructions for Contractor's Personnel, Employer's Personnel Visitors;

(m) Any onshore or offshore activities which cannot be undertaken 24 hours per day due to safety or other constraints;

(n) Accident / Near Miss investigation procedures;

(o) Competency testing;

(p) Employee training;

(q) Tool Box Meetings, Work Area Inspections; Signage, First Aid facilities and trained personnel;

(r) Equipment lock out procedures;

(s) Confined space access procedures;

(t) Auditing frequency;

(u) Reporting;

(v) Contractors Anti-Child Labour Policy or statement.

2.3 Training

2.3.1 All personnel shall be suitably qualified, experienced and trained by the Contractor for the equipment or duty that they are engaged on.

2.3.2 A sufficient number of the Contractor's employees who speak the language of the State/region shall be fully qualified in first-aid so that first- aid will be immediately available in case of accident at any time and at any place throughout the Site and any off-site camps, housing or other facility. The persons so designated shall be made known to all employees by the posting of their name, designation and photograph in prominent positions on Site. Such first-aiders or medical service providers shall be trained.

2.4 Substances Hazardous to Health

2.4.1 The Contractor shall not use or generate any material in the Works which are hazardous to the health of persons, animals or vegetation. Where it is necessary to use some substances, which can cause injury to the health of workers/environment, the Contractor shall provide protective clothing or other appliances for security of his workers or requisite control measures to prevent effect on environment, as approved by the Employer.

2.4.2 Care shall be taken not to damage the oil pipelines passing through the approach road and it is the responsibility of the contractor to provide proper barricades at their cost to segregate the pipeline from the working area. In the event of any damages noticed to pipeline noticed, due to the negligence of the contractor, the same shall be rectified by the contractor at their own cost.

2.4.3 In addition no hot work shall be carried out nearer to the oil pipeline without obtaining the prior approval from the Deputy Conservator of Port.

2.5 Safety Audits

2.5.1 The Contractor’s Head Office personnel qualified and experienced to do so, shall undertake audits of the site management performance and project operations during the Works in order to evaluate the degree of compliance of the Contractor’s site operations to the Contract requirements for Health and Safety.

2.5.2 Audits shall be undertaken by an audit team. The audit team shall consist of the Contractor's Head Office Representative (team leader), a Representative of the Employer and Employer. An audit agenda based on the Contractor's commitments will be prepared and agreed prior to the audit.

2.5.3 Any audit shall follow the normal procedure for this type of activity with an Entry Meeting, the Audit and a Close-out Meeting where preliminary findings will be discussed directly with the Contractor's project staff. An audit report shall be prepared and agreed by the audit team. The contractor shall take appropriate action on all noncompliance and the action taken report shall be submitted by the contractor before settling off the final bill.

2.5.4 Based on the audit, the audit team will issue an audit report, indicating the site Health and Safety Performance based on performance indicators as internationally acceptable in the industry. The Audit report will also have corrective and preventive action plan based on risk grading. The contractor is to develop the findings closure plan and issue a compliance report fortnightly based on findings and severity.

2.5.5 Contractor shall routinely audit the use of training aids and drills and provide training and direction to the project management staff and to all supervisors and crews.

2.5.6 The Contractor's head office personnel shall arrange regular audits of all project management personnel against documented company procedures and Indian Occupational Health and Safety Law and Regulations.

2.5.7 The Employer shall be entitled to hold a Health and Safety audit of the Contractors safety procedures and the practices on site at any time with no notice. The contractor shall provide all required assistance to the Employer in this respect including access to appropriate information, site areas and personnel. The costs of this assistance shall be borne by the Contractor and no delays shall be attributable to such audit activities. Such audits will be undertaken quarterly or six monthly as per Employers discretion.

2.6 Incidents and Accidents

2.6.1 Incident and Accident reporting and statistics shall be undertaken to the relevant Indian Standard, Employer's and Contractor's requirements.

2.6.2 The Contractor shall send, to the Employer, details of any accident on or about the Site or in connection with the execution of the Works, as soon as practicable and, in any event within 24 hours after its occurrence. The Contractor shall also report such accident to the appropriate Authority whenever such report is required by the Laws. In the case of any fatality or serious accident, the Contractor shall in addition notify the Employer immediately by the quickest available means. Investigation techniques of Root Cause Analysis (such as Five Why, Causal tree Analysis or Fish bone Analysis, etc.) shall be used by the Contractor.

2.6.3 If an accident results in an injury to an employee or damage to equipment or release of hydrocarbons from the vessel or requires evacuation of personnel from floating equipment, oil spill clean-up, subsequent hospitalization of any individual or major repairs to equipment the Contractor shall arrange for a qualified independent third-party investigation and report. The third-party investigator shall be approved by the Employer.

2.6.4 A preliminary report shall be prepared and submitted to the Employer within 24 hours and a detailed report shall be submitted within seven (7) calendar days of the occurrence of the accident or incident. Should any construction activity need to stop work for

(a) The duration of the investigation, attendance of witnesses etc.;

(b) Modifications to safety plan, Job Safety/Hazard Analysis;

(c) Modification and validation of work procedures;

(d) Government Agency inspections and procedures;

(e) Any other reason;

2.6.5 All costs associated with the delay shall be at the cost of Contractor.

2.6.6 The Contractor's attention is drawn to the likelihood that any downtime resulting through loss of life, limb or other serious accident or incident may be considered as prima facie evidence that the Contractor's Works and Safety Management Plan and or Environmental Management Plan procedures and recruitment and training system are inadequate and/ or deficient. The Employer and other Agencies may require a complete reworking and independent audit of the Contractor's safety system and job safety analysis sub elements and environmental protection procedures. The cost of such delays and reworking of procedures caused by such activities will be at the cost of Contractor.

3 ENVIRONMENTAL REQUIREMENTS

3.1 General

3.1.1 The Contractor shall take all precautions for safeguarding the environment during the course of the execution of the Works. He shall abide by all laws, rules and regulations in force governing pollution prevention/abatement and environmental protection that are applicable in the area where the Works are situated/ carried out.

3.1.2 The Contractor shall observe and comply with all environmental requirements (including all applicable laws, regulations and any requirement of any relevant Authority (central/state or regional regulatory authority) and any directions of the Employer), the requirements of the Environmental Clearance and other Permits for the permanent Works as held by the Employer and any other requirements that apply to the Site generally.

3.1.3 The Contractor shall consider all Site conditions and adopt pollution prevention principles and techniques that are best suited to avoid, or where avoidance is

not possible, minimize adverse impacts on human health and the environment. The principles and techniques applied during the Works shall be tailored to the hazards and risks associated with the nature of the task and consistent with applicable regulatory requirements and Best Management Practices (BMP) as appropriate.

3.1.4 The Contractor shall implement effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs during the execution, with a focus on areas that are considered for Work activities.

3.1.5 The Contractor will avoid the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release in compliance with regulatory requirements. This applies to the release of pollutants to air, water, and land due to routine, non-routine, and accidental circumstances with the potential for local, regional, and trans boundary impacts (if any). In case of any contamination (soil/groundwater/marine), Contractor shall be responsible for adequate clean-up (remediation) in consultation with Employer.

3.1.6 The Contractor shall be responsible for any environmental impact(s) due to its operations and shall be liable to undertake remedial measures in consultation with the Employer//regulatory authorities as the case may be.

3.2 General Environment Management

3.2.1 Permits: Contractor, in consultation with Employer, shall ensure that all applicable Permits/Licenses/Certificates/No Objection Certificate required for construction works shall be obtained prior to commencement of works.

3.2.2 The Contractor shall ensure that applicable Permits (as and when applicable) are obtained well on time and provide copy of application submitted along/or with license obtained to Employer. The Contractor shall ensure that the permits are valid at any given point of time.

D QUALITY MANAGEMENT

1 QUALITY MANAGEMENT PROGRAM REQUIREMENTS

1.1 The Contractor shall be responsible for all quality management in the planning and execution of the Works. The quality management shall cover all stages of work such as setting out, selection of materials, selection of construction methods, selection of equipment and plant, deployment of personnel and supervisory staff, quality control testing, etc.

1.1.1 The Contractor shall be responsible for the following work under the quality provisions of this Contract:

(a) Implementing their corporate Quality Management System and providing evidence of third-party assessment and endorsement;

(b) Developing and implementing an effective and comprehensive Project Quality Plan (PQP) to cover all Works under the Contract, whether permanent or temporary both on-site and off-site;

(c) This PQP shall be submitted to “The Employer” for his/her review and approval prior to using in the contracted Works. The Contractor shall make changes and adjustments to the PQP as recommended by the Employer.

(d) Operating, maintaining and reviewing the Project Quality Plan and associated quality management system procedures; and

(e) Keeping Quality Records in accordance with Project Quality Plan.

2 PROJECT QUALITY PLAN

2.1 The Contractor shall prepare a project specific Project Quality Plan in line with his Corporate Quality System. The PQP shall be Contract-specific and shall include specific quality practices, resources, activities and responsibilities relevant to the Contract Works.

2.2 The Contractor shall submit the PQP to the Employer within 45 days of the Contract Commencement Date or at least 14 days prior to the intended commencement of any permanent Works under the Contract, whichever is earlier. The Employer will take maximum 7 days for issuing comments (if any) to be incorporated by the Contractor.

2.3 The resolution of such comments on the PQP submission to the satisfaction of the Employer and the subsequent acceptance of the PQP by the Employer shall constitute a Hold Point on the commencement of any permanent Works under the Contract.

2.4 System Element Procedures

2.4.1 Quality System Procedures shall be prepared to meet the requirements of Employer’s Quality Plan. These Procedures and Instructions shall be submitted to the Employer for approval 14 days prior to the commencement of the relevant activity.

2.5 Hold Points & Witness Points

2.5.1 Hold Points are those points beyond which the work may not proceed without review and comment by the Employer.

2.5.2 Witness Points are those points beyond which the work may not proceed without approval of the Employer.

2.5.3 As a minimum requirement, the specified Hold Points shall be included in the Inspection and Test Plans where identified in the technical Clauses of the Specification by the words “to the approval of the Employer”, “Employer for Approval”, “and “agreement of the Employer” or similar.

2.5.4 The Employer may nominate additional Witness and Hold Points in the Contractor's Inspection and Test Plans.

2.5.5 Where Hold Points are nominated, no work shall proceed unless agreed by the Employer.

2.5.6 For avoidance of doubt, the review by the Employer of any Hold Point or Witness Point will not relieve the Contractor of any responsibility for the satisfactory execution or performance of the work that is the subject of the review.

2.6 Documentation

2.6.1 In addition to the documentation required by ISO 9001, copies of all relevant Codes of Practice, Test Methods and Standards referred shall be kept on Site.

2.7 Inspection and Test Plans (ITPs)

2.7.1 Inspection and Test Plans (ITP’s) shall be prepared for each of all on- site and off-site construction activities/processes for which the Contract requires inspections of test to be performed. ITPs shall describe all inspections and tests required, the criteria for acceptance and the person in charge and responsible for each inspection or test. ITPs shall note any Hold Points or Witness Points that require the Employer’s approval or presence.

2.7.2 Proforma ITPs shall be submitted to the Employer for review and approval within14 days (unless specified otherwise) before the subject operation/activity is first undertaken. Operations which are subject to inspection or test shall not commence until the relevant ITP is accepted by the Employer.

2.7.3 The ITPs shall cover all inspection and testing required by the Contract and shall include surveying and measuring verification processes, as well as sampling procedures. All quality control laboratory tests shall be performed in accordance with the relevant Indian or other standards approved in writing by the Employer for the relevant test. Test reports shall be certified by an approved signatory.

2.7.4 The ITPs shall clearly state the times within which each activity will be completed. All test reports shall be made available immediately on its receipt. Failure to produce satisfactory test reports within the specified time may be

considered to demonstrate that the work to which the test report relates is unsatisfactory, and remedial work may be ordered to be undertaken forthwith.

2.8 Sampling and Testing

2.8.1 All sampling and testing required by the Contract or instructed by the Employer shall be carried out only by such independent commercial testing facilities as may be approved by the Employer.

2.8.2 The Contractor shall submit to the Employer the name(s) of the independent commercial testing facilities that are proposed. The submission shall contain such data as is necessary to fully demonstrate to the Employer that (each) such testing facility is adequately equipped, supervised and staffed and has relevant previous experience. The testing facility shall obtain the accreditation from the National Accreditation Board for Testing and Calibration Laboratories (NABL) for the relevant tests unless otherwise approved by the Employer, and where appropriate, shall be on a list approved by the relevant Authorities. The Contractor's submission shall also include the lists of sampling and tests proposed to be undertaken by the testing facility (or facilities) together with a statement for each test regarding whether it is to be executed at the testing facility or elsewhere (including on Site). In the latter case, and for all sampling, attendance of personnel from the testing facility shall be provided during the sampling and/or execution of the test. Once any testing facility has been approved in writing by the Employer, it shall be appointed by the Contractor and then will be termed an Approved Laboratory for the tests listed within such approval.

2.8.3 The Contractor may propose to undertake testing at the Field Laboratory on Site, provided these meet all the above requirements, and in particular that the testing facility is operated, managed and staffed by independent commercial testing company. Should the Employer at any time be dissatisfied with the quality of testing carried out at the testing facilities established on Site, he may require such tests to be performed at a permanent independent commercial testing facility away from the Site until such time as the Contractor can demonstrate to the Employer‘s satisfaction that the necessary improvements have been made at the testing facilities on Site.

2.8.4 Should the Contractor have reasonable cause to change testing facilities, he may propose an acceptable alternative to the Employer. Should the Employer at any time have reasonable cause to be dissatisfied with the performance of any Approved Laboratory, he will so inform the Contractor who shall propose an acceptable alternative independent testing facility. In either case, after receiving written approval of the new testing facility (and upon completion of any test or series of tests already committed) the Contractor shall make the necessary change in appointment. Costs, if any, of or associated with any such change shall be borne by the Contractor.

2.8.5 The management of each Approved Laboratory shall nominate in writing the person or persons who are authorized by them to sign test reports, and a copy of this authorization shall be sent to the Employer. No test report shall be accepted by the Employer as valid without the signature of a person whom the Employer has been informed in writing, is so authorized to sign test reports from that Approved Laboratory.

2.8.6 Where tests or other samples are required to be made, prepared or selected, such work as is necessary to cut or otherwise make or prepare the selected specimen(s) shall be executed by the Contractor under the supervision of the Approved Laboratory unless specifically agreed otherwise by the Employer. If any test or sample preparation, making or selection proceeds without such supervision they shall not be accepted and the work re-executed. The Employer shall be notified prior to the carrying out of such work so that he can be present. The Employer may also instruct that the Contractor carry out additional sampling or testing in order to verify that the requirements of the Contract are being met.

2.8.7 The Employer shall reserve the right to carry out his own independent sampling and testing for the purposes of cross–checking and verification of the Contractor's sampling and testing. The Contractor shall provide all reasonable access to the Works for the Employer to carry out such independent sampling and testing. Where the findings of the Employer's independent sampling and testing indicate a non-conformance with the Contract Requirements, the Contractor shall immediately raise a Non-Conformance Report covering the work represented by the non-conforming results.

2.8.8 Any additional sampling or testing related to replacement of damaged or lost samples, to the methods of working or construction, to previously failed tests or any other cause whatsoever, shall be executed by an Approved Laboratory.

2.8.9 The Contractor shall clearly identify methods of sampling and testing and the party or parties responsible in the ITPs for the relevant construction activity.

2.9 Storage of Samples

2.9.1 Where samples are required by the Contract, the Contractor shall provide and maintain a suitable facility or facilities to temporarily store such samples on Site. The samples shall be kept as long as the Employer requires, and then taken to an Approved Laboratory for testing and/or disposed of, by the Contractor.

2.10 Inspection

2.10.1 The Contractor shall provide the Employer with access to all laboratories and other facilities used for quality control tests such that it can be verified that the specified requirements are being met.

2.11 Identification and Traceability

2.11.1 All test samples shall be marked with a unique reference and in a manner such that the reference will not be erased or otherwise lost prior to testing. Should it

not be appropriate for the samples to be immediately collected by the Approved Laboratory, the Contractor shall deliver them to an approved sample store(s) on Site. Such sample store(s) shall be provided and maintained by the Contractor. The Contractor shall provide and maintain within the sample store(s), all necessary racks and/or equipment and keep them in good repair.

2.11.2 All quality records shall be traceable from the Inspection and Test Procedures to the deliverable set.

2.12 Records

2.12.1 The Contractor shall generate quality records covering all construction / execution activities.

2.12.2 Conformance records shall be stored and maintained such that they are readily retrievable in facilities that provide a suitable environment to minimize deterioration or damage, and to prevent loss. Records shall be retained progressively and handed over completely, within four weeks of the issue of the Taking-over Certificate for the completed Works.

2.12.3 Conformance records shall be available at all reasonable times, and copies provided within 24 hours of receipt of the test results.

2.13 Non-conformance

2.13.1 The Contractor shall notify the Employer of any product or service non-conformance. Notification shall be submitted as Non-Conformance Reports (NCR) and shall indicate the proposed method of rectification and shall be subject to acceptance by the Employer. Additionally, the Employer may require the Contractor to raise an NCR for any work that is in the opinion of the Employer not in conformance to the requirements of the Contract. The Contractor shall prepare Standard forms for use as Non-Conformance Reports; the format of these forms shall be agreed with the Employer prior to the Works.

2.13.2 Work which is the subject of a Non-conformance Report shall not be covered prior to inspection and agreement with the Employer.

2.14 Surveillance and Audit

2.14.1 The Employer, or his representative, shall carry out Quality Surveillance and Audits (scheduled and unscheduled) to ensure conformance to the requirements of the Contract. These will involve system element audits, product and service audits, and process and technical procedure audits.

2.14.2 The audits to be undertaken will be in addition to the Contractor's audits and will not relieve the Contractor of its responsibilities under the Contract. The Employer will carry out audits in accordance with ISO 19011:2011 at times to be determined by the Employer. The Contractor will be given at least five (05) days' notice that a quality audit is to be carried out. The Contractor shall provide or

arrange to be available all necessary facilities, documents etc. including Sub Contractors etc. for audits.

2.15 Sub Contractors

2.15.1 The Contractor shall be fully responsible for integrating all Sub Contractors' Quality Systems into its own Quality System or alternatively for arranging for the Sub Contractor to work within a Quality system developed and provided by the Contractor.

2.15.2 The Contractor shall be the single point of responsibility for the production, implementation and auditing of the Quality System required under the Contract.

E TEMPORARY FACILITIES AND CONTROLS

1 CONTRACTOR'S SITE ESTABLISHMENT PLAN

1.1 The Contractor shall submit his own Site Establishment Plan to the Employer for approval at least seven (07) days prior to the commencement of any site establishment, temporary or any other Works under the Contract.

1.2 This submission shall include confirmation of the Contractor's intended date for the commencement of site establishment and any other site work.

1.3 The Contractor's Site Establishment Plan shall include details of the proposed facilities including but not limited to the following items:

(a) General layout of site fencing (3 m high fencing), site access points, stacking and storage of construction material, other security arrangements;

(b) General layout of construction facilities including the Contractor's field offices, sheds, sanitary and first aid facilities, Field Laboratory and CoPT's office.

(c) Details of arrangements for emergency access/egress and evacuation points;

(d) General layout of work areas, casting yards, crushing yard, fabrication or coating workshops, if Contractor's Work Plan defines onshore casting/crushing/fabrication/coating;

(e) Dust protection measures from adjacent bulk stockpiles of materials; and;

(f) All other details relating to the site establishment as required under the Contract or by any relevant authority.

1.4 The approval of the Site Establishment Plan by the Employer shall constitute a Hold Point on the commencement of site establishment, temporary or any other Works under the Contract.

1.5 Any request by the Contractor to change the agreed proposals shall be subject to the agreement of the Employer.

2 TEMPORARY UTILITIES

2.1 It is the responsibility of the Contractor to arrange and obtain permission from the relevant Authorities for the installation, connection and disconnection of temporary services and utilities such as power, water, and any other services the Contractor deems necessary to execute the Works. The Contractor shall be responsible for all costs associated with the supply of these services.

2.2 The Contractor shall install, maintain and pay for such services like water and power and any other facility/service required for the construction of Works. The Contractor shall lay cables/pipelines from nearest connection points up to the Site at his own cost. In case of the realignment of utilities due to the construction

constraints, the same shall be carried out by the Contractor at this own cost and nothing extra shall be payable on this account.

2.3 The Employer at its own discretion may provide LT power supply and drinking water provision from the nearest point for construction purpose subject to availability as per the Port's tariff prevailing from time to time.

2.4 All temporary services shall be removed and made good on completion of the Works, as per the directions of the Employer.

3 CONSTRUCTION FACILITIES

3.1 Contractor's Site Compound

3.1.1 The entire Contractor's Site Compound (with 3 m high fencing) including Contractor's site offices, sanitary and first aid facilities, car parking, field laboratory, security facilities, and Employer's Field Offices and the like shall be confined within the area designated for the Contractor's site establishment as instructed by the Employer.

3.1.2 The Contractor shall take all necessary measures to reduce dust from adjacent areas, including from bulk stockpiles and crushing yard by means of barriers or other suitable systems. Special precautions are to be taken during the monsoon period taking into account the prevailing wind directions.

3.1.3 The Contractor shall submit the proposed location and layout of the Contractor's Site Compound to the Employer for approval as part of his Site Establishment Plan.

3.2 Sanitary Facilities

3.2.1 The Contractor shall provide and maintain to the satisfaction of the Employer, sufficient sanitary facilities and ablutions for all personnel engaged on the Works who shall use these provided facilities exclusively. The Contractor shall be responsible for arranging for the proposed handling and disposal of sewage from the site and for obtaining all required permissions from the relevant authorities.

3.2.2 No sewage or effluent shall be discharged into any river, creek, backwaters or the waters of the sea or navigation channels. Sewage should be treated so as to achieve the required standards prescribed by the applicable regulatory agencies and reused/recycled within the Works to the extent feasible.

3.3 Provision of Field Laboratory

3.3.1 The Contractor shall submit the details of the Site Laboratory to be set up by him for the successful completion of the Work. The Contractor shall obtain the approval of Employer prior to commencement of such laboratory set up.

3.3.2 The laboratory shall be equipped with the required testing equipment. The testing equipment shall be calibrated as per QA Plan of the Contractor.

3.3.3 The Contractor is encouraged to use the approved construction material testing laboratories located in Kochi for fulfilling the testing requirements on day to day basis required under the Contract for site control on the quality of materials and the Works. In case the contractor sets up his own laboratory at site.

3.3.4 The Contractor shall be responsible for all aspects of maintenance and operation of the Laboratories, including all associated costs with purchase, delivery, erection, calibration of equipment, operation, including sampling, storage, curing and testing of materials, periodic re-calibration of equipment, supply of consumables, recording and submitting test results to the Employer and removal on completion of the Works.

3.3.5 The field laboratory shall be provided with equipment including but not limited to the following:

3.3.5.1 General:

(a)	Oven - Electrically operated, thermostatically controlled range upto 200 ^{0}C sensitivity 1^{0}C	1 No.
(b)	Platform balance 300 kg capacity	1 No.
(c)	Balance 20 kg capacity- self indicating type	1 No.
(d)	Electronic Balance 5 kg capacity accuracy 0.5 gm	1 No.
(e)	Water bath - electrically operated and thermostatically controlled with adjustable shelves, sensitivity 1^{0}c	1 No.
(f)	Thermometers: Mercury-in-glass thermometer range 0^{0}c to 250^{0}c Mercury-in-steel thermometer with 30cm stem, range upto 300^{0}c	2 Nos.
(g)	Gas stove or electric hot plate	1 No.
(h)	Glassware, spatulas, wire gauzes, steel scales, measuring tape, casseroles, karahis, enameled trays of assorted sizes, pestle-mortar, porcelain dishes, gunny bags, plastic bags, chemicals, digging tools like pickaxes, shovels etc.	As required
(i)	Set of IS sieves with lid and pan: 450mm diameter: 106mm, 75.0mm, 63mm, 53mm, 37.5mm, 26.5mm, 19.0mm, 13.2mm, 9.5mm, 6.7mm, and 4.75mm size 200mm diameter: 2.36mm, 2.0mm, 1.18mm, 600-micron, 425-micron, 300 micron,150 micron, and 75 microns	 1 set 1 set
(j)	Water testing kit	1 set
(k)	First aid box	1 set

3.3.5.2 For soils and stones:

(a)	Riffle Box	1 No.
(b)	Atterberg Limits (liquid and plastic limits) determination Apparatus	1 set
(c)	Compaction Test Equipment both 2.5 kg and 4.5 kg rammers (Light and Heavy compactive efforts)	1 set
(d)	Dry Bulk Density Test apparatus (sand pouring cylinder, tray, can etc.) complete	1 set
(e)	Speedy Moisture Meter complete with chemicals	1 set
(f)	Post-hole Auger with extensions	1 set
(g)	Core cutter apparatus 10 cm dia, 10/15 cm height, complete with dolly, rammer etc.	1 set
(h)	Aggregate Impact Value Test apparatus/Los Angeles Abrasion Test apparatus	1 set
(i)	Flakiness and Elongation Test Gauges	1 set
(j)	Standard measures of 30, 15 and 3 liters capacity along with standard tamping rod	1 set
(k)	California Bearing Ratio test apparatus	1 set

3.3.5.3 For Cement & Cement Concrete:

(a)	Vicat apparatus for testing setting times	1 Set
(b)	Slump testing apparatus	2 sets
(c)	Compression and Flexural strength testing machine of 200-ton capacity with additional dial for flexural testing	1 No.

3.4 Provision of Employer's Office

The Contractor shall provide and maintain a separate fully furnished office accommodation measuring a minimum of 60m^2 with toilet facilities for the sole use of the Employer and the supervisory staff of the Employer during the entire period of contract including extended period. The Employer's Office shall be located in such a location and position as directed by the Employer. Arrangements for fresh water supply and power supply to the office building shall be made by the contractor. Necessary fans and lights shall be provided. In case the contractor proposes to provide Porta cabins for site office accommodation it shall be air-conditioned. On completion of the work, the office accommodation provided by the contractor including furniture and all office equipments shall be disposed off by the contractor on AS IS WHERE IS basis.

3.4.1 The Contractor shall provide the Employer's Office (fully furnished and operational) within 1 (One) month of the Contract Commencement Date.

3.4.2 The complete establishment of the Employer's Office to be provided by the Contractor to the satisfaction of the Employer shall constitute a Hold Point on the commencement of any permanent Works on site under the Contract. The Employer's Office shall be provided and maintained until 28 days after the issue of the Taking-Over Certificate for the complete Works.

3.5 Assistance to the Employer

3.5.1 The Contractor shall allow for the provision of labourers to assist the Employer, if and when required throughout the Works.

3.5.2 The Contractor shall provide and maintain one (01) number four wheeled drive along with Driver, air-conditioned vehicle with year of Registration not later than 2015, (Mahindra XUV500 make or equivalent), to accommodate 5-6 people, and for the exclusive use of the Employer.

3.5.3 The vehicle shall be equipped with fire extinguisher and first aid kits. The vehicle shall be fitted with seatbelts for the driver and all passengers as well as any other safety equipment as may be required under the prevailing local, port and Contractor's site regulations. Vehicle to be provided shall be of atleast 2019 make and maximum running of vehicle will be about 1,200 km/ month.

3.5.4 The proposed make, model and condition of the vehicle shall be subject to the approval of the Employer.

3.5.5 The Contractor shall provide the specified Employer's Vehicle within 28 days of the Contract Commencement Date or at least 07 days prior to the commencement of any site establishment, temporary Works or any other site Works under the Contract, whichever is earlier. The vehicle shall be provided and maintained until 28 days after the issue of the Taking-Over Certificate for the complete Works.

3.5.6 A vehicle shall be replaced with a new vehicle after its maximum run of 100,000 km or five years of manufacture, whichever is earlier. All necessary taxes for operating the vehicle shall be fully paid and all necessary papers shall be provided as required by prevailing Motor Vehicle Act with comprehensive insurance cover for the vehicle. The Contractor shall also make available drivers having valid license at such times and for such duration as instructed by the Employer.

3.5.7 The vehicle shall be maintained in a reasonable smooth-running condition. All expenses required for keeping the vehicle in smooth running condition such as fuel, lubrication oil and other consumables, necessary service and maintenance, drivers, repairs and replacement etc. shall be met by the Contractor. In the event of any vehicle being off the road for maintenance or on account of breakdown, the Contractor shall provide equivalent substitute vehicle(s) immediately.

3.5.8 If the Contract Works are not completed within the stipulated period or within the granted extended time of completion, provision and maintenance of vehicle shall be carried out by the Contractor at his own cost and no payment shall be made for the same.

3.5.9 The Contractor shall provide and maintain Personal Protective equipment (PPE)as may be required by the Employer for inspection of the works.

3.6 Provision for Security Operation

3.6.1 The Contractor shall be responsible for physical security of the assets and persons at his Work Site. The security personnel deployment shall be carried out based on the requirement. The security posture shall consist of security processes, guarding manpower and technology control which shall be decided in consultation with the Employer.

3.6.2 The security guards shall be deployed at a calculation of 2% of the total work force of the Contractor for managing security operation of the Work Site. All compliances need for manpower deployment shall be followed by the Contractor. All supervisory control shall remain with the Employer.

4 CONTRACTOR'S SITE ACCESS MANAGEMENT PLAN

4.1.1 The Contractor shall submit his Site Access Management Plan to the Employer for approval at least 07 days prior to the commencement of any site establishment, temporary or any other Works under the Contract. The Contractor shall follow the overall Project Site Management Plan. Contractor's Site Access Management Plan will be reviewed and approved by the Employer.

4.1.2 The Contractor's Site Access Management Plan shall include figures or drawings and accompanying notes detailing the proposed site traffic management Works (subject to the further requirements of this section of the Specification) including but not limited to the following items:

(a) General methodology and route for accessing Site;

(b) Arrangement and approximate timing for the delivery of materials and equipment throughout the course of the Works as well as any special arrangements or controls for mobilisation of oversize plant or delivery of oversize equipment;

(c) Labour timing;

(d) Proposed internal construction traffic controls (signage, line-marking, signals etc.) both for internal site roads and at interfaces with existing external roads;

(e) Any proposed temporary traffic controls for existing external roads that may be necessary from time to time to facilitate delivery of materials or equipment to site or any other Works on such roads; and

(f) Arrangement for marine access to marine construction work and Site Portions including navigational arrangement, temporary aids to navigation, anchoring and mooring arrangement.

4.1.3 The Contractor shall prepare the Site Access Management Plan with a view to minimizing interference with existing traffic (both landside road traffic and marine traffic and shipping) to and from the existing facilities in the vicinity of the site. All vehicles or marine craft using the existing public roads/ waters external to the site shall comply with the prevailing local and port rules and regulations as well as the requirements of any other relevant authorities.

4.1.4 The Site Access Management Plan shall identify such facilities as are necessary to ensure that construction dust and debris is not carried onto the existing port/Naval roads, thoroughfares or adjoining properties by vehicles leaving the site. Any damage or disturbance caused by vehicles leaving the site shall be rectified immediately by the Contractor to the satisfaction of the Employer.

4.1.5 The approval of the Site Access Management Plan by the Employer shall constitute a Hold Point on the commencement of site establishment, temporary or any other Site Works under the Contract as well as mobilization of plant and delivery of any materials or equipment to the site.

4.1.6 Any request by the Contractor to change the agreed proposals shall be subject to the agreement of the Employer.

4.2 Following shall be considered regarding the access to Project Site:

(a) Security clearances: Security clearances for personnel, vehicles, equipment for entry into Port premises shall be provided by Cochin Port Trust (CoPT) on best effort basis. Details of manpower to be employed shall be provided to CoPT at least six working days in advance. Application shall include complete details of personnel, photographs, UID No., permanent address, contact numbers and shall mandatorily contain police verification certificates. CoPT shall have the right to undertake photography of personnel employed and undertake physical/electronic search / frisking of body and equipment / materials / cargo.

(b) Security against Items or Damage: The Contractor shall be responsible for safety of his stores / items / works. The Employer will not be responsible for the Contractor's stores / items / works.

(c) Entry / Exit: The entry / exit shall be as per the existing provisions in force and as amended from time to time. The gates for entry / exit will be specified by the Station Commander. A separate register shall be implemented / maintained by the Contractor for movement of personnel and materials at the security gates. The data should be made available to the Employer / IN on a regular basis.

(d) Identity Cards or Passes: The issuance of passes for personnel would be as per the existing provisions, as amended from time to time.

5 TEMPORARY BARRIERS AND ENCLOSURES

5.1 The Contractor shall maintain fencing, employ watchmen and any other measures necessary so as to maintain the security of the Field Office, Work Site,

and all other facilities related with this Contract, at all times pursuant to the requirements of the Conditions of Contract.

5.2 Temporary fencing shall be installed and maintained by the Contractor for the security of plant, equipment and materials used in connection with the Works.

5.3 The temporary fence shall be completed as soon as practical following initial Possession of the Site and removed immediately prior to issue of the Taking-Over Certificate for the Works (or part thereof).

5.4 It remains the responsibility of the Contractor to establish the type of fencing that the Contractor requires to separate the construction area from public areas, other sites and port/Naval operational areas and to provide the level of site security/safety the Contractor deems necessary for the site and work areas. A view cutter of 3m height is required to be installed on the periphery of the work areas.

5.5 Construction work shall be confined to areas within the fenced construction site area except with the written approval of the Employer.

6 PROJECT INFORMATION SIGN BOARD

6.1 The Contractor shall erect two signboards at prominent locations on the Site to identify the site to occasional visitors. The size, layout and location of the signboards shall be agreed with the Employer.

6.2 The Contractor shall not erect within or near the site or elsewhere on the Employer's land any sign or notice board without prior approval, except safety signs.

6.3 The Contractor shall dismantle, remove and dispose of all such signs off site upon issue of the Taking-Over Certificate for the Works.

F PRODUCT/ MATERIALS REQUIREMENTS

1 COMMON REQUIREMENTS

1.1 General

1.1.1 Materials to be used in the Work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these Specifications.

1.1.2 Only new products, materials or equipment shall be supplied for use in the permanent Works. Pre-owned or pre-used products, materials or equipment shall not be supplied unless specifically accepted in writing by the Employer.

1.1.3 Products, materials and equipment to be incorporated in the permanent Works shall not be used in any temporary Works prior to their incorporation into the permanent Works unless specifically accepted in writing by the Employer.

1.1.4 If any material, not covered in these Specifications, is required to be used in the Work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Employer.

1.2 Approval of Manufacturers and Suppliers

1.2.1 The Contractor shall submit details of the proposed source, manufacturer or supplier of all products, materials or equipment to be used in the permanent Works to the Employer for approval. The details to be submitted by the Contractor shall include but not be limited to the following:;

(a) Name of the product, material or equipment to which the submission relates including reference to relevant sections of the Contract Documents;

(b) Name of the proposed source, manufacturer or supplier; Certificates, test results or any other information or evidence demonstrating that the proposed product, material or equipment confirms to the requirements of the Contract;

(c) Declaration that the product, material or equipment shall be supplied in accordance with the requirements of the Contract including all specified markings and certificates;

(d) Instructions or directions for the handling, storage or usage of the product, material or equipment from the source, manufacturer or supplier;

(e) Any other relevant technical details as may be required under the Contract or by the Employer.

1.3 The Contractor shall submit such details to the Employer for approval at least 14 days prior to placing orders for the subject product, materials or equipment. The approval of the submission by the Employer shall constitute a Hold Point on the delivery of the subject product, materials or equipment to site. Irrespective of any such approval, the Contractor shall remain responsible for the quality and

conformance of the subject product, material or equipment to the requirements of the Contract.

1.4 Once approved, sources shall not be changed without the written approval of the Employer. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from other sources at his own expense.

1.5 Samples

1.5.1 Where required by the Employer, the Contractor shall at his own expense, submit to the Employer for approval, samples of any of the materials and components to be used in the Contract Works. The quality of materials and components to be used in the Works shall not be inferior to the approved samples.

1.5.2 Aggregates from the quarries shall be submitted by the Contractor to the Employer at no extra cost.

1.5.3 SamplesprovidedtotheEmployerorhisrepresentativefortheirretention are to be in labelled boxes suitable for storage.

1.5.4 Samples required for approval and testing must be supplied well in advance at least 48 hours or minimum period required for carrying out relevant tests to allow for testing and approval.Delay to Works arising from the late submission of samples will not be acceptable as a reason for delay in the completion of the Works.

1.5.5 If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall have to be borne by the Contractor.

1.6 Alternatives or Equivalents

1.6.1 In all cases where the name of a particular type or make of material, product, equipment or item is referred to in the Contract, this indicates the minimum acceptable standard. The Contractor may offer equipment or materials other than those specified and in all such cases, the Contractor's offer shall be of at least equal quality. The same shall apply where the words "or approved equivalent" are used.

1.6.2 In these instances, the Contractor shall submit to the Employer for approval, a statement detailing the alternative material or equipment and shall include full technical descriptions, drawings and specifications and shall provide such further information as is required to demonstrate to the Employer that the alternatives are equivalent in every way to those specified.

1.6.3 Acceptance of the Contractor's offered alternatives shall be subject to the acceptance and approval of the Employer who shall not be bound to accept any such offer.

1.7 Delivery, Storage and Handling Requirements

1.7.1 No products, materials or equipment shall be delivered to site until the Contractor has established all traffic and environmental controls on site and has adequate facilities on site for unloading and storage of the products, material and equipment prior to their incorporation into the Works.

1.7.2 All products, materials and equipment delivered to site shall be handled and stored so as to prevent damage or deterioration prior to their incorporation into the permanent Works. All stockpiles and storage stacks shall be maintained by the Contractor in a safe state with sufficient working space provided to permit safe access by the Employer for inspection and checking of the delivered products, materials and equipment.

1.7.3 All proprietary products, materials and equipment used on the Works shall be handled, stored, used, fixed or applied strictly in accordance with the manufacturer's instructions and to the satisfaction of the Employer. The Contractor shall obtain the manufacturer's instructions in this regard at the time of ordering and shall submit to the Employer along with his submission of the proposed source.

2 TESTS AND STANDARD OF ACCEPTANCE

2.1 General

2.1.1 All materials, even though stored in an approved manner, shall be subjected to an acceptance test prior to their immediate use.

2.1.2 Independent testing of cement for every consignment shall be done by the Contractor at site in the laboratory approved by the Employer before use. Any cement with lower quality than those shown in manufacturer's certificate shall be debarred from use. In case of imported cement, the same series of tests shall be carried out before acceptance.

2.2 Testing and Approval of Material

2.2.1 The Contractor shall furnish test certificates from the manufacturer/supplier of materials along with each batch of material(s) delivered to site.

2.2.2 The Contractor shall be responsible or testing of all materials, finished products used in the construction as per requirements of Conditions of Contract and the relevant Specifications. The testing of all the materials shall be carried out by the Employer or his representative for whom the Contractor shall make all the necessary arrangements and bear the entire cost.

2.2.3 Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's expense at any recognised laboratory/testing establishments in India or abroad, as approved by the Employer. All necessary cost for witnessing the test by Employer's representative shall have to be borne by the Contractor.

2.3 Rejection of Materials not conforming to the Specifications

2.3.1 Any stack or batch of material(s) of which sample(s) do not conform to the prescribed tests and quality, shall be rejected by the Employer, or his representative, and such materials shall be removed from site by the Contractor at his own cost. Such rejected materials shall not be made acceptable by any modifications.

2.4 Testing and Approval of Plant and Equipment

2.4.1 All plant and equipment used for preparing, testing and production of materials for incorporation into the permanent Works shall be in accordance with manufacturer's specifications and shall be got approved by the Employer before use.

G PROJECT EXECUTION

1 EXAMINATION AND PREPARATION

1.1 Construction Work Method Statements

1.1.1 In addition to the submission of the Detailed Construction Sequence and Methodology as defined in this Section, the Contractor shall submit separate individual Construction Work Method Statements (CWMS) detailing the sequence and method of working he intends to adopt for various items of works. The CWMS shall be consistent with the overall Detailed Construction Sequence and Methodology and shall comply with any additional construction sequence or phasing requirements nominated on the Drawings and/or elsewhere in this Specification. The purpose of the CWMS is to aid the planning and integration of activities and correct technical execution of the Works within the requirements of the Contract. In this regard, it shall be written such that it can be understood completely by the labour and supervisory personnel responsible for the Works.

1.1.2 The CWMS shall provide detailed information regarding materials, equipment and plant to be utilized, labour requirements, time frame and schedule of the Works including Authorized Subcontractors, prerequisite conditions, details and order of activities for each operation, safety measures, environmental controls and any other relevant technical aspects including those detailed elsewhere in the Specification or Drawings.

1.1.3 The CWMS shall be consistent with the requirements of the approved Project Quality Plan and shall include a description of testing and inspection records, reporting channels (including names of responsible supervisory personnel) and frequency and actions where records indicate non-conformance with the Specification. The relevant agreed ITPs for the subject Works shall be appended to the CWMS for easy reference.

1.1.4 Proposed repair methods for the rectification of any anticipated minor defects or damage shall also be appended to the CWMS.

1.1.5 Where any construction activity includes an interface with either the existing operations, or with an associated contract, the CWMS shall also include the procedures to be followed by his staff and equipment for the management of such interfaces.

1.1.6 Unless specifically noted otherwise in the relevant sections of this Specification, the Contractor shall submit the proposed CWMS to the Employer for approval at least 21 days prior to the intended date for first commencement of the construction Works to which the CWMS relate. The Employer will take maximum 14 days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

1.1.7 The resolution of such comments on the CWMS submission will be to the satisfaction of the Employer and the Employers subsequent approval of the

CWMS shall constitute a Hold Point on the commencement of the Works to which the CWMS relates.

1.1.8 Examination and/or approval by the Employer of the CWMS submitted by the Contractor shall not relieve the Contractor of his responsibilities or liabilities under the Contract. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor will remain with the Contractor, irrespective of any approval given by the Employer.

1.1.9 The Contractor shall be responsible for issuing copies of the approved CWMS to the relevant Works personnel and supervisory staff to ensure that they are fully familiar with the CWMS.

1.1.10 Notwithstanding any approval of the CWMS, the Employer shall reserve the right to require further amendment or modification of the CWMS in the event that additional issues are observed on site following commencement of the construction Works to which the CWMS relates. Similarly, the Contractor is free to propose further amendment or modification to the CMWS subject to the approval of the Employer.

1.2 Survey and Layout Data

1.2.1 Levels shall be set out to Port's Chart Datum (CD), which is 0.582 m below AMSL. Coordinates are based on the Indian Geodetic Datum survey grid system as adopted from the Survey of India.

1.2.2 The Reference Bench Mark for the area shall be obtained by the Contractor from the Employer. The Contractor shall establish working Bench Marks tied with the Reference Bench Mark in the area soon after taking possession of the site.

1.2.3 Throughout the duration of the Works, the Contractor shall be responsible for the establishment, maintenance and protection of suitable permanent and temporary benchmarks and control points for the setting out of the Works and for the correctness of all such setting out.

1.2.4 The Contractor shall provide sufficient permanent survey marks to properly set out the Works and shall take all necessary precautions to prevent these marks from being disturbed. The working Bench Marks/levels shall be as approved by the Employer. Checks must be made on these Bench Marks at least once every month and adjustments, if any, agreed with the Employer and recorded. An up-to-date record of all Bench Marks including approved adjustments, if any, shall be maintained by the Contractor and also a copy supplied to the Employer for his record.

1.3 Structures Condition Survey

1.3.1 Prior to commencement of any construction Works in the vicinity of any structure owned or operated by the Employer/Government property or privately owned property, the Contractor shall undertake a Condition Survey of the in-situ

position and condition of all area likely to be impacted by the Contractor's Works. The Condition Survey shall be carried out by suitably qualified persons approved by the Employer and it shall be capable of audit by third parties.

1.3.2 The Condition Surveys shall include all parts of the structure and surrounds likely to be impacted by the Contractor's operations and shall be subject to agreement with the Employer.

2 DAMAGE TO EXISTING STRUCTURES

2.1 If, in the sole opinion of the Employer, the Contractor has caused damage to any part of an existing structure by unloading or loading or any other operations, the Contractor shall be responsible for carrying out repairs to the structure to the satisfaction of the Employer/relevant authority.

2.2 All costs and expenses associated with the repairs to such damage or the replacement of damaged parts shall be at the cost of Contractor.

3 EXISTING UTILITIES AND SERVICES

3.1 All information regarding the existing or future utilities and services shown on the Drawings has been obtained and/or reproduced from various sources and is for indication only. The Contractor shall be responsible for making his own assessment of the exact details, lines, levels, nature, type, size, location and all other matters of relevance to the existing utilities and services at the site prior to commencement of any site Works.

3.2 Any unidentified services uncovered by the Contractor shall be immediately brought to the attention of the Employer.

3.3 The information on affected services and utilities may not be exhaustive and the final position of these services within the Works shall have to be drawn up based on the information furnished by different authorities linked with the utilities as directed by the Employer. The Contractor's programme must take into account the period of notice and duration of diversion work concerning each authority as given on the Drawings and the Contractor must also allow for any effect of these services and alterations upon the Works and for arranging regular meetings with the various authorities on commencement of the Contract and throughout the period of the Works in order to maintain the required co-ordination. During the period of the Works, the Contractor shall have no objection if the public utility bodies / authorities vary their decisions in the execution of their proposals in terms of programme and construction, provided that, in the opinion of the Employer, the Contractor has received reasonable notice thereof before the relevant alterations are put into operation.

3.4 The Contractor shall take every precaution to avoid damage to existing utilities and services at the site. No clearance or alterations of utilities or services shall be carried out unless specifically ordered by the Employer.

3.5 Any services affected by the Works must be temporarily supported by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the Works. The work of temporarily supporting and protecting the public utility services during execution of the Works shall be deemed to be part of the Contract and no extra payment shall be made for the same.

3.6 The Contractor may be required to carry out the removal or shifting of certain service/utilities on specific orders from the Employer. Such work shall be taken up by the Contractor only after obtaining clearance from the Employer and ensuring adequate safety measures.

4 EXECUTION

4.1 General

4.1.1 In every case, the Works shall be carried out to the satisfaction of the Employer and conform to the location, lines, dimensions, grades and cross-sections shown on the drawings or as indicated by the Employer. The quality of materials, processing of materials as may be needed at the site, salient features of the construction work and quality of finished work shall comply with the requirements set forth in succeeding sections of this Specification.

4.2 Radio Communications

4.2.1 Any radio frequencies proposed for use by the Contractor for site communications shall be subject to the approval of the Employer or relevant Authority. The Contractor shall be responsible for arranging all permits and licences required for the operation of radio equipment throughout the Works.

4.3 Construction Plant and Equipment

4.3.1 In addition to the general conditions indicated in the Contract Documents, the following conditions regarding use of equipment in executing the works shall be satisfied:

(a) The Contractor shall be required to give a trial run of the equipment for establishing their capability to achieve the laid down Specifications and tolerances to the satisfaction of the Employer before commencement of the Works;

(b) All equipment provided shall be of proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Employer;

(c) All the plant/equipment to be deployed on the Works shall be approved by the Employer for ensuring their fitness and efficiency before commencement of work;

(d) Any material or equipment not meeting the approval of the Employer shall be removed from the site forthwith;

(e) No equipment shall be removed from site without permission of the Employer; and the Contractor shall also make available the equipment for site quality control work as directed by the Employer;

(f) All equipment shall comply with the environmental requirements set out in this Document; and.

5 MARINE / FLOATING EQUIPMENT

5.1 All crafts used for the Contract shall be registered in accordance with applicable laws/regulations and the masters/operators may themselves require local licences and certificates as required by the Employer and any other applicable regulations. All vessels, working craft and other floating equipment shall display appropriate international and local signals to indicate the nature of their work. All work over water must comply with all relevant regulations of the Kerala State Inland Navigation Corporation/ CoPT.

5.2 Floating equipment shall be maintained in a satisfactory and seaworthy condition and shall have adequate attendance by competent seamen at all times, shall be fully provided with sound and satisfactory ropes, lines and moorings and shall be fully equipped with lights. At all times, the Contractor shall be wholly responsible for the protection and safety of all floating craft engaged by them.

5.3 Where work is carried out from dumb lighters, pontoon or other non-self-propelled floating equipment, a suitably powered craft shall be in attendance at all times.

5.4 All marine craft, pontoons or platforms shall be adequately braced, secured and anchored and of such size and construction as to ensure a satisfactory performance of the Work. The marine craft shall also be fitted out to allow the types of investigation, sampling and in-situ testing required to be carried out to the satisfaction of the Employer. The Contractor shall provide the Employer with adequate assistance for gaining access to the marine crafts, pontoons or platforms.

5.5 Area of temporary anchorage of Contractor's marine craft shall be agreed with the Employer, shall be outside any permanent or temporary navigation channel and shall be clearly marked with marker buoys or other system to the satisfaction of the Harbour Master of Cochin Port Trust.

5.6 All lifesaving, fire equipment, medical facilities shall be maintained as required by relevant code or comparable requirements.

5.7 The originals of all statutory certification including but not limited to the following documentation shall be kept on-board all vessels deployed on the Works:

(a) Certificate of Registry;
(b) Load Line Certificate;
(c) Tonnage Certificate;
(d) Certificate of Class (Hull and Machinery);
(e) Cargo Ship Safety Certificate;

(f) Life Saving Apparatus Certificate;
(g) De-rating Certificate;
(h) Quarantine Certificates for Ballast Water and Hull Cleanliness prior to entering Indian Waters;
(i) Radio Certificate; and
(j) Stability Booklet for loading conditions, as may be foreseen for the Works

5.8 Vessels shall be operated at all times during the Works within the limits of its current Vessel Marine Documentation and Certification.

6 CRANES AND LIFTING EQUIPMENT

6.1 All cranes, lifting equipment and winches shall comply with Indian and Local Government requirements and third-party surveyor requirements, for example Lloyds, B.V., DNV, ABS, and Indian Safety Authority or similar approved.

6.2 Test certificates, maintenance records and the like for all cranes, wires, slings and winches shall be available for inspection by the Employer and for third party audit. Slings for which test certificates are not available shall not be used and shall be removed from site prior to the commencement of the Works.

7 REPAIR METHODS

7.1 The Contractor shall submit to the Employer for approval, details of all proposed repair methods to be employed as may be necessary to rectify any minor defects or incidental damage in elements of the permanent Works.

7.2 Details shall include but not be limited to information on the type and manufacturer of any proprietary products to be used and any specific directions from the manufacturer regarding their use, detailed work methods for affecting the repairs and any other relevant technical information as may be required by the Employer.

7.3 The Contractor shall generally submit these details pre-emptively as part of his CWMS for the relevant construction activity. Where additional or unforeseen repairs are required, the Contractor shall make additional submission as directed by the Employer.

8 CLEANING AND WASTE MANAGEMENT

8.1 Site Maintenance

The Works includes the housekeeping of the Site including but not limited to:

(a) Daily cleaning of the Site including all amenities and facilities supplied by the Contractor to the Employer;
(b) Collection and disposal of all domestic, toxic and hazardous waste, oils, empty drums and other containers, waste timber, asbestos impregnated products all in accordance with all applicable Laws and regulations governing the disposal of these items or materials;
(c) Retrieval of any waste materials deposited on the sea bed by the Contractor;
(d) Collection and storage of all surplus construction material;

(e) Special clean-ups required throughout the monsoon season and tie down Works required for cyclone alerts including any damage preventative measures to both temporary facilities and amenities and to partly or wholly constructed installations and enclosures;
(f) Final clean-up and re-instatement of the Site;
(g) Compliance with all environmental protection requirements.

8.2 Construction Waste Management and Disposal

8.2.1 The Contractor is required to implement procedures for waste minimization to reduce, reuse, recycle and recover as much waste material or reuse as is practical. Waste minimization and segregation shall be exercised during mobilization, installation, execution and demobilization phases of the Works.

8.2.2 The Contractor shall endeavor to minimize waste materials such as equipment consumables, packaging and the like. All scrap generated during construction shall be segregated into components such as glass, paper products, aluminum, steel, rubber, insulation materials, plastics, steel, wood and the like.

8.2.3 All demolished and excavated material, excess building materials and waste, other than material designated to be stockpiled on the site, shall be removed from the Site and disposed of, in a legal manner. No waste shall be disposed in the Coastal Regulation Zone (CRZ) area. All permits and approvals necessary for the removal and disposal of demolition materials shall be obtained in advance. The municipal wastes generated by labour during construction, shall be handled, transported and disposed as per the relevant municipal handling rules.

8.2.4 All unused material shall be removed from site in a progressive manner either by use of a weekly emptied dump hopper or similar removal arrangement. The sellable wastes shall be sold only to the authorized vendors. The Site and surrounds shall be kept tidy at all times.

8.2.5 Plastics and rubber shall not be disposed of by burning and is to be handled and disposed as per the draft plastic rules. Asbestos use shall be minimized and shall be disposed of, in accordance with all relevant regulations. Materials infested by vermin, pests or rot shall be destroyed in a way that will minimize the risk of infecting other materials. Hazardous wastes shall be handled, stored, managed and disposed off, in compliance with the relevant regulations.

8.2.6 The Contractor shall take all precautions to ensure that with the exception of materials that will form part of the Works, no materials of any kind being used or transported to or from the Site fall on adjoining property or public thoroughfares or into the water. Any material or item that does so fall shall be removed as early as practical, to the satisfaction of the Employer.

8.2.7 Construction and demolition (C&D) wastes from this Contract shall remain the property of the Contractor and shall be removed by the Contractor from the Site or adjoining area as applicable to the satisfaction of the Employer. All such work

shall be carried out at the Contractor's own expense for which payment shall be deemed to have been included in the Contract Sum.

8.2.8 If there is any change in the existing rules and the new rules become effective for the construction, transportation, treatment and disposal for municipal, hazardous, C&D, electrical and electronic and plastic wastes, the new rules have to be followed. All such work shall be carried out at the Contractor's own expense for which payment shall be deemed to have been included in the Contract Price.

9 PROTECTING INSTALLED CONSTRUCTION

9.1 The Contractor shall follow procedures and assignments as contained in the Project Site Management Plan and will minimize impact to the ongoing operations wherever possible, or as directed by the Employer.

10 COMPLETION PROCEDURES

10.1 General

10.1.1 Requirements for Tests on Completion, Employer's Taking Over of the Works and Defects Liability shall be as per the requirements of the Conditions of Contract and subject to the additional requirements outlined in this Specification. The additional requirements specified in the following sections shall not be interpreted as limiting the Contractor's responsibilities under Contract in this regard in any way.

10.2 Preliminary Inspection of the Works at Completion

10.2.1 In addition to the requirements of the Contract regarding Tests on Completion, the Contractor shall undertake joint general inspection of the completed Section with the Employer, at least 14 days prior to the Contractor's intended submission of application for a Taking-over Certificate for the Section.

10.2.2 The Contractor shall record any and all defects or omissions identified during the joint inspection including any, that in the sole opinion of the Employer, are required to be rectified prior to the issue of a Taking-Over Certificate and those that may be rectified after issue of the Taking-Over Certificate under Defects Liability.

10.2.3 Following the joint inspection, the Contractor shall submit the agreed Draft List of Defects and Minor Omissions including the agreed disposition with respect to the timing and method of rectification of each to the Employer for approval. The Contractor shall also include on the List any outstanding documentation or administrative requirements under the Contract. The Contractor shall advise the date for rectification of each individual item on the Draft List of Defects and Minor Omissions.

10.2.4 The acceptance of this Draft List of Defects and Minor Omissions by the Employer shall constitute a Hold Point on the submission of application for a Taking-Over Certificate for the Section by the Contractor.

10.3 Inspection of the Works at Completion

10.3.1 Within 7 days following receipt of the Contractor's application for a Taking-Over Certificate for the Section (subject to the requirements above), the Contractor shall undertake a further joint general inspection of the Section with the Employer

10.3.2 This final inspection shall be to confirm that all items previously identified on the Draft List of Defects and Minor Omissions as being required to be rectified prior to issue of the Taking-Over Certificate, have been rectified and to re-confirm the status of the items permitted to be rectified after issue of the Taking-Over Certification for the Works under Defects Liability.

10.3.3 Following the joint inspection, the Contractor shall submit the agreed Final List of Defects and Minor Omissions including the agreed disposition with respect to the timing and method of rectification of each to the Employer for approval.

10.3.4 The acceptance of this Final List of Defects and Minor Omissions by the Employer as well as completion of all Tests on Completion and submission of all other required documentation and submittals per the requirements of the Contract shall constitute a Hold Point on the issuing of the Taking-over Certificate for the Section.

11 SUBMITTALS AT COMPLETION

11.1 Operation and Maintenance Data

11.1.1 The Contractor shall provide a full set of all operations and maintenance manuals as may be required under the Contract in hardcopy (03 No. copies) and electronic PDF format to the Employer prior to submittal of the Contractor's application for a Taking-Over Certificate for the completed Section.

11.1.2 These manuals shall provide sufficient detail for the Employer to operate, maintain, dismantle, reassemble, adjust and repair the Plant/Structure. The wording of all such manuals shall be agreed with the Employer in advance.

11.1.3 A Section shall not be considered to be completed for the purposes of Taking Over as defined in the Conditions of Contract until the Employer has received in the form required by the Contract, final operation and maintenance manuals in such detail, and any other manuals specified in the Specifications and the Drawings for these purposes.

11.2 As-Built Drawings

11.2.1 The Contractor shall prepare, and keep up-to-date, a complete set of "As-Built" records of the execution of the Works, showing the exact as-built locations, sizes and details of the Work as executed. These records shall be kept on the Site and shall not be used by the Contractor for any purpose other than for the purposes of the preparation of the As-Built Drawings in accordance with the requirements of the Contract.

11.2.2 The Contractor shall prepare a full set of As-Built drawings for the whole of the Works based on the Contract Drawings with amendments made to reflect any major changes in set out, design or construction method.

11.2.3 All dimensions, levels and set-out coordinates shall be updated based on the in-survey, progress and As-built surveys undertaken throughout the Works. Additional information on the As-Built pile founding depths and set-out shall be added to the drawings based on the Contract piling records.

11.2.4 The Contractor shall submit the draft As-Built drawings in hardcopy (03 No. A3) and electronic CAD and PDF format to the Employer for approval prior to the submittal of the Contractor's application for a Taking-Over Certificate for the completed Works.

11.2.5 The Contractor shall incorporate all comments and amendments required by the Employer and once agreed, shall submit the final As-Built Drawings in hardcopy (03 No. A3 and 03 No. A1) and electronic CAD and PDF format to the Employer.

11.2.6 The Works shall not be considered to be completed for the purposes of Taking Over as defined in the Conditions of Contract until the Employer has received these documents in the form required by the Contract.

12 WARRANTIES

12.1 The Contractor shall provide a full set of all warranties for products of workmanship as may be required under the Contract in hardcopy (02 No. copies) and electronic original format and PDF format to the Employer prior to submittal of the Contractor's application for a Taking-over Certificate for the completed Section.

12.2 The wording of all such warranties shall be agreed with the Employer and the Employer in advance.

13 PROJECT RECORD DOCUMENTS

13.1 The Contractor shall provide a full set of the Project Quality Records in hardcopy (02 No. copies) and electronic original format and PDF format to the Employer within 28 days of issue of the Taking-Over Certificate for the completed Section.

13.2 The Contractor shall maintain separate volume covering Quality Documentation for any outstanding minor Works carried out under Defects Liability Period. This separate volume shall be submitted to the Employer at least 14 days prior to the expiration of the Contract Defects Liability Period.

VOLUME-II
SECTION 6B
SPECIFICATIONS FOR CIVIL AND MARINE WORKS

TABLE OF CONTENTS

A GENERAL

1 APPLICATION

1.1 These Technical Specifications shall apply to all works as are required to be executed under the Contract unless otherwise directed by the Employer (as defined in the Conditions of Contract).

1.2 The Specifications must be read in conjunction with the Scope of Work, Employer's requirement inter-alia the Design Criteria, Particular Conditions, General Conditions of Contract, Drawings and other documents forming the Contract documents.

B SITE CLEARING AND DEMOLITION

1 GENERAL

1.1 The Section of the Specifications covers the construction requirements for site clearance and demolition works required for the construction of Jetty as shown on the Drawings or as directed by the Employer.

1.2 **Construction Work Method Statement**

1.2.1 The Contractor shall submit a Construction Work Method Statement (CWMS) for all sites clearing and demolition works in accordance with the general requirements specified in General Specifications and incorporating all additional detailed technical requirements as specified in this section.

1.2.2 The Contractor's CWMS shall include details of all proposed safety and environmental controls to be employed in carrying out the works.

1.2.3 The Contractor's CWMS shall include details of procedures and certification/permits to be employed to ensure that all existing services are identified, protected, terminated, isolated or otherwise made safe prior to the commencement of the work.

1.2.4 The Contractor shall submit his CWMS for approval at least 14 days prior to the intended date for first commencement of the site clearance and demolition works. The Employer will take maximum 7 days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

1.2.5 The resolution of such comments on the CWMS submission to the satisfaction of the Employer and the Employer's subsequent approval of the CWMS shall constitute a HOLD POINT on the commencement of site clearance and demolition works.

1.2.6 Only such methods, tools and equipment as are nominated in the Contractors approved CWMS and which will not affect the property to be preserved shall be adopted for the Work.

2 DISCONNECTION AND ISOLATION OF SERVICES

2.1 All existing services affected by the demolition works shall be disconnected, isolated and/or relocated or otherwise made safe prior to commencement of demolition work.

3 CLEARING AND GRUBBING

3.1 Scope

Demolition of existing jetty and damaged approach trestle to the extent required. Removal of piles upto existing bed level to the extent required as detailed elsewhere in the contract.

4 DISPOSAL OF MATERIALS

4.1 All materials arising from clearing and grubbing operations shall be removed from the Site and disposed at South End Reclamation Area about 5km from Project Site. Burning of materials on-site shall not be permitted.

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C MATERIALS FOR CONSTRUCTION – GENERAL REQUIREMENTS

1 GENERAL

1.1 Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these specifications.

1.2 If any material, not covered in these specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Employer.

2 SOURCES OF MATERIAL

2.1 The Contractor shall notify the Employer of his proposed sources of materials prior to delivery. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any other source proves unacceptable at any time, the Contractor shall furnish acceptable material from other sources at his own expense.

3 STORAGE OF MATERIALS

3.1 General

3.1.1 All materials shall be stored at proper places so as to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The storage space must also permit easy inspection, removal and re-storage of the materials. All such materials even though stored in approved godowns/ places, must be subjected to acceptance test prior to their immediate use.

3.2 Aggregates

3.2.1 Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard, levelled and well drained. If necessary, the ground shall be covered with 50 mm plank.

3.2.2 Aggregates placed directly on the ground shall not be removed from the stockpile within 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

3.3 Cement

3.3.1 Cement shall be transported, handled and stored on the site in such a manner so as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and water–tight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.

3.3.2 Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the

works and shall be removed from the site by the Contractor without charge to the Employer.

3.3.3 The Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Employer at all times.

3.3.4 The Contractor shall make a monthly return to the Employer on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

3.4 TMT Reinforcement

3.4.1 The TMT reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms, skids, or other supports with well-drained surface, and shall be protected from mechanical injury and from deterioration by exposure.

3.5 Water

3.5.1 Water shall be stored in containers/tanks covered at top and cleaned at regular intervals in order to prevent intrusion by foreign matter or growth of organic matter. Water from shallow, muddy or marshy surface shall not be permitted. The intake pipe shall be enclosed to exclude silt, mud, grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

4 TESTS AND STANDARD OF ACCEPTANCE

4.1 General

4.1.1 All materials, even though stored in an approved manner shall be subjected to an acceptance test prior to their immediate use.

4.1.2 Independent testing of cement for every consignment shall be done by the Contractor at site in the laboratory approved by the Employer before use. Any cement with lower quality than those shown in manufacturer's certificate shall be debarred from use.

5 TESTING AND APPROVAL OF MATERIAL

5.1 The Contractor shall furnish test certificates from the manufacturer/supplier of materials along with each batch of material(s) delivered to site.

5.2 The Contractor shall set up a field laboratory with necessary equipment for testing of all materials, finished products used in the construction as per requirements of conditions of contract and the relevant specifications. The testing of all the materials shall be carried out by the Employer or his representative for which the Contractor shall make all the necessary arrangements and bear the entire cost.

5.3 Tests which cannot be carried out in the field laboratory have to be got done at the Contractor's expense at any government recognized laboratory/testing establishments in India or abroad as approved by the Employer. All necessary cost for witnessing the test by Employer's representative shall have to be borne by the Contractor.

6 SAMPLING OF MATERIALS

6.1 Samples provided to the Employer or his representative for their retention is to be in labelled boxes suitable for storage.

6.2 Samples required for approval and testing must be supplied well in advance at least 48 hours or minimum period required for carrying out relevant tests to allow for testing and approval. Delay to works arising from the late submission of samples will not be acceptable as a reason for delay in the completion of the works.

6.3 If materials are brought from abroad, the cost of sampling/testing whether in India or abroad shall have to be borne by the Contractor.

7 REJECTION OF MATERIALS NOT CONFORMING TO THE SPECIFICATIONS

7.1 Any stack or batch of material(s) of which sample(s) does not conform to the prescribed tests and quality shall be rejected by the Employer or his representative and such materials shall be removed from site by the Contractor at his own cost. Such rejected materials shall not be made acceptable by any modifications.

8 TESTING AND APPROVAL OF PLANT AND EQUIPMENT

8.1 All plants and equipment used for preparing, testing and production of materials for incorporation into the permanent works shall be in accordance with manufacturer's specifications and shall be got approved by the Employer before use.

D CAST-IN-SITU CONCRETE PILES

1 GENERAL

1.1 Cast-in-situ concrete piles shall be constructed by driving or sinking non-structural tubular steel casings into the ground upto refusal/required level as approved by the Engineer, clearing all material from inside the casing, placing reinforcement and then filling the casings with concrete. The steel casings shall remain permanently in place and shall form part of the permanent works.

2 CONSTRUCTION WORK METHOD STATEMENT

2.1 The Contractor shall submit a Construction Work Method Statement (CWMS) for all piling works in accordance with the general requirements as specified in the specifications and incorporating all additional detailed technical requirements as specified in this section.

2.2 In broad terms, the Contractor's CWMS for piling works shall include but not be limited to the following items subject to the additional technical requirements for piling works as specified herein for approval of Employer:

(a) Description of overall piling works construction sequence and programme trial piles and routine testing of working piles (Static as well as Dynamic);
(b) Details of proposed materials for use in the piling works, including description, source and material test results or certificates demonstrating conformance of the materials to the requirements of these specifications;
(c) Details of construction methods for the piling works including but not limited to details of;
  (i) Temporary works or bracing;
  (ii) Survey set out and control;
  (iii) Trial Piles to be constructed and testing methods;
  (iv) Piling, excavation and other plant, equipment and labour to be used;
  (v) Any safety, environmental or other controls to be employed;
(d) Contingency plans or procedures to be employed in the event of unforeseen interruption of piling works due to adverse weather, obstructions, plant breakdown, or another malfunction;
(e) Details of inspection, test methods and analysis or calculations to be undertaken to ensure conformance of the constructed piles with the requirements of these specifications.
(f) Details of methods for rectification in the event of non-conformance of either material of construction requirements of these specifications;
(g) Details of piling records to be kept including pro-forma piling records;

2.3 Depending on the Contractors proposed sequence and programme of works and subject to the agreement of the Employer, the Contractor may choose to either submit a single CWMS covering all piling works under the Contract, or a number of CWMSs covering individual sections of the piling works.

2.4 Irrespective, the Contractor shall submit his CWMS for approval at least 28 days prior to the intended date for first commencement of the piling works to which the CWMS refers. The Employer will take maximum 10 working days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

2.5 The resolution of such comments on the CWMS submission to the satisfaction of the Employer and the Employer's subsequent approval of the CWMS shall constitute a HOLD POINT on the commencement of the piling works to which the CWMS refers.

3 NOTIFICATION OF PILING WORKS AND WEEKLY REPORTING

3.1 The Contractor shall give at least 48 hours' advance notice to the Employer prior to commencing the first pile to enable the Employer or his representative to be present.

3.2 The Contractor shall submit to the Employer each week his working programme for the piling works scheduled for the following week including a breakdown of activities planned for each day such that the Employer can coordinate his inspection of the works.

4 PROTECTION OF EXISTING UTILITIES, SERVICES AND STRUCTURES

4.1 The position of existing utilities shall be determined and underground utilities adjacent to the piles shall be exposed or otherwise accurately located before piling works start.

4.2 All necessary measures shall be taken to minimise the settlement of the ground and adjacent structures and utilities and to prevent the formation of cavities in the ground resulting from piling works.

4.3 The vibrations due to piling works at structures, utilities and previously installed piles measured in terms of peak particle velocity shall not exceed 25 mm/s.

4.4 The vibrations due to piling works at structures, utilities and previously installed piles measured in terms of vibration amplitude shall not exceed 0.2 mm.

4.5 The Contractor shall be responsible for and shall bear the cost of any claims for damage to adjacent structures and facilities arising from the execution of the piling works.

5 MATERIALS

5.1 General

5.1.1 The basic materials shall conform to the specifications for materials given in the tender document. The specifications for steel reinforcement, structural concrete, and structural steel to be used in pile foundations shall be as given in the relevant sections of these specifications.

5.2 Pile Casings

5.2.1 The quality and thickness of steel for the permanent sacrificial casings shall be commensurate with the installation method and ground conditions including differential soil and hydrostatic pressure to the satisfaction of the Employer. Permanent casings shall have minimum thickness of 6mm or as specified on the Drawings.

5.2.2 Permanent casings shall be free before and after installation from significant distortions and internal projections which might prevent the proper formation of the piles.

5.2.3 Where permanent casings are to be made from a series of short sections they shall be joined and installed so as to have a constant internal diameter.

5.2.4 Permanent casing joints shall be welded to form a continuous shaft.

5.2.5 Details of the pile casings shall be proposed by the Contractor for the acceptance of the Employer as part of the CWMS for the piling works.

6 SETTING OUT

6.1 The Contractor shall check the casing position for each pile during and immediately after placing the casing and agree it with the Employer.

6.2 Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile casing, the pile casing position shall be marked with suitable identifiable markers.

7 REQUIREMENTS FOR PILE FOUNDING LEVELS

7.1 All bored piles in the works shall be socketed into the hard strata for the minimum length or terminated upto the required level.

7.2 Estimated pile founding levels shall be shown for all piles in the Good for Construction (GFC) Drawings based on the data obtained from geotechnical investigations.

7.3 These estimated pile founding levels are indicative only and shall not be taken as in any way limiting the requirements of this section with respect to the requirements for proposed and final pile founding levels or the acceptance of piles by the Employer.

7.4 SPT shall be conducted at the founding level as per the directions of the Employer. Founding level of each pile will be individually approved by the Employer satisfying himself from observations and all data including SPT tests at his disposal, of the soundness of the end bearing stratum. In case of rocky strata, the pile shall be socketed a minimum of one diameter of the pile or as directed by the Employer. In other soils the penetration shall be as per design, with the approval of the Employer.

7.5 During the drilling of piling works any anomalies like cavities at the drill locations which could not be observed during pre-drilling works should be informed to the Employer. The Employer will review the available data and confirm the required founding level for that pile or group of piles.

8 INSTALLATION OF PERMANENT PILE CASINGS

8.1 All marine piles shall be constructed within permanent MS sacrificial liner/ casing as per the site conditions or as shown on GFC drawings. The pile casings shall be installed using suitable pile driving equipment to extend through all type of soil strata upto minimum 7 m below or design dredged level or refusal, whichever is lower level, as defined in these specifications or as instructed by the Employer.

8.2 The pile casings shall be installed from firm ground or from temporary supports or from fixed platform. The arrangement shall provide sufficient rigidity to ensure accuracy of pile casing driving under all conditions of tide, stream flow or hammer drop. Pile casings shall be driven from a fixed frame of sufficient rigidity to ensure accuracy of driving within specified tolerances.

8.3 Pile casings shall not be driven eccentrically from the designed axis or bent into position and shall be effectively guided during driving. Attempts to correct any tendency for the pile to run off-line by the application of significant horizontal restraint will not be permitted. Shortly after the commencement of driving and at regular intervals throughout the driving operation, checks shall be made to ensure that the pile frame does not exert any undue lateral force on the pile due to restraint within the helmet.

8.4 For piles used in soils liable to flow, the driving of casing shall be achieved by continuous removal of muck from the bore thereby filling with required consistency and viscous polymeric slurry preventing the formation of cavities and settlements in the adjoining ground. Any joints in the casing shall be made as water-tight as possible to minimize inflow of water or leakage of slurry during concreting.

8.5 If the indications are that a pile casing will finish outside the specified tolerances, driving operations on that pile casing will cease. The pile casing shall be withdrawn, the hole filled and the pile casing re-driven at no extra cost.

8.6 To avoid the possibility of premature “set-up” pile casing driving shall be continuous in the later stages, without any deliberate stops. (Delays of an hour or more may lead to significant “set-up” in piles i.e. resistance to further driving increases after driving is stopped).

8.7 If any pile casing is damaged in any way during driving, it shall be repaired or replaced as directed by the Employer, at no extra cost. If during driving, the head of a pile is damaged to the extent that further driving is not possible, the head shall be cut off and driving continued. The cost of cutting off shall be borne by the Contractor and where, as a result of such cutting off the head, the pile is too short, the Contractor, shall, at his own cost, supply and splice on sufficient length of pile to restore the pile to its correct length.

8.8 Liner or pile bore which is improperly located or shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Employer at the cost of the Contractor.

8.9 The Contractor shall include all details of the pile casings and the proposed methods of installation as part of his CWMS for the works as specified earlier in this Section.

9 PILE BORE BOTTOM CLEANING

9.1 Prior to placing concrete, polymeric slurry flushing at high pressure shall be done in the same way as the pre-bore flushing but using tremie pipes connected to polymer pump. At the end of flushing, contractor shall ensure that heavy contaminated polymer suspension has not settled at bottom of pile bore

9.2 Immediately after the completion of boring, flushing of the borehole shall be done with the chisel in position for a period not less than two hours. After removing the chisel, the bore hole shall be further cleaned with a suitable bailer having adequate weight. The pile bore shall be cleaned using either by Reverse Mud Circulation (Air Lift Flushing) or Direct Mud Circulation (Polymer Flushing). The decision for borehole cleaning methodology shall be taken at the site based on effectiveness.

9.3 The cleaning shall be continued till the density of the contaminated drilled mud at the (slurry collected in sampler tube) bottom of pile is less than 1.12 gm/ml

10 INSTALLATION OF REINFORCEMENT

10.1 Prefabricated reinforcement cages for piles shall be marked and fitted with spacers to ensure that the cage is correctly orientated and positioned within the pile. Details of the proposed spacers shall be included in the Contractors CWMS for the piling works.

10.2 The number of joints in longitudinal steel bars shall be kept to a minimum. Joints in reinforcement shall be such the full strength of the bar is effective across the joint and shall be made so that there is no relative displacement of the reinforcement during the construction of the pile.

10.3 All prefabricated reinforcement cages shall be inspected prior to placement by the Employer. The Contractor shall have his foreman and steel fixer on standby to rectify any unsatisfactory work found during inspection. Any approval of the reinforcement by the Employer shall not relieve the Contractor of his responsibilities and obligations under the terms of the Contract.

10.4 The reinforcement cage shall be lowered into position only in the daytime after the Employer has accepted the final founding level of the pile and verified the length of the reinforcement cage.

10.5 Reinforcement protruding above a concreted pile shaft shall be protected against corrosion with cement paste that shall be removed before subsequent construction works commence. If the protection period is longer than a few weeks, weak concrete should be used instead of cement paste.

11 PLACEMENT OF CONCRETE

11.1 To prevent segregation, a tube or tremie pipe shall be used to place concrete in all piles. The tremie shall be water-tight throughout its length and have a hopper attached at its head by a water-tight connection.

11.2 Tremie of 150 mm to 200 mm diameter shall be used for concreting. The tremie should and shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal.

11.3 The tremie pipe shall be of sufficient strength and shall have uniform and smooth cross-section inside. The diameter of the tremie shall be large enough in relation to the size of coarse aggregates in the piling concrete. For 20 mm aggregate the tremie pipe shall be of diameter not less than 150 mm and for larger size aggregate diameter of tremie pipe shall not be less than 200mm. All piling above 600mm diameter shall preferably be done using 200mm diameter tremie.

11.4 If the hole cannot be practically dewatered, the Employer may permit placement of the concrete under water. The level of the top of the concrete in piles shall be at least 900 mm above the specified cut-off level and after the concrete has hardened; excess concrete shall be removed to the specified cut-off level. Before placing concrete, measures shall be taken such as airlifting and agitation to ensure that there is no accumulation of silt or other loose materials at the base of the bored holes. The Employer may impose other conditions on the placement of concrete under water.

11.5 In all cases, the tremie pipe shall be lowered to the bottom of the bore-hole before pouring concrete. The tremie pipe shall always be kept full of concrete and the discharge end shall be maintained below the upper surface of the rising concrete at all times with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

11.6 The placing of concrete shall be a continuous process from the toe level to the top of the pile. Operations that in the opinions of the Employer are likely to disturb or affect the concrete or placing of the concrete shall not be carried out unless agreed by the Employer.

11.7 Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting shall be avoided.

11.8 The concrete shall be properly graded, shall be self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Sufficient

head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.

11.9 The diameter of the finished pile shall not be less than that specified and a continuous record shall be kept by the Employer as to the volume of concrete placed in relation to the length cast. To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.

11.10 After placing of the concrete from each delivery, the Contractor shall record the volume of concrete deposited and the level of concrete in the pile shaft. The reading shall be plotted in a graph showing the theoretical volume/actual volume and the depth of the concrete placed. This record must be submitted as part of the Contractors quality records for the piling works. For quality check of concrete, concrete cube test on 15 cm cube should be tested at 28 days' strength.

11.11 Water to be used for concrete preparation shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities.

11.12 The pH value of water shall generally be not less than 6. Admixture of approved quality may be used in order to achieve specific site requirements, such as setting time, early strength etc.

11.13 The aggregates to be used as constituent of concrete shall be natural or crushed gravel or crushed rock and free from deleterious material and shall comply with the requirements of IS-383. Aggregates used for concrete shall not be more than 20mm in size for piling.

11.14 Concreting of the piles shall be carried out uninterrupted.

12 CUT-OFF AND CLEAN-UP OF TOP OF PILE

12.1 The minimum embedment of cast-in-situ concrete piles into the structure supported by pile shall be provided as per design. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete.

12.2 The reinforcement in the pile shall be exposed for full anchorage length to permit it to be adequately bonded into the pile cap. Exposing such length shall be done carefully to avoid damaging the rest of the pile. Defective piles shall be removed or left in place as judged convenient without affecting the performance of adjacent piles or pile cap. Additional piles shall be provided to replace the defective piles.

12.3 Pile heads shall be trimmed to the cut-off levels shown in the Drawings within a tolerance of +/-25 mm preferably on the negative side. Details of mechanical tools used in the trimming of pile heads shall be submitted to the Employer for approval as part of the Contractors CWMS for the piling Works to ensure that the concrete at or below the cut-off levels would not be damaged by the trimming operation.

13 TOLERANCES

13.1 Permissible Tolerances for Bored Piles

13.1.1 Piles shall be installed to within the tolerances specified in this section of the Specifications.

13.1.2 Piles which do not comply with the specified tolerances shall not be forcibly corrected and it may be rejected or condemned by the Employer.

(a) Variation in cross-sectional dimensions : + 50 mm, -10 mm

(b) Variation in the final position of the head in plan : 75 mm

(c) Variation of level of top of piles : +/- 25 mm

14 DEFECTIVE PILE

14.1 In case defective pile are formed they shall be replaced or left in place wherever is convenient without affecting performance of the adjacent piles or the cap as a whole. Additional pile shall be provided to replace them as directed by Employer. Contractor shall not be paid for the new piles.

14.2 Any change in the pile length, diameter, pile cap, defect in concrete forming pile, deviation in reinforcement detailing, and deviation from any other requirement as defined in the specification and drawing etc. shall be termed as defective pile.

14.3 Any deviation beyond permissible limits in designed pile location, and alignment etc. shall be noted and adequate measures shall be taken well before the concreting of the pile cap. If the deviation cannot be controlled, pile shall be discarded as directed by the Employer and these piles shall be replaced without any extra cost to the Employer.

14.4 Any deviation from the safe load capacity observed during the load test shall be noted and corrective measures shall be taken as directed by the Employer. If the safe load capacity does not meet due to defective test pile construction, the defective test pile shall be replaced with the new test pile without any additional cost.

14.5 During chipping of the pile top, manual chipping may be permitted after three days of pile casting; pneumatic tools for chipping shall not be used before seven days after pile casting.

14.6 After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

15 TESTING OF PILES

15.1 The exact locations and details of Piles to be tested shall be as instructed by the Employer. The piles shall be load tested in accordance with provisions laid down in these specifications. Unless otherwise permitted by the Employer pile load test shall be completed within the time allowed as per the relevant codes.

15.2 **Static Load Tests**

15.2.1 Pile load tests shall be carried out in accordance with the requirements of these specifications as follows;

(a) Routine Load Tests shall be carried out on not less than 2 in number but not more than 2 percent depending upon the number of piles of all working piles for the related structure to a maximum of 1.5 times the working load of the working pile and as per table given below;

Total No. of Piles in Berth Structure	Number of Tests
Up to 50	2
51 to 150	3
Beyond 150	2% of total working piles (fractional number rounded to next higher integer number)

15.2.2 Routine Load Tests shall be distributed evenly throughout the works so as to provide adequate data in support of the proposed pile founding levels for all piles. The Contractor shall propose the distribution and scheduling of routine pile load tests to the Employer for acceptance as part of his CWMS for the piling works.

15.2.3 Load tests shall be carried out by the Contractor in the presence of the Employer under the direction of a qualified and experienced Contractor's Engineer who shall record the results.

15.2.4 All equipment's to be used for load test shall be calibrated to the design test load and a recent calibration test certificates of all equipment's shall be certified from IIT / any government Institutions and shall be submitted to Employer for approval.

15.2.5 It shall be ensured that at least one load test shall be completed prior to installation of 10% of total no. of piles covered under this contract.

15.2.6 The Contractor shall submit for the approval of the Employer details of the test procedure that he proposes to adopt, together with full details of the reaction/ anchor, supports, measurement devices etc. as part of his CWMS for the piling works. The method and procedures for static load tests to determine the settlement of the pile under load shall generally conform with the requirements of IS: 2911 (Part-4) and IS 14593 except as modified in these specifications.

15.3 Concrete Cores from Piles

15.3.1 Concrete cores from concrete piles shall only be taken when instructed by the Employer. The positions from which the cores are taken shall be as instructed by the Employer.

15.3.2 Where required, concrete cores shall be of 100mm diameter and the method of taking concrete cores shall be in accordance with relevant Indian Standards else specified in this specification. Holes formed by taking

concrete cores from piles shall be reinstated using an approval concrete mix or an approved grout mix.

15.3.3 Each concrete core from a pile shall be inspected for evidence of segregation of the constituents and for the presence of voids. Specimens selected from each core shall be tested to determine the compressive strength.

15.3.4 The method of preparing, inspecting and testing concrete cores shall be as per specification of Concrete given in these tender specifications.

15.3.5 If the result of any test on a concrete core from a pile does not comply with specified strength, additional cores shall be taken from the same pile and additional tests shall be carried out.

15.3.6 Additional concrete cores shall be 100mm diameter for concrete of 20mm nominal maximum aggregate size and 150mm diameter for concrete of 40mm nominal maximum aggregate size. The number of additional cores shall be as instructed by the Employer.

15.3.7 If the result of any additional test does not comply with the compliance criteria for concrete cores the Contractor shall submit remedial proposals to the Employer for approval. The number of additional piles and additional tests shall be as instructed by the Employer.

15.4 Integrity Testing

15.4.1 Integrity testing (Low strain) of piles shall be carried out for all piles. Non-destructive integrity test shall comply with IS 14893. The Contractor shall submit the proposed procedures and details of proposed testing equipment for Integrity testing to the Employer for approval at least 7 days before concreting.

15.4.2 The Contractor shall submit the following information to the Employer at least two weeks before testing:

(a) The name and address of the proposed independent testing organisation;
(b) Qualifications and experience of the organisation‘s staff to be employed in carrying out and interpreting the testing;
(c) Written evidence of the organisation’s recent experience of undertaking the specified type of testing on similar projects;
(d) One copy of the proposed test report form;
(e) A method statement for each type of test proposed.

15.4.3 Non-destructive integrity tests shall be carried out by an independent Testing Firm as approved by the Employer. The Contractor shall provide attendance and other preparatory works as required. The Contractor shall provide the Testing Firm with a copy of the ground investigation report, a Site plan showing bore hole locations and pile layout and a list of the piles to be tested with the date of concreting, total length, length of casing (if

any), diameter and volume of concrete used plus any other relevant information required for the testing of the pile.

15.4.4 The methodology for Integrity testing should be in accordance with relevant Indian Standard else specified in this specification. The interpretation of test shall be carried out by competent persons and the full test results and findings shall be given to the Employer within 10 days of the completion of each phase of testing.

15.4.5 The Contractor shall submit the initial test results, which shall include a copy of the field data obtained during the testing but exclude detailed analysis, to the Employer within 24 hours of the completion of the test.

15.4.6 All tests shall be carried out under the direction of an experienced and competent supervisor conversant with the test procedure and acceptable to the Employer. All personnel operating the test equipment shall have been trained in its use.

15.4.7 The Contractor shall not carry out any testing of a concrete pile until at least 14 days after it has been cast and shall ensure that damage does not occur to complete piles.

15.4.8 Integrity testing shall be carried out progressively as piling is completed and in sufficient time before the relevant piling works obstructs access to carry out the test. The results of integrity tests shall be used to enable the Employer to select piles for further testing.

15.4.9 The testing organization shall examine and interpret the results in detail and prepare a report on the tests. The report shall be submitted to the Employer within 10 days of completion of the testing, and shall contain information in accordance with the following schedule where applicable:

(i) Contract name and number
(ii) Contract location
(iii) Pile reference number
(iv) Pile type and size
(v) Pile toe level
(vi) Total length of pile
(vii) Length of pile from instrumentation location to Toe
(viii) Working load
(ix) Date of pile installation
(x) Date of test
(xi) Cube strength of pile concrete
(xii) Penetration of pile below commencing surface
(xiii) Identification of supervisor
(xiv) Identification of person carrying out the analysis
(xv) An interpretation of each record
(xvi) A review of any anomalies in terms of influence of poor materials or workmanship during pile construction.

15.4.10 Any deviation in the record from that which would be expected from a sound pile without defect shall be reported. The report shall indicate the nature, location and severity of the defect and recommendations shall be

made for further testing. Where possible, the implication of the existence of the defect on the performance of the pile shall be evaluated.

15.4.11 If the result of any integrity test on a pile does not comply with the specified requirements, additional tests shall be carried out. The number of additional tests shall be as instructed by the Employer.

15.4.12 In the event that any anomaly is found in the results of such testing, the Employer may call for further testing to be carried out or for the relevant part of the pile to be exposed where practicable for inspection, in order to investigate the cause, nature and extent of the anomaly and whether the pile is satisfactory for its intended use.

16 RECORDS OF PILING WORKS

16.1 General

16.1.1 Records of each cast-in-situ piles shall be signed by the Employer after he has carried out the inspection/verification personally.

16.1.2 Records of piling shall be kept by the Contractor on the Site and submitted to the Employer within 24 hours after the driving or installation of each pile has been completed. The records shall be kept on standard forms as submitted with the Contractors CWMS and agreed with the Employer.

17 RECORDS OF GROUND STATE

17.1 During excavation the Contractor shall keep a record of the nature of the ground including the levels of changes in strata, a description of the soil encountered and the depth, thickness and nature of any boulders or other obstructions.

17.2 When directed by the Employer disturbed samples of the soil shall be taken and kept in screwed top sample jars marked with the pile number and depth from which the samples are taken. Such samples shall be kept on site until such time as the Employer may direct.

18 RECORDS OF LOAD TESTS

18.1 Records of load tests on piles shall be kept by the Contractor on the Site and a report shall be submitted to the Employer within 48 hours after the test has been completed. The records shall be kept on standard forms as submitted with the Contractors CWMS and agreed with the Employer. The records shall include graphs showing load and settlement versus time, plotted in the format shown in BS 8004, Figure 15(a) or equivalent IS.

19 PILING RECORDS

19.1 The Contractor shall keep a record of the following data (as applicable) and keep daily record sheets signed by the Contractor's representative and submit these to the Employer each week, or on completion of each pile, whichever is more frequent. The format of the records shall be as submitted with the Contractors CWMS and agreed with the Employer.

(i) Date and time of installation;
(ii) Weather condition including significant wave height and direction of approach;

(iii) Pile serial reference number and size;
(iv) Type of work carried out;
(v) Length of pile/tube or casing used;
(vi) Seabed/ground CD level at pile position;
(vii) Actual position of pile as constructed;
(viii) Pile vertical and horizontal deviations, if any;
(ix) Gross and net lengths or depth of casing driven and pile bored;
(x) CD level of top or bottom of pile after completion of piling;
(xi) Depth concreted and mix and volume of concrete placed and time of start and completion of concreting;
(xii) Details of reinforcement;
(xiii) Details of sub-soil strata and ground water encountered in boring;
(xiv) Detail of obstructions and delays or interruptions and actions taken;
(xv) Accurate records of any tests; and
(xvi) Any other relevant data requested by the Employer.

19.2 The Contractor shall prepare and maintain a piling record plan throughout the works. The piling record plan shall be updated progressively based on the pile completed and shall be submitted to the Employer weekly throughout the piling works. The piling record plan(s) shall include:-

(i) Location of each pile and its size,
(ii) C.D. levels of the top and bottom of each pile;
(iii) C.D. cut-off level of each pile;
(iv) Ground level at the pile position;

20 TESTS AND STANDARDS OF ACCEPTANCE

20.1 The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

20.2 The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

20.3 Condemned or Rejected Piles

20.3.1 If at any time, any piles are found to be in any way unsatisfactory or out of position, they will be condemned. The Contractor shall provide new sound piles and carry out any other additional works, generated by the remedial work at his own expense.

20.3.2 In the event that changes due to defective pile such as these are necessary the Contractor shall compensate the Employer for the extra costs involved, including the following:

(i) Payment for extra design or checking costs if design is carried out by the Employer;
(ii) Payment for extra cost of foundation(s) and the associated testing;
(iii) Compensation for liquidated and ascertained damages for the delay.

E FORMWORK

1 GENERAL

1.1.1 Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Employer, together with all props, staging, centering, scaffolding and temporary construction required for their support. The design, erection and removal of formwork shall conform to IS 14687: False work for Concrete Structures -Guidelines.

2 MATERIALS

2.1 General

2.1.1 All materials shall comply with the requirements of IRC: 87/MORTH. Materials and components used for formwork shall be examined for damage or excessive deterioration before use/re-use and shall be used only if found suitable after necessary repairs. In case of timber formwork, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits.

2.1.2 Forms shall be constructed with metal or marine plywood. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Adjustable steel props can be used as support for forms

3 DESIGN OF FORMWORK

3.1 General

3.1.1 The Contractor shall furnish the design and drawing of complete formwork (i.e. the forms as well as their supports) for approval of the Employer before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information to the Employer for approval.

3.1.2 Notwithstanding any approval or review of drawing and design by the Employer, the Contractor shall be entirely responsible for the adequacy and safety for formwork.

3.1.3 The design of the formwork shall conform to provisions of IS 14687. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection

4 WORKMANSHIP

4.1 General

4.1.1 The formwork shall be robust and strong and the joints shall be leak-proof.

4.1.2 Balli shall not be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Staging shall be provided with an appropriately designed base plate resting on firm strata.

4.1.3 The number of joints in the formwork shall be kept to a minimum by using large size panels. The design shall provide for proper “soldiers” to facilitate alignment. All joints shall be leak proof and must be properly sealed. All joints in formwork shall be sealed with PVC JOINT sealing tapes, foam rubber or PVC T-section to prevent leakage of grout.

4.1.4 As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be withdrawn easily. Use of double headed nails shall be preferred.

4.1.5 Use of through ties shall not be permitted for any structures in “Extreme” exposure class.

4.1.6 The use of through ties for other structures shall be restricted, as far as practicable. Wherever ties are used shall be used with HDPE sheathing so that the ties can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.

4.1.7 The chamfers, beveled edges and mouldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as per drawing and as directed by the Employer.

4.1.8 Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing of concrete.

4.1.9 The formwork shall be constructed with pre-camber to the soffit to allow for deflection of the formwork. Pre-camber to allow for deflection of formwork shall be in addition to that indicated for the permanent structure in the drawings unless noted otherwise.

4.1.10 Where centering trusses or launching trusses are adopted for casting of superstructure, the joints of the centering trusses, whether welded, riveted or bolted should be thoroughly checked periodically. Also, various members of the centering trusses should be periodically examined for proper alignment and unintended deformation before proceeding with the concreting. They shall also be periodically checked for any deterioration in quality due to steel corrosion.

4.1.11 The formwork shall be made so as to produce a finished concrete true to shape, line and levels and dimensions, subject to the tolerances specified in respective sections of these specifications, or as directed by the Employer.

4.1.12 Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.

4.1.13 Forms shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration during and after placing the concrete.

4.1.14 The formwork shall take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures, having regard to the deformation of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes.

4.1.15 Suitable camber shall be provided to horizontal members of structure, especially in long spans to counteract the effects of deflection. The formwork shall be so fixed as to provide for such camber.

4.1.16 All formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating (machine oils) shall be prohibited for use as coating or releasing agent.

5 FORMED SURFACE AND FINISH

5.1 The formwork shall be lined with material approved by the Employer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and so fixed to its backing as not to impart any blemishes. It shall be of the same type and obtained from only one source throughout for the construction of any one structure.

5.2 The surface finish of all concrete works shall be assessed in accordance with AS3610.The required surface finish shall be as follows:

(i) Class 2: All vertical faces of Land structures;
(ii) Class 3: All other concrete works

5.3 The contractor shall make good any imperfections in the resulting finish as required by the Employer. Internal ties and embedded metals parts shall be carefully detailed, and their use shall be subject to the approval of the Employer.

6 PRECAUTIONS

6.1 Special measures in the design of formwork shall be taken to ensure that it does not hinder the shrinkage of concrete. The soffit of the formwork shall be so designed as to ensure that the formwork does not restrain the shortening and/or hogging of beams. The forms may be removed at the earliest opportunity to the minimum time for removal of forms with props retained in position.

6.2 Where necessary, formwork shall be so arranged that the soffit form, properly supported on props only can be retained in position for such period as may be required by maturing conditions.

6.3 Any cut-outs or openings provided in any structural member to facilitate erection of formwork shall be closed with the same grade of concrete as the adjoining structure immediately after removal of formwork ensuring watertight joints.

6.4 Provision shall be made for safe access on, to and about the formwork at the levels as required.

6.5 Close watch shall be maintained to check for settlement of formwork during concreting.

6.6 Any settlement of formwork during concreting shall be promptly rectified.

6.7 Water used for curing should not be allowed to stagnate near the base plates supporting the staging and should be properly drained.

7 PREPARATION OF FORMWORK BEFORE CONCRETING

7.1 The inside surfaces of forms shall, except in the case of permanent form work or where otherwise agreed to by Employer be coated with a release agent supplied by approved manufacturer or of an approved material to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not allowed to come into contact with any reinforcement. Different release agents shall not be used in formwork for exposed concrete.

7.2 Before re-use of forms, the following actions shall be taken:

(i) The contact surfaces of the forms shall be cleaned carefully and dried before applying a release agent.

(ii) It should be ensured that the release agent is appropriate to the surface to be coated. The same type and make of release agent shall be used throughout on similar formwork materials and different types should not be mixed.

(iii) The form surfaces shall be evenly and thinly coated with release agent. The vertical surface shall be treated before horizontal surface and any excess wiped out.

(iv) The release agent shall not come in contact with reinforcement or the hardened concrete.

7.3 All forms shall be thoroughly cleaned immediately before concreting with compressed air.

7.4 The Contractor shall give the Employer due notice before placing any concrete in the forms to permit him to inspect and approve the formwork, but such inspection shall not relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

8 TOLERANCES

8.1 Except where otherwise noted on the Drawings, formwork shall be designed and constructed such that concrete surfaces shall be formed within the tolerances specified for the completed structural concrete elements of these specifications. Where tolerances conflict, the lesser tolerance shall be adopted.

8.2 The dimensions lines, levels and grades of the formwork shall be checked by the Contractor immediately prior to the placing of the concrete and again immediately after placement of concrete.

9 REMOVAL OF FORMWORK

9.1 The scheme for removal of formwork (i.e. de-shuttering and de-centering) shall be planned in advance and furnished to the Employer for scrutiny and

approval. No formwork or any part thereof shall be removed without prior approval of the Employer.

9.2 The formwork shall be so removed as not to cause any damage to concrete. Centering shall be gradually uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

9.3 Where not specifically approved, the time of removal of formwork (when ordinary Portland Cement is used without any admixtures at an ambient temperature exceeding 10 degrees Celsius) shall be as under:

(a)	Walls, abutments, columns and vertical faces of structural	: 12 to 48 hours as may be decided by Employer
(b)	Soffits of Slabs (with props left under)	: 3 days
(c)	Props (left under slabs)	: 14 days
(d)	Soffit of beams (with props left under)	: 7 days
(e)	Props (left under beams)	: 21 days
(f)	Cantilever Construction	: Formwork shall remain till structures for counteracting or bearing down have been erected & have attained sufficient strength (minimum 14 days).

9.4 Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set, in order to avoid cracking due to shrinkage of concrete.

10 RE-USE OF FORMWORK

10.1 When formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such examination shall always be carried out before being used again. Before re-use all components shall be cleaned of deposits of soil, concrete or other unwanted materials. Threaded parts shall be oiled after cleaning.

10.2 All bent steel props shall be straightened before re-use. The maximum deviation from straightness is 1/600 of the length. The maximum permissible axial loads in used props shall be suitably reduced depending upon their condition. The condition of the timber components, plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

11 SPECIALISED FORMWORK

11.1 Specialized formwork may be required in the case of, underwater concreting, segmental construction etc. Such specialized formwork shall be designed and detailed by competent agencies and a set of complete working drawings and installation instructions shall be supplied to the Employer for approval. The site personnel shall be trained in the erection and dismantling as well as operation of such specialized formwork. In case proprietary equipment is used, the supplier shall supply drawings, details, installation instructions, etc., in the form of manuals along with the formwork. Where specialized formwork is used, close co-ordination with the design of permanent structure is necessary.

11.2 In order to verify the time and sequence of striking/removal of specialized formwork, routine field tests for the consistency of concrete and strength development are mandatory and shall be carried out before adoption.

11.3 For specialized formwork, the form lining material may be either plywood or steel sheet of appropriate thickness. Plywood is preferred where superior quality of surface is desired, whereas steel sheeting is normally used where large number of repetitions is involved.

12 TEST AND STANDARDS OF ACCEPTANCE

12.1 The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

12.2 The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

13 CEMENT

13.1 Standard

13.1.1 Cement to be used in the Works shall be conforming to the following IS standards codes-

- 53 Grade Ordinary Portland Cement: IS 8112
- Portland Pozzolana Cement (fly ash based): IS 1489 (part-I)

14 SUPPLY & STORAGE

14.1 The cement to be used on works shall be OPC or PPC (fly ash based) as specified. Unless otherwise specified, Ordinary Portland Cement or PPC shall be supplied in bags containing 50 Kg. each. Stacking of cement rejected due to aging or not fulfilling IS requirements shall be at the cost of the Contractor. The Cement held in storage for a period more than 90 days shall be tested before its use, if directed by Employer. A common cement register shall be kept at site office showing the supply, stock and issue on a daily basis. Contractor will have to make his own arrangements for storage of cement which shall meet the requirements of IS 4082.

15 TESTS

15.1 A certified report, attesting the conformance of the cement to IS Specifications by the cement manufacturer shall be furnished to the Employer, by the contractor.

15.2 Samples of cement shall be taken immediately on receipt of cement at site. The methods and procedure of sampling shall be as per IS 3535. Tests shall be carried out for fineness, initial and final setting time and compressive strength as per IS 4031.

15.3 Supplier of cement shall furnish the following documents before the cement is delivered to site:

(a) Certificate conforming that chemical composition and physical characteristics are within the stipulated values for types of cement supplied as per relevant codes.
(b) Certificate conforming that the chloride content in the cement is not in excess of 0.05 percent of mass of cement.

15.4 If during subsequent testing of cement supplied in lots any of the properties are found to be outside the acceptable limits, the lot of cement shall be rejected.

15.5 Each 1000 bags or part thereof, of cement or each wagon load of cement shall constitute one lot of cement for the purpose of conducting tests at site.

15.6 Samples for testing at site shall be taken at random from 2% of the total quantity supplied in one lot. For cement supplied in bags, samples shall be drawn from minimum of 5 bags and thefor bulk cement, sampling shall be done with the help of slotted sampler to be as per IS 3535.

15.7 Results of test conducted on samples drawn shall be submitted to the Employer for his approval. If in the opinion of the Employer, the test results are not within permissible limits, the lot of cement from which samples have been obtained for testing shall stand rejected and the material shall be removed from site.

15.8 Following tests shall be conducted at site on each lot of cement delivered:

Mandatory Tests	**Number of Test per Lot**
Consistency of standard cement paste	5
Initial and final setting time	5 each
Compressive strength test	10
Fineness Test & Soundness Test	5

15.9 Mean values of the results from the above results shall be taken as the representative value and the acceptance criteria shall be based on these tests. All test procedures and computation of test results shall be as per IS 4031.

15.10 Apart from mandatory tests specified as above, the Employer may at his discretion, call for any additional tests that he may consider necessary. All such tests shall be done on representative samples taken from each lot described above and testing and computation of test results shall be done as per IS4031.Chargesforsuchtestingshallbebornebythe contractor.

16 FINE AGGREGATE

16.1 Standard

16.1.1 Fine aggregate for different end uses (other than light weight concrete) shall conform to the following standards:

For Structural Concrete - IS: 383 (between Grading Zones I & II)

For Mortar & Grout - IS: 2116

For Plastering - IS: 1542 (Class A grading)

16.1.2 Fine aggregate shall consist of natural sands or machine crushed rock/gravel. It shall be clean, sharp, hard, strong and durable and free from dust, vegetable substances, adherent coating, clay, loam, alkali, organic matter, mica, soluble sulphate, gypsum or any other deleterious substances which can be injurious to the setting qualities / strength / durability of concrete. Use of sea sand is prohibited.

16.2 Source

16.2.1 Once a specific source of supply of fine aggregate is accepted, the source shall not be changed without prior approval of the Employer.

16.3 Storage

16.3.1 Fine aggregates shall be stored at site in adequate quantity on clean and well-maintained hard floor and areas not liable to flooding. Contamination with foreign matter and earth shall be avoided during storage and while heaping the materials.

16.4 Usage

16.4.1 Fine aggregate shall be thoroughly washed at site with clean fresh water such that the percentage of all deleterious matter is within the permissible limits as laid down in IS 2386 (Part-II).

16.4.2 Screening of sand shall be done if necessary, and as and when directed by the Employer to remove all objectionable foreign matter and effecting any grading.

17 WATER

17.1 Standard

17.1.1 Water supplied shall conform to the various provisions detailed under Clause 5.4 of IS 456:2000. Broadly stated water used for mixing and curing as also for cooling / washing of aggregates shall be clean and fresh, free from oils, acids, alkalizes, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Sea water or water from excavation shall not be used.

17.1.2 Potable water is generally considered satisfactory for mixing concrete. As a guide the following concentration represent the maximum permissible values:

17.1.3 To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The test shall be conducted as detailed in 8.1 of IS 3025 (Part 22).

17.1.4 To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H2SO4. The test shall be conducted as detailed in 8 of IS 3025 (Part 23)

17.1.5 Permissible limits for solid content shall be as given in the table below:

S. No.	Particulars	Tested as per	Permissible limits (Max)
i.	Organic	IS 3025 (Part 18)	200 mg/l
ii.	Inorganic	IS 3025 (Part 18)	3000 mg/l
iii.	Sulphates (as SO_3)	IS 3025 (Part 24)	400 mg/l
iv.	Chlorides (as Cl)	IS 3025 (Part 32)	2000 mg/l for concrete not consisting embedded steel & 500 mg/l for reinforced concrete work
v.	Suspended matter	IS 3025 (Part 17)	2000 mg/l

17.2 **Storage**

17.2.1 Water shall be so stored that it remains free from all deleterious materials as mentioned above.

17.3 **Tests**

17.3.1 No water shall be used until tested for its chemical and other impurities in accordance with IS 3025 to ascertain its suitability. Tests shall be conducted whenever the source is changed or during seasonal variation.

18 MORTAR MIXING

18.1 Cement and sand in the specified proportions shall be mixed in dry thoroughly by using mechanical mixer or by hand mixing, if permitted. Composition (cement and sand mortar, or lime and sand mortar or cement, lime and sand mortar) and proportions of mortars shall be as specified in the respective items of work. The ingredients of the mortar shall be accurately gauged by measure. Compressive strength test / cube test for mortar shall be done for every $10m^3$ of mix as per IS 4031. Charges for all the required tests shall be borne by the contractor.

18.2 **Precaution**

18.2.1 Mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.

F PLAIN CEMENT CONCRETE (PCC) WORKS

1 CEMENT

1.1 **Cement shall be as specified under –Mortars specifications**

2 AGGREGATE

2.1 **Coarse Aggregates**

2.2 **Standard**

2.2.1 Coarse aggregate for use in concrete (other than light weight concrete) shall conform to IS 383.

2.2.2 Coarse aggregate shall have a minimum specific gravity of 2.6 (saturated surface dry basis). Aggregate below this specific gravity shall not be used without specific permission of the Employer.

2.2.3 Coarse aggregate shall consist of natural or crushed stone, angular in shape with granular or crystalline surfaces or approved river shingle or gravel, rounded in shape. All aggregate shall be clean and free from elongated, friable, flaky or laminated pieces, adherent coatings, clay lumps, mica, organic matter and any other deleterious matter that may cause corrosion of reinforcement or impair the strength and/or durability of concrete. It shall be chemically inert, hard, strong, dense, and durable against weathering.

2.2.4 The maximum quantities of deleterious materials in the coarse aggregate shall not exceed the limits indicated in the IS 383when tested as per IS 2386 Part-I & Part-II “Method of Tests for Aggregate for Concrete”.

2.3 **Source**

2.3.1 Once a specific source of supply of coarse aggregate is accepted, the source shall not be changed without prior approval of the Employer.

2.3.2 Supplier of aggregates shall furnish the following information before the material is delivered to site:

2.3.3 Precise location of source from where the material is to be supplied

2.3.4 Trade group of principal rock type as per table given below

2.3.5 Presence or reactive minerals.

Trade group names of aggregate	Granite, Gabbro, Dolerite, Rhyolite
To be used for concrete	Basalt, Quartzite, Gneiss

The supplier shall also furnish reports of test results giving the following information for approval to Employer before delivery of material at site:

(a) Specific gravity
(b) Bulk density
(c) Moisture content
(d) Absorption value
(e) Aggregate crushing strength

(f) Aggregate impact value
(g) Abrasion value
(h) Flakiness index
(i) Elongation index
(j) Limits of deleterious substances in the aggregate
(k) Soundness of aggregate
(l) Potential reactivity of aggregates.

2.4 **Storage**

2.4.1 Coarse aggregate of available sizes shall be stored at site as separate stacks over clean and well-maintained hard floor and areas not liable to flooding. Alternatively, they will be stored in bins.

2.4.2 Contaminationwithforeignmaterialsandearthduringstorageandwhileheapingthematerials shall be avoided. It shall be kept in layers not exceeding 1.2 m in height to prevent coning or segregation.

2.5 **Usage**

2.5.1 Coarse aggregate, which is not clean, shall be washed with clear fresh water before use in the job. Screening would be done if considered necessary by the Employer without extra cost.

2.6 **Tests**

2.6.1 All test shall be conducted in accordance with IS 2386 (Part I to VIII).

2.6.2 In addition to above, the following tests shall be carried out on representative samples from every lot of aggregates after delivery at site. These test results are to be submitted to the Employer for his approval. Acceptance criteria for aggregates shall be based on the results of this set of tests only. If in the opinion of the Employer, the test results are not within permissible limits, the lot of aggregates from which the samples have been obtained for testing shall stand rejected and the material shall be removed from the site.

2.6.3 Mandatory Tests on Aggregates at site shall be min. 3 on each 10 cum or part there of as per IS: 2386. Mean value of the results from site test shall be taken as the representative value and the acceptance criteria shall be based on these. All test procedures &computations for test results shall be as per IS 2386.

2.6.4 Apart from above, the Employer may at his discretion, call for any additional tests that he may consider necessary. Sampling, procedure and computations for such test shall be done in accordance with IS 2430 and IS 2386 as applicable.

2.7 **Fine Aggregates**

2.7.1 Fine aggregates shall be as specified under –Mortars specifications.

2.8 **Water**

2.8.1 Water shall be as specified under –Mortars specifications.

2.9 Admixtures

2.9.1 Admixtures if required shall be as specified under Structural Concrete specifications.

2.10 Placing of Cement Concrete

2.10.1 Placing of cement concrete shall be as specified under-Reinforced Cement Concrete specifications (relevant as applicable). All concrete shall be protected against damage until final acceptance by the Employer.

G STRUCTURAL CONCRETE

1 DESCRIPTION

1.1 General

1.1.1 The work shall consist of furnishing and placing structural concrete and incidental construction in accordance with these specifications and in conformity with the lines, grades and dimensions, as shown on the drawings or as directed by the Employer.

1.2 Construction Work Method Statement

1.2.1 The Contractor shall submit a Construction Work Method Statement (CWMS) for all concrete works in accordance with the general requirements as specified in the specifications and incorporating all additional detailed technical requirements as specified in this section.

1.2.2 In broad terms, the Contractors CWMS for concrete works shall include but not be limited to the following items subject to the additional technical requirements for concrete works as specified herein:

(a) Description of overall concrete works construction sequence and programme including trial mix production and testing;

(b) Details of methods for the production of concrete for the Works including but not limited to, details of the following;

Material Constituents

(i) Description and source of all constituent materials;

(ii) Material test results or certificates demonstrating conformance of the constituents to the requirements of these specifications;

Concrete Mixes (for each concrete mix proposed for use)

(iii) Description of each concrete mix and proposed usage in the Works;

(iv) Target batch weights in kg/m^3 for all constituents;

(v) Design total water content in L/m^3;

(vi) Actual combined grading curve and design combined grading curve for all standard IS sieve sizes presented in cumulative % passing;

(vii) Trial mix slump and corresponding nominated slump;

Batching, Mixing and Transport

(viii) Details of the concrete batching plant where the concrete is to be mixed;

(ix) If concrete is to be supplied by an external supplier from an offsite batching plant, statement from the supplier guaranteeing that the concrete can be supplied to the site at sufficient rate and in sufficient quantity to permit uninterrupted placement of concrete on site;

(x) Level of control and accuracy of batching;

(xi) Level of control and accuracy of determination of the aggregate moisture content;

(xii) Minimum mixing and discharging time.

(c) Details of construction methods for the placement of concrete in the works, including but not limited to details as follows;

(i) Details of labour, plant and equipment to be utilised;

(ii) provision of safe access and sufficient lighting for concreting works;

(iii) Measures for the limiting and controlling maximum curing temperatures and temperature differentials;

(iv) methods of placement and compaction of concrete;

(v) methods of finishing unformed surfaces;

(vi) measures for the prevention of plastic shrinkage or settlement cracking and actions to be taken in the event that these are observed;

(vii) methods of curing including details of any products proposed; and

(viii) any safety, environmental or other controls to be employed;

(d) Contingency plans or procedures to be employed in the event of unforeseen interruption of concrete works due to adverse weather, batch plant breakdown, or another malfunction;

(e) Details of inspection, test methods and analysis or calculations to be undertaken to ensure conformance of the concrete works with the requirements of these specifications (including relevant ITPs and proforma pre-pour checklists);

(f) Details of methods for rectification in the event of non-conformance of either material of construction requirements of these specifications including details of concrete repair methods and proprietary products;

1.2.3 Depending on the Contractors proposed sequence and programme of works, and subject to the agreement of the Employer, the Contractor may choose to either submit a single CWMS covering all concrete works under the Contract, or a number of CWMSs covering the individual sections of the concrete works.

1.2.4 Irrespective, the Contractor shall submit his CWMS for approval at least 42 days prior to the intended date for first commencement of the concrete works to which the CWMS refers. The Employer will take maximum 7 days for issuing comments (if any) to be incorporated by the Contractor and resubmit/approval.

1.2.5 The resolution of such comments on the CWMS submission to the satisfaction of the Employer and the Employer's subsequent approval of the CWMS shall constitute a HOLD POINT on the commencement of the concrete works to which the CWMS refers.

1.3 Notification of Concrete Placement and Weekly Reporting

1.3.1 The Contractor shall give at least 24 hours advance notice to the Employer prior to his intended commencement of concrete placement in the works to enable the Employer or his representative to inspect the installed reinforcement and any cast-in fitments.

1.3.2 The inspection and acceptance of the installed reinforcement and any cast-in fitments by the Employer shall constitute a HOLD POINT on the placement of concrete in that section of the Works.

1.3.3 The placement of concrete in the Works shall constitute a WITNESS POINT for the Employer or his delegated representative.

1.3.4 The Contractor shall submit to the Employer each week his working programme for the concrete works scheduled for the following week including a breakdown of activities planned for each day such that the Employer can coordinate his inspection of the works.

2 MATERIALS

2.1 Cement

2.1.1 Cement to be used in the works shall be any one of the following types with the prior approval of the Employer:

(a) Ordinary Portland Cement, 53 Grade, conforming to IS: 12269.
(b) Portland Pozzolana Cement, conforming to IS: 1489 Part I and II

2.1.2 Cement conforming to IS: 12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS: 456 are sulphate concentration in excess of 0.2 percent in soil sub-strata or 300 ppm (0.03 percent) in ground water. Tests to confirm actual values of sulphate concentration are essential when the structure is located near the sea coast, chemical factories, and agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS: 12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 540 kg/cum of concrete.

2.1.3 Cement conforming to IS: 8041 shall be used only for precast concrete products after specific approval of the Employer.

2.1.4 Total chloride content in cement shall in no case exceed 0.05 percent by mass of cement. Also, total Sulphur content calculated as sulphuric anhydride (SO3) shall in no case exceed 2.5 percent and 3.0 percent when

tri-calcium aluminate percent by mass is up to 5 or greater than 5 respectively.

2.1.5 Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high as per IS 4082. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.

2.1.6 Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the Contractor without charge to the Employer.

2.1.7 The Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Employer at all times.

2.1.8 The Contractor shall make a monthly return to the Employer on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

2.2 **Coarse Aggregates**

2.2.1 For plain and reinforced cement concrete (PCC and RCC) coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali-silica reaction shall not be used. All coarse aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, Parts I to VIII.

2.2.2 The contractor shall submit for the approval of the Employer, the entire information of making aggregates from quarry stones. Further reference to conform in line with Appendix A of IS: 383.

2.2.3 Maximum nominal size of coarse aggregate for various structural components in PCC, RCC shall conform to Section9B902.1

2.2.4 The maximum value for flakiness index for coarse aggregate shall not exceed 35 percent. The coarse aggregate shall satisfy the following requirements of grading:

IS Sieve Size	Percent Weight Passing the Sieve		
	40 mm	20 mm	12.5 mm
63 mm	100	-	-
40 mm	95-100	100	-
20 mm	30-70	95-100	100
12.5 mm	-	-	90-100
10 mm	10-35	25-55	40-85
4.75 mm	0-5	0-10	0-10

2.2.5 Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard, levelled and well drained. If necessary, the ground shall be covered with 50 mm plank. The total amount of deleterious/ foreign materials shall not exceed 5% by weight according to IS 383-1970. If the contamination is found to be exceeding the limit, the stone metal shall be screened and washed before using.

2.2.6 Coarse aggregates, unless otherwise agreed by the Employer in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more). Aggregates placed directly on the ground shall not be removed from the stockpile within 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

2.3 **Sand/Fine Aggregates**

2.3.1 For plain and reinforced cement (PCC and RCC) concrete works, fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorized sand washing machines should be used for screening and removal of foreign material, pebbles and other material from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, (Parts I to VIII). The Contractor shall submit to the Employer the entire information indicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

2.3.2 Sand/fine aggregate for structural concrete shall conform to the following grading requirements:

IS Sieve Size	Percent by Weight Passing the Sieve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 microns	15-34	35-59	60-79
300 microns	5-20	8-30	12-40
150 microns	0-10	0-10	0-10

2.4 Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard, levelled and well drained. If necessary, the ground shall be covered with 50 mm plank.

2.5 **Water**

2.5.1 Only Potable water shall be used for construction work. Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted. As a guide, the following concentrations represent the maximum permissible values:

(a) To neutralise 200 ml sample of water, using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.

(b) To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCI.

(c) The permissible limits for solids shall be as follows when tested in accordance with IS: 3025:

(d) Permissible Limits (max)

Organic	200 mg/lit
Inorganic	3000 mg/lit
Sulphates (SO4)	500 mg/lit
Chlorides (CI)	500 mg/lit
Suspended matter	2000 mg/lit

* In case of building structures, the permissible limit of chlorides may be increased up to 1000 mg/litre.

2.5.2 All samples of water (including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements stated herein.

2.5.3 The pH value shall not be less than 6 and water shall meet all the requirements mentioned in Clause 5.4 of I S: 456-2000.

3 CONCRETE ADMIXTURES

3.1 General

3.1.1 Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state.

3.1.2 Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and full-fledged laboratory facilities for the manufacture and testing of concrete.

3.1.3 The contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

(a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.
(b) The chemical names of the main ingredients in the admixtures.
(c) The chloride content, if any, expressed as a percentage by the weight of the admixture.
(d) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.
(e) Whether or not the admixture leads to the entrapment of air when used as per the manufacturer's recommended dosage, and if so to what extent.
(f) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.
(g) Confirmation that there would be no risk of corrosion of the reinforcement or other embedment as a result of using the admixture.

3.2 Physical and Chemical Requirements

3.2.1 Admixtures shall conform to the requirements of IS: 9103. In addition, the following conditions shall be satisfied:

3.2.2 "Plasticizers" and "Super–Plasticizers" shall meet the requirements indicated for "Water reducing Admixture".

3.2.3 Except where resistance to freezing and thawing and to disruptive action of de-icing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS: 1199 shall not be more than 2 percent higher than that of the corresponding control mix and in any case not more than 3 percent of the test mix.

3.2.4 The chloride content of the admixture shall not exceed 0.2 percent when tested in accordance with IS: 6925. In addition, the maximum permissible

limit of chloride content of all the constituents as indicated in Section B-1200 shall also be observed.

3.2.5 Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

3.2.6 The tests that shall be performed along with permissible variations in the same are indicated below (as per IS 9103):

(a) Dry Material Content: to be within 3 percent and 5 percent of liquid and solid admixtures respectively of the value stated by the manufacturer.
(b) Ash content: to be within 1 percent of the value stated by the manufacturer.
(c) Relative Density (for liquid admixtures): to be within 2 percent of the value stated by the manufacturer.

3.2.7 All tests relating to the concrete admixtures shall be conducted periodically at an independent laboratory approved by the Employer and compared with the data given by the manufacturer.

4 CONCRETE REQUIREMENTS

4.1 The following minimum requirements shall apply to reinforced concrete in land structures. Land structures comprise all reinforced concrete structures in buildings and on precast concrete piles or sub-base.

Land Structures	
Maximum Water/Cement Ratio by Weight	0.45
Minimum Cement Content	400 kg/m3
Minimum 28-day Strength (Cube)	30 MPa
Maximum Drying Shrinkage (28 days)	500 macro strain
Slump	80mm*

* to be obtained by the use of an approved superplasticizer / high range water reducing agent as appropriate.

5 GRADES OF CONCRETE

5.1 General

5.1.1 The grades of concrete shall be designated by the specified characteristic compressive strength as given in Table below(as per table 2 of IS 456.), where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Grade Designation	Specified Characteristic Compressive Strength of 150 mm cubes at 28 days, in N/mm2
M 15	15
M 20	20
M 25	25
M 30	30

Grade Designation	Specified Characteristic Compressive Strength of 150 mm cubes at 28 days, in N/mm2
M 35	35
M 40	40
M 45	45
M 55	55

5.1.2 The specified characteristic compressive strength of structural concrete elements to be constructed under this Contract is as defined on the Drawings. Concrete for blinding or non-structural mass concrete fill applications shall be Grade M 20 unless noted otherwise on the Drawings.

5.1.3 If the Contractor so elects, the Employer may permit the use of higher-grade concrete than that specified on the drawing, in which event the higher-grade concrete shall meet the specifications applicable thereto without additional compensation.

5.1.4 Design Mix Concrete shall be used for all structural concrete works and shall be subject to the requirements for Design Mix Concrete set out in these specifications.

5.1.5 Notwithstanding the above, where proposed by the Contractor, the Employer may at his sole discretion permit the use of Nominal Mix Concrete for Grade M 20 non-structural unreinforced mass concrete fill or blinding concrete which shall be subject to the requirements for Nominal Mix Concrete set out in these specifications.

5.2 Size of Coarse Aggregate

5.2.1 The size (maximum nominal) of coarse aggregates for concrete to be used in the works shall be 20mm except in confined or constrained applications where the maximum nominal size may be reduced to 10mm on a case by case basis subject to the agreement of the Employer.

5.2.2 The proportions of the various individual sizes of aggregates shall be so adjusted that the grading produces densest mix.

6 REQUIREMENTS FOR DESIGN MIX CONCRETE

6.1 General

6.1.1 The Contractor shall design concrete mixes for all Design Mix Concrete in accordance with the requirements of IS:456 and Mix Design Code (IS 10262 latest). The mix designs shall be based on the prevailing site and service conditions and shall be designed such that the requirements of these specifications are met.

6.2 Target Mean Strength

6.2.1 The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the ‘current margin’.

(a) The current margin for a concrete mix shall be determined by the Contractor and shall be taken as 1.65 times the standard deviation of

samples test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.

(b) Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table below:

Concrete Grade	Current Margin (N/mm^2)	Target Mean Strength (N/mm^2)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58

6.2.2 The initial current margin given in the Table above shall be used till sufficient data is available to determine the current margin as per sub-clause (a) above.

6.3 **Durability Requirements**

6.3.1 Durability requirements for Design Mix Concrete shall be based on the specified exposure class for the various concrete elements to be constructed under this Contract as given in Table below.

Exposure Class	Concrete Elements
Severe	Non-structural Mass Concrete Fill and Blinding Concrete
	Service Pits and Drainage Structures
	High Mast Light Tower Footings
	Concrete Kerbs and Edge Beams for Landside Pavement / Road works
Extreme	Bored Concrete Piles/ Precast Piles
	Precast Beams and slabs, kerb etc.
	In-situ Concrete Topping, Beams, Pile Caps, all marine concrete elements
	All other concrete elements unless deemed otherwise by the Employer

6.3.2 The minimum cement content and water-cement ratios shall be maintained for the specified exposure classes as indicated in Table below.

Exposure Class	Min. cement content (kg/cum)	Maximum Water cement ratio
Severe	400	0.45
Extreme	420	0.40

(a) The minimum cement content is based on 20 mm aggregate (nominal max. size).
(b) For underwater concreting, the cement content shall be increased by 10 percent.

6.3.3 The cement content shall be low as possible but not less than the quantities specified above. In no case shall it exceed 540 kg/cum of concrete.

6.3.4 The chloride content of the coarse and fine aggregate (determined in accordance with B.S. 812: Part 117), combined in the proportions intended for the particular concrete, shall not exceed 0.02% chloride ion by mass of combined aggregate.

6.3.5 Measures to control the occurrence of alkali-aggregate reaction (AAR) in concrete for all concrete elements shall be submitted to the Employer for approval. In the absence of alternative proposals such control shall be achieved by limiting the reactive alkali content of the concrete. The properties of aggregates shall be such that the reactive alkali of any concrete used in the Contract expressed as the equivalent sodium oxide per cubic meter of concrete shall not exceed 3.0 kg.

7 WORKABILITY REQUIREMENTS

7.1 The mix shall have the consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency.

7.2 The workability tests shall be carried out in accordance with IS 1199: Method of sampling & analysis of concrete.

7.3 The Contractor shall nominate the target slump for the Design Mixes within the ranges nominated in Table below, or as directed by the Employer. The slump of concrete shall be checked as per IS 1199.

S. No.	Structure Type	Slump (mm)
1.	RCC structures with widely spaced reinforcements, e.g. solid columns, footings,	40–50
2.	RCC structures with fair degree of congestion of reinforcement; e.g. junction of quay beam and pile, walls with thickness greater than 300 mm, beam column junction etc.	50– 75
3.	RCC structures with highly congested	75 – 125

S. No.	Structure Type	Slump (mm)
	reinforcements e.g. walls with thickness less than 300 mm	
4.	Concreting through tremie e.g. cast-in-situ piling	100 – 200
5.	Pavement Quality Concrete	25 - 30

8 SHRINKAGE REQUIREMENTS

8.1 For all Design Mixes, the maximum drying shrinkage strain of concrete specimens prepared and tested in accordance with IS shall be as follows;

(a) After 21 days drying period: 500 micro strain
(b) After 56 days drying period: 700 micro strain

9 ADMIXTURES

9.1 Water-reducing admixtures (including plasticizers or super-plasticizers) may be used at the Contractor's option, subject to the approval of the Employer. Other types of admixtures shall be prohibited, unless specifically permitted by the Employer.

9.2 Where two or more admixtures are proposed for incorporation into a concrete mix, their compatibility shall be certified by the manufacturers. No admixtures shall be used without written approval from the Employer.

9.3 As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of his products only after obtaining complete knowledge of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the project.

10 ADDITIONAL REQUIREMENTS

10.1 Concrete shall meet with any other requirements as specified on the drawing or as directed by the Employer. Additional requirements shall also consist of the following overall limits of deleterious substances in concrete:

(a) The total chloride content of all constituents of concrete as a percentage of mass of cement in mix shall be limited to 0.2 percent.
(b) The total sulphuric anhydride (SO_3) content of all constituents of concrete as a percentage of mass of cement in the mix shall be limited to 4 percent.

11 TRIAL MIXES

11.1 The Contractor shall give notice to enable the Employer to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor shall prepare trial mixes, using samples of approved materials typical of those he proposes to use in the works, for all grades to the Employer's satisfaction prior to commencement of concreting. The initial trial mixes shall generally be carried out and witnessed by the Employer or

Employer's representative in an established laboratory approved by the Employer.

11.2 In exceptional cases, the Employer may at his sole discretion permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full-fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. In all cases complete testing of materials forming the constituents of proposed Design Mix shall have been carried out prior to making trial mixes.

11.3 Sampling and testing procedures shall be in accordance with these specifications.

11.4 During the finalization of Trial Mixes, the relationship between compaction factor and slump test shall be established for each grade of concrete as well as for various levels of workability.

11.5 When the site laboratory is utilized for preparing initial mix design, the concrete plant shall be able to produce the same mix proportion and means of transport of pre-mixed concrete shall be by transit mixers from the batching plant to the work location.

11.6 Test cubes shall be taken from trial mixes as follows. For each mix, set of six cubes shall be made from each of three consecutive batches. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Employer. The cubes shall be made, cured, stored, transported and tested in accordance with these specifications.

12 SUBMISSION OF DESIGN MIXES

12.1 The Contractor shall submit the following information for the Employer's approval for each Design Mix:

(a) Nature and source of each material and current test results not more than 12 months old demonstrating compliance with the materials requirements of these specifications;
(b) Quantities of each material per cubic metre of fully compacted concrete;
(c) Either of the following:
  (i) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement(s) as specified.
  (ii) Full details of tests on trial mixes.

12.2 The Contractor shall submit the above documentation demonstrating that the proposed Design Mix conforms with the requirements of these specifications to the Employer for acceptance at least 14 days before the Design Mix is proposed to be used. The acceptance of this submission by the Employer shall constitute a HOLD POINT on the use of the Design Mix in the works.

13 VARIATION TO DESIGN MIXES

13.1 Any change in the source of material or in the mix proportions shall be subject to the Employer's prior approval.

(a) Adjustment to Mix Proportions
  (i) Adjustments to mix proportions arrived at in the trial mixes shall be made subject to the Employer's approval, in order to minimise the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

(b) Change of Current Margin
  (i) When required by the Employer, the Contractor shall recalculate the current margin as deemed appropriate. The recalculated value shall be adopted as directed by the Employer, and it shall become the current margin for concrete produced subsequently.

(c) Additional Trial Mixes
  (i) During production, the Contractor shall carry out trial mixes and tests, if required by the Employer, before substantial changes are made in the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with this clause.

14 REQUIREMENTS FOR NOMINAL MIX CONCRETE

14.1 Requirements for nominal mix concrete unless otherwise specified shall be as detailed in Table below.

Concrete Grade	**Total Quantity of dry aggregate by mass per 50 kg of cement to be taken as the sum of individual masses of fine and coarse aggregates (kg)**	**Proportion of fine to Coarse aggregate (by mass)**
M 20	250	Generally, 1:2, subject to upper limit 1:1.5 and lower limit of 1:1.25

14.2 **Submission of Nominal Mix(s)**

14.2.1 The Contractor shall submit the following information for the Employer's approval for each Design Mix:

(a) Nature and source of each material and current test results not more than 12 months old demonstrating compliance with the materials requirements of these specifications;
(b) Statement giving the proposed mix proportions for nominal mix concrete.
(c) Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional

requirement(s) as specified.

14.2.2 The Contractor shall submit the above documentation demonstrating that the proposed Nominal Mix conforms with the requirements of these specifications to the Employer for acceptance at least 14 days before the Nominal Mix is proposed to be used. The acceptance of this submission by the Employer shall constitute a HOLD POINT on the use of the Nominal Mix in the works.

15 BATCHING AND MIXING OF CONCRETE

15.1 General

15.1.1 Details of equipment for the production, batching and mixing of concrete for use in the works shall be as proposed by the Contractor in his CWMS for the concrete works and shall be subject to the acceptance of the Employer and the requirements of these specifications.

15.1.2 Production of concrete for all Works shall be carried out using concrete batching and mixing plant fully automatic with minimum capacity of 30 cum per hour.

15.1.3 All materials, stockpile bins, silos and storage areas shall be clearly marked such that operators can read the labels from their normal working locations. Any cross contamination from one storage area to the other shall be treated as a non-conformance.

15.1.4 All measuring devices of the equipment shall be maintained in a clean and serviceable condition. Its accuracy shall be checked over the range in use, when set up at each site and thereafter periodically as directed by the Employer.

15.1.5 The accuracy of the measuring devices shall fall within the following limits:

(a) Measurement of Cement +3 percent of the quantity of cement in each batch
(b) Measurement of Water +3 percent of the quantity of water in each batch
(c) Measurement of Aggregate +3 percent of the quantity of aggregate in each batch
(d) Measurement of Admixture +5 percent of the quantity of admixture in each batch

15.1.6 Concrete shall be mixed either in a concrete mixer or in a batching and mixing plant, as per these specifications. Hand mixing shall not be permitted. The batching plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Employer. The batching capacity, method of loading, mixing time and speed of operation shall be measured by the Contractor and noted in the CWMS for the concrete works.

15.1.7 Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained. The mixing time from the time

of adding water shall be in accordance with IS 1791-1985, In no case shall mixing be done for less than 2 minutes or at least 40 revolutions.

15.1.8 Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Mixing plant shall be thoroughly cleaned before changing from one type of concrete to another.

15.1.9 The Contractor shall keep full and detailed batch records and materials test results for all concrete produced. Copies of the test results shall be submitted to the Employer progressively throughout the works and a full set shall be submitted upon completion of the Works.

16 TRANSPORTATION AND DELIVERY OF CONCRETE

16.1 General

16.1.1 Concrete shall be transported to the point of discharge by truck mounted drum mixers. On completion of mixing the concrete shall be continuously agitated until it is fully discharged.

16.1.2 The method of transporting and placing concrete shall be included in the Contractors CWMS for the concrete works and approved by the Employer. Concrete shall be transported and placed as near as practicable to its final position, so that no contamination, segregation or loss of its constituent materials takes place.

16.1.3 When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. Maximum fall height shall be limited to 1.2 m. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

16.1.4 The time from addition of the cement to the aggregates until concrete placement and compaction shall not exceed 60 minutes. Irrespective, concrete shall not be placed in the works if its consistency is outside the specified tolerances. Concrete when deposited shall have a temperature of not less than 5 degrees Celsius, and not more than 40 degrees Celsius. Under no circumstances shall water be added to a batched load of concrete. In all such matters, the Employer's decision shall be final.

16.2 Slump/Consistency

16.2.1 The slump of the concrete shall be tested in accordance with the requirements of IS 1199. If the measured slump is not within the specified limits, one repeat test shall be made immediately from another portion of the same sample. If the value obtained from the repeat test falls within the specified limits, the concrete represented by the sample shall be deemed to comply with the specified value, otherwise the load shall be rejected.

17 PLACEMENT, COMPACTION AND FINISHING OF CONCRETE

17.1 General

17.1.1 All formwork and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete.

17.1.2 No concrete shall be placed in any part of the structure until the approval of the Employer has been obtained.

17.1.3 If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Employer. Concreting then shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.

17.1.4 Except where otherwise agreed to by the Employer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not exceeding 300 mm in all other cases. Approved mechanical vibrators of adequate power and having a frequency of not less than 6000 impulses per minute shall be used for compacting concrete.

17.1.5 Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimise the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc., shall be avoided. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and a half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns.

17.1.6 Mechanical vibrators used are to comply with IS: 3558, IS:7246,

17.2 Finishing

17.2.1 Immediately after the removal of forms, all fins caused by form joints, all cavities produced by the removal of form ties other holes and depressions, honeycomb sports, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be

applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used subject to the approval of the Employer.

17.2.2 All construction and expansion joints in the completed work shall be carefully tooled and cleared from any mortar and concrete and filled with appropriate joint filler material.

17.2.3 Immediately on removal of forms, the concrete work shall be examined by the Employer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance shall be rejected. Surface defect of a minor nature may be accepted. On acceptance of such work by the Employer, the same shall be rectified as directed by the Employer.

17.3 **Construction Joints**

17.3.1 Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings, except with express approval of the Employer. The joint shall be provided as shown in the drawings.

17.3.2 Construction joint surfaces shall be formed by the use of surface retarders painted onto the surface of the construction joint form or stop end and subsequent high-pressure water blasting to achieve a pronounced profile with a surface roughness of not less than 3mm. All loose aggregate particles and laitance shall be removed.

17.3.3 Keyways shall be formed in all construction joints to provide resistance against shear across at least 40% of the section. Key ways shall be accurately formed to approved dimensions with formwork which will not be displaced during concreting. Water stops shall be provided at construction joints in water retaining structures and water tight structures, together with joint seals on the side retaining the water.

17.3.4 Immediately before placing fresh concrete against faces of previously placed and hardened concrete, the surface of construction joints shall be thoroughly cleaned and wetted with clean water and approved (Employer) bonding agents has to be applied as per specification such that the surface of the construction joint is moist when fresh concrete is placed against it. Horizontal joints in structures subject to vibration shall be covered with a thick layer of sand/cement mortar immediately prior to placing the concrete on them. The concrete shall be thoroughly vibrated against the joint.

18 CONCRETING UNDER WATER

18.1 General

18.1.1 When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used shall be got approved from the Employer before any work is started. Concrete shall contain 10 percent more cement than that required for the same mix placed in the dry.

18.1.2 Concrete shall not be placed in water having a temperature below 5 degrees Celsius. The temperature of the concrete, when deposited, shall not be less than 16 degrees Celsius, nor more than 40 degrees Celsius.

18.1.3 Cofferdams or forms shall be sufficiently tight to ensure still water conditions, if practicable, and in any case to reduce the flow of water to less than 3 meters per minute through the space into which concrete is to be deposited. Coffer dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter. To minimise the formation of laitance, great care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

18.1.4 All under water concreting shall be carried out by tremie method only, using tremie of appropriate diameter. The number and spacing of the tremies should be worked out to ensure proper concreting. The tremie concreting when started should continue without interruption for the full height of the member being concreted. The concrete production and placement equipment should be sufficient to enable the underwater concrete to be completed uninterrupted within the stipulated time. Necessary stand-by equipment should be available for emergency situation.

18.1.5 The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength for the job shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise slowly the tremie in order to allow a uniform flow of concrete, but it shall not be emptied so that water is not allowed to enter above the concrete in the pipe. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the concrete. This will

cause the concrete to build up from instead of flowing out over the surface and thus avoid formation of layers of laitance.

19 ADVERSE WEATHER CONDITIONS

19.1 Concreting in Inclement Weather

19.1.1 In the event of rainstorm or any other severe conditions arising, concreting shall be stopped and appropriate temporary stop ends, vee grooves, etc. placed as may be necessary. During wet weather, the concrete shall be adequately protected as soon as put into position.

19.1.2 The Contractor shall always have in readiness approved framed sheeting, tarpaulin, etc. for the protection of newly placed concrete during inclement weather. Should any concrete be damaged due to rainstorms or other weather conditions, the Employer may order the cutting out and replacement of the damaged concrete, all at the expense of the Contractor.

20 PROTECTION AND CURING

20.1 General

20.1.1 Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor.

20.1.2 Curing and protection of concrete shall start immediately after compaction of the concrete to protect it from:

(i) Premature drying out particularly by solar radiation and wind
(ii) High internal thermal gradients
(iii) Leaching out by rain and flowing water
(iv) Rapid cooling during the first few days after placing
(v) Low temperature or frost
(vi) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement

20.1.3 Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Employer.

20.2 Water Curing

20.2.1 Water for curing shall be as specified for use in Structural Concrete previously in this section.

20.2.2 Sea water shall not be used for curing. Sea water shall not come into contact with concrete members unless it has attained adequate strength.

20.2.3 Sprinkling of water shall be done after 2 hours of initial setting time and exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacks, canvas, Hessian cloth or similar materials which shall be covered with polyethylene sheet of minimum thickness of 250 microns and shall be kept constantly wet for a period of not less than 14 days from the date of placing of concrete.

20.3 **Steam Curing**

20.3.1 Where steam curing is adopted, it shall be ensured that it is done in a suitable enclosure to contain the live stream in order to minimise moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.

20.3.2 Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.

20.3.3 The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete and the ambient air temperature shall increase at a rate not exceeding 5 degrees Celsius per hour until a maximum temperature of 60 degrees Celsius to 70 degrees Celsius is reached. The maximum temperature shall be maintained until the concrete has reached the desired strength.

20.3.4 When steam curing is discontinued, the ambient air temperature shall not drop at a rate exceeding 5 degrees Celsius per hour until a temperature of about 10 degrees Celsius above the temperature of the air to which the concrete will be exposed, has been reached.

20.3.5 The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

20.4 **Curing Compounds**

20.4.1 Curing compounds shall only be permitted in special circumstances and will require specific approval of the Employer. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist, cured and no curing compound will be permitted in locations where concrete surface are required to be bonded together.

20.4.2 Curing compounds shall be continuously agitated during use. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately after acceptance of concrete finish. If the surface is dry, the concrete shall be saturated with water and curing compound applied as soon as the surface film of water disappears. The second application shall be made after the first application has set. Placement in more than two coats may be required to prevent streaking.

21 INSTALLATION OF PRECAST CONCRETE UNITS

21.1 General

21.1.1 Contact surfaces between in-situ concrete and precast concrete units shall be prepared as stated in the Contract. Dimensional tolerances shall be checked before the precast concrete units are lifted into position. All lifting, handling and storage procedures shall be approved by the Employer before their implementation.

21.1.2 Temporary supports and connections shall be provided as soon as practicable during installation of precast concrete units.

21.1.3 Final structural connections shall be completed as soon as practicable after the precast concrete units have been installed.

21.1.4 Levelling devices which have no load bearing function in the finished structure shall be slackened, released or removed after the precast concrete units have been installed.

21.1.5 The Contractor shall maintain records of the identification and serial number of each unit at each location where precast units are placed in the permanent Works. The records shall be submitted to the Employer within 7 days of the last concrete poured on each individual structure or part of structure as agreed in advance with the Employer.

21.1.6 Any pre-cast concrete unit, which is damaged or has any perceptible faults, will be liable to be rejected by Employer.

21.1.7 Concrete beams shall not normally be placed in position less than 28 days after casting of the sub-structures. Should an earlier placing time be required the Contractor shall provide design calculations to show the sub-structure is of adequate strength to support the beams.

22 TOLERANCES

22.1 Tolerances for dimensions/shape of various components shall be as indicated in these specifications or as directed by the Employer.

22.2 Unless otherwise specified the tolerance in position for in-situ concrete in the finished Work shall be:-

(a) Variation of level or lateral position of any point from its level or lateral position indicated on or computed from the drawings to be 12 mm

(b) not withstanding (a) above variation from the vertical in any 3 m 6 mm in any 12 m 18 mm

(c) variation in slab and wall thickness + 6 mm, - 2 mm

(d) maximum rate of deviation from mean level of any surface or any beam soffit in any 3m to be 3 mm

(e) maximum deviation from nominal cross section dimensions of columns, beams, walls, floors, roof slabs, and other structures including dimensions of openings in all in-situ concrete (but excluding stressed members)

(i) dimension less than 150mm: + 10 mm, - 2 mm

(ii) dimension of 150mm or greater: + 12 mm, - 3 mm

(f) maximum deviation from any nominal cross section for stressed members
   (i) dimension less than 75mm + 2mm, - 0mm
   (ii) dimension of 75mm to 450mm + 3mm- 0mm
   (iii) dimension over 450mm + 5mm, - 0mm
   (iv) maximum rate of deviation in any 3m 3mm

(g) maximum differential in surface across deck joint to be 3 mm

22.3 Unless otherwise specified the tolerances for precast concrete construction in the finished work shall be as given in BS 8110 Part I Clause 6.11 with the following exceptions: -

(a) for straightness both in plan and elevation the tolerance shall be half that specified;
(b) for the length of beams the tolerance shall be + 10 mm.

22.4 The allowable tolerances noted above shall never be allowed to cause an abrupt or visible change in the face of the finished concrete.

22.5 The position of cast in items in in-situ concrete shall be controlled, including the use of templates where appropriate, to achieve a tolerance in position (variation in level or lateral position) from the position indicated or computed of ±3mm.

22.6 Discrepancies in dimensions of the concrete construction works shall be rectified by methods approved by the Employer. If the said concrete construction works cannot be rectified to the satisfaction of the Employer, the concrete construction works shall be removed and reconstructed.

23 TESTS AND STANDARDS OF ACCEPTANCE

23.1 General

23.1.1 Concrete shall conform to the surface finish and tolerance as prescribed in these specifications for respective components.

23.1.2 Random sampling and lot by lot of acceptance inspection shall be made for the 28 days cube strength of concrete.

23.1.3 Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following:

(a) No individual lot shall be more than 30 cum in volume;
(b) At least one cube forming an item of the sampling representing the lot shall be taken from concrete of the same grade and mix proportions cast on any day;
(c) Different grades of mixes of concrete shall be divided into separate lots;
(d) Concrete of a lot shall be used in the same identifiable component of the structure.

23.2 **Sampling and Testing**

23.2.1 Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure laid down in IS: 1199.

23.2.2 A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, that is the sampling should be spread over the entire period of concreting and cover all mixing units.

23.2.3 150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS: 516. The 28-day test strength result for each cube shall form an item of the sample. In all cases 28-day compressive strength specified in Table-2 of IS: 456-2000 shall alone be the criterion for acceptance or rejection of the concrete.

23.3 **Test Specimen and Sample Strength**

23.3.1 Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

23.3.2 The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than + 15 percent of the average.

23.4 **Frequency**

23.4.1 The minimum frequency of sampling of concrete of each grade shall be in accordance with Table below(clause 15.2 of IS: 456-2000).

Quality of concrete in work, m^3	**No. of samples**
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
51 – and above	4 plus one additional sample for each additional 50 m3 or part thereof

23.4.2 At least one sample shall be taken from each shift of work.

23.5 **Acceptance Criteria**

23.6 **Compressive Strength**

23.6.1 When both the following conditions are met, the concrete complies with the specified compressive strength:

23.6.2 The mean strength determined from any group of four consecutive samples should exceed the specified characteristic compressive strength.

23.6.3 Strength of any sample is not less than the specified characteristic compressive strength.

23.6.4 The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

23.7 **Chloride and Sulphate Content**

23.7.1 The total chloride and sulphuric anhydride (SO_3) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this section of the specifications.

23.8 **Density of Fresh Concrete**

23.8.1 Where minimum density of fresh concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

23.9 **Density of Hardened Concrete**

23.9.1 Where minimum density of hardened concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

23.10 **Permeability Test**

23.10.1 The concrete should pass the following test if it is properly compacted and is not considered permeable.

(i) Prepare a cylindrical test specimen 150 mm dia and 160 mm high
(ii) After 28 days of curing, the test specimen is fitted in a machine such that the specimen can be placed in water under pressure up to 7 bars.
(iii) At first a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for next 24 hours.
(iv) After the passage of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.
(v) The water penetration in the broken core is to be measured with a scale and the depth of penetration assessed in mm (max. permissible limit 25 mm).

23.10.2 If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be

investigated by the Contractor as directed by the Employer. The Employer may accept the concrete as sub-standard work. Any additional work required by the Employer for such acceptance shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable after investigation, the Contractor shall remove the rejected concrete forthwith.

H STEEL REINFORCEMENT

1 DESCRIPTION

1.1 General

1.1.1 This work shall consist of furnishing and placing uncoated mild steel or high strength deformed reinforcement bars of the shape and dimensions conforming to these Specifications or as approved by the Employer.

1.1.2 Reinforcements should be Corrosion Resistant Steel (CRS) high strength deformed TMT bars. Reinforcements shall be uncoated unless specified otherwise or directed by the Employer.

2 MATERIALS

2.1 Reinforcement

2.1.1 For Reinforced Cement Concrete (RCC) works, the reinforcement shall consist of the following grades of reinforcing bars (as designated on the Drawings).

Grade Designation	Bar Type conforming to governing IS Specification	Characteristic Strength fy (MPa)	Elastic Modulus (GPa)
Fe 500 D	IS: 1786 CRS TMT High Yield Strength Deformed Bars (HYSD)	500	200

2.1.2 Other grades of bars conforming to IS: 1786 shall not be permitted.

2.1.3 All steel shall be procured from original producers; no re-rolled steel shall be incorporated in the work.

2.1.4 Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

2.1.5 The reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms, skids, or other supports with well-drained surface, and shall be protected from mechanical injury and from deterioration by exposure.

2.1.6 The unit weight and cross sectional area of the reinforcement bar shall be as per the as per IS 1786 Clause 6.2, Table 2

3 WORKMANSHIP

3.1 Protection of Reinforcement

3.1.1 Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sand blasting, mechanical wire brushing, etc., as directed by the Employer. Reinforcements shall be stored on block, racks or platforms and above the

ground in a clean and dry condition and shall be suitably marked to facilitate inspection and identification.

3.1.2 Portions of uncoated reinforcing steel and dowels projecting from concrete shall be protected within one week after initial placing of concrete with a brush coat of neat cement mixed with water. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete.

3.2 **Bending of Reinforcement**

3.2.1 Bar bending schedule shall be furnished by the Contractor and approved by the Employer before start of work. For approval, Bar Bending schedule shall be submitted to the Employer at least two weeks before the bars are to be bent.

3.2.2 Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules.

3.2.3 Bars shall be bent cold to the specified shape and dimensions or as directed by the Employer using a proper bar bender, operated by hand or power to obtain the correct radii of bends and shape.

3.2.4 Bars shall not be bent or straightened in a manner that will damage the parent material or the coating.

3.2.5 Bars bent during transport or handling shall be straightened before being used on work and shall not be heated to facilitate straightening.

3.3 **Placing of Reinforcement**

3.3.1 The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. Prolonged time gap between assembling of reinforcements and casting of concrete, which may result in rust formation on the surface, shall not be permitted.

3.3.2 Reinforcement bars shall be placed accurately in position as shown on the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to IS: 280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1mm.

3.3.3 Bars shall be kept in position usually by the following methods:

(a) In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover shall be placed between the bars and formwork subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Employer, provided they have the same strength and specifications as those of the member.

(b) In case of dowels for columns and walls, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concreting has progressed up to a level just below their location.

(c) Layers of reinforcements shall be separated by spacer bars at approximately one metre intervals. The minimum diameter of spacer bars shall be 12 mm or equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be allowed to sag between supports.

(d) Necessary stays, blocks, metal chairs, spacers, metal hangers, supporting wires etc. or other subsidiary reinforcement shall be provided to fix the reinforcements firmly in its correct position.

(e) Use of pebbles, broken stone, metal pipe, brick, mortar or wooden blocks etc., as devices for positioning reinforcement shall not be permitted.

(f) Sufficient to say that reinforcement placement should be done as per IS 2502: code of practice for bending and fixing of bars for concrete reinforcement (latest revision)

3.3.4 Placing and fixing of reinforcement shall be inspected and approved by the Employer before concrete is deposited. When indicated diameter of reinforcement bar is not available, the Contractor shall use other diameter of reinforcement bars on written approval of the Employer.

4 BAR SPLICES

4.1 Lapping

4.1.1 All reinforcement shall be furnished in full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing, will be permitted without approval of the Employer. The lengths of the splice shall be as indicated on drawing or as approved by the Employer. Overlapping bars shall be bound with annealed steel binding wire, not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface. Lapped splices shall be staggered or located at points, along the span where stresses are low. Lapping of bars shall be done in accordance with the relevant requirements specified in IS: 456 Code of Practice for Plain and Reinforced Concrete (Latest Revision). Laps shall be staggered.

4.2 Welding

4.2.1 Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Employer. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

4.2.2 The method of welding shall conform to IS: 9417 and to any supplemental specifications to the satisfaction of the Employer.

4.2.3 Welding may be carried out by metal arc welding process. Precautions on overheating, choice of electrode, selection of correct current in arc welding etc., should be strictly observed. Oxy-acetylene welding shall not be used.

4.2.4 When appropriate lap lengths are not available, all bars shall be butt welded conforming to IS: 9417except for smaller diameter bars (diameter of less than 20 mm) which may be lap welded. Single-V or Double-V butt joints may generally be used. For vertical bars single bevel or double bevel joints may be used.

4.2.5 Welded joints shall be located well away from bends and not less than twice the bar diameter away from a bend.

4.2.6 Generally, shop welding in controlled conditions is to be preferred, where feasible. Site welding where necessary shall, however, be permitted when the facilities, equipment, process, consumables, operators, welding procedure are adequate to produce and maintain uniform quality at par with that attainable in shop welding to the satisfaction of the Employer.

4.2.7 Joint welding procedures which are to be employed shall invariably be established by a procedure specification. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS: 9417. Visual Inspection of welds and quality control tests shall conform to IS: 9417 and destructive or non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional check inspection shall not be accepted.

4.2.8 M.S. electrodes used for welding shall conform to IS: 814.

4.3 Mechanical Coupling of Bars

4.3.1 Bars may be jointed with approved patented mechanical devices conforming to IS: 16172 and as indicated on the drawing or as approved by the Employer e.g. by special grade steel sleeves swaged on to bars in end to end contact or by screwed couplers. In case such devices are permitted by the Employer, they shall develop at least 125 percent of the characteristic strength of the reinforcement bar. The coupler shall be qualified as per ASME, Section III, and Div.2.

5 TESTING AND ACCEPTANCE

5.1 General

5.1.1 The material shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, will be got carried out by the Contractor at his own cost.

5.1.2 The fabrication, furnishing and placing of reinforcement shall be in accordance with these specifications and shall be checked and accepted by the Employer.

I STRUCTURAL METALWORK

1 DESCRIPTION

1.1 This work shall include furnishing, fabricating, transporting, erecting and painting structural steel, and other incidental metal construction of the kind, size and quantity in conformity with the drawings and these specifications or as desired by the Employer.

2 GENERAL

2.1 General requirements relating to the supply of material shall conform to the specifications of IS: 1387, for the purpose of which the supplier shall be the Contractor and the purchaser shall be the Employer.

2.2 The technical requirements of this Specification are the absolute minimum acceptable. Where not specifically referenced herein, materials and workmanship shall comply with the latest edition and amendments of the applicable Indian Standard.

3 MATERIALS

3.1 General

3.1.1 Unless otherwise permitted herein, all structural steel shall before fabrication comply with the requirements of the following Indian Standards:

IS: 808: Specifications for Rolled Steel Beam, Channel and Angle Sections
IS: 1161: Steel Tubes for Structural Purposes Specification
IS: 1239: Mild Steel Tubes
IS: 1730: Dimension for Steel Plate, sheet and strip for structural and general Engineering purposes
IS: 1731: Dimension for Steel flats for structural and general Engineering purposes
IS: 1732: Dimension for round and square steel bars for structural and general Engineering purposes
IS: 1852: Rolling and cutting tolerances for hot rolled steel products
IS: 2062: Steel for General Structural Purposes Specification
IS: 4923: Hollow Steel sections for structural use
IS: 11587: Structural weather resistant steel

3.1.2 The use of structural steel not covered by the above standards may be permitted only with the specific approval of the Employer.

3.2 Welding consumables

Welding consumables shall comply with the following Indian Standards as appropriate:

IS: 814 Covered Electrodes for Metal Arc Welding of structural steel for (Part 1) welding other than sheet
IS: 814 For welding sheets (Part 2)
IS: 816 Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel.

IS: 822	Code of Procedures for Inspection of Welds
IS: 1278	Filler rods and wires for gas welding
IS: 1395	Low and medium alloy Steel covered electrodes for manual Metal Arc Welding
IS: 3613	Acceptance Tests for wire flux combinations for sub-merged arc welding of structural steel
IS: 7280	Bare wire electrodes for gas shield arc welding of structural steel
IS: 6419	Welding rods and bare electrodes for gas shielded arc welding of structural steel

3.2.1 In aggressive environment, corrosion resistant steel can be used. These are low-alloyed steels containing a total of 1 percent – 2 percent alloys, in particular, copper, chromium, nickel and phosphorous.

4 TECHNICAL REQUIREMENTS

4.1 Materials

4.1.1 Type and Grade of Steel unless otherwise shown on the Drawings, all steel shall comply with other types and grades of steel shall not be used without the Employer's approval. Stainless steel plates and sections shall have a minimum 0.2% proof stress of 300MPa unless noted otherwise on the Drawings.

4.1.2 All materials shall be new and surface defects shall be removed using the method specified in the appropriate standard

5 SUPPLY AND SUBSTITUTION

5.1 Substitution of structural sections, grade or length shall not be made without the written permission of the Employer.

5.2 Members shall be made of single lengths unless otherwise permitted by the Employer in writing.

6 TESTING

6.1 The Contractor shall obtain from the respective manufacturers for all steel and aluminium, test certificates stating that these materials have been tested and found to comply with the requirements of the relevant standards and shall forward these to the Employer. The Contractor should arrange for In-situ tests of all stainless steel material to ascertain the quality of material i.e. stainless steel fixtures/accessories as per manufacturer's standard / BIS / ASTM standard, to the satisfaction of Employer.

7 DIMENSIONS

7.1 The Contractor shall verify all dimensions and be responsible for their accuracy.

7.2 Any discrepancies shall be referred to the Employer immediately and an instruction obtained before work on the affected part is commenced.

8 FORMWORK

8.1 The formwork shall be properly designed, substantially built and maintained for all anticipated loads. The Contractor, if required, shall submit plans for approval to the Employer. Approval of the plans, however, shall not relieve the Contractor of his responsibility.

9 STRAIGHTENING BENT MATERIAL

9.1 The straightening of plates, angles and other shapes shall be done by methods not likely to produce fracture or any injury. The metal shall not be heated unless permitted by the Employer for special cases, when the heating shall not be to a temperature higher than that producing a dark “cherry red” colour, followed by as slow cooling as possible. Following the straightening of a bend or buckle the surface shall be carefully investigated for evidence of fracture. Sharp kinks and bends may be the cause for rejection of material.

10 FIELD INSPECTION

10.1 General

10.1.1 All materials, equipment and work shall be subject to the inspection of the Employer who shall be provided with all facilities including labour and tools required at all reasonable times. Any work found defective is liable to be rejected.

10.1.2 No protective treatment shall be applied to the work until the appropriate inspection and testing has been carried out. The stage inspection shall be carried out for all operations so as to ensure the correctness of fabrication and good quality. Girder dimensions and camber shall not be finally checked until all welding and heating operations are completed and the member has cooled to a uniform temperature.

10.2 Testing of Material

10.2.1 Structural steel shall be tested for mechanical and chemical properties as per various IS codes as may be applicable and shall conform to requirements specified in IS: 2062, IS: 11587, IS: 977, IS: 8500 and IS: 961, etc.

10.2.2 Rolling and cutting tolerance shall be as per IS: 1852. The thickness tolerance check measurements for the plates and rolled sections shall be taken at not less than 15 mm from edge.

10.2.3 Steel work shall be inspected for surface defects and exposed edge laminations during fabrication and blast cleaning. Significant edge laminations found shall be reported to the Employer for his decision.

10.2.4 Chipping, grinding, machining or ultrasonic testing shall be used to determine depth of imperfection.

11 WELDING AND WELDING CONSUMABLES

11.1 Welding procedure, welded connection and testing shall be in compliance with codal requirements.

11.2 All facilities necessary for stage inspection during welding and on completion shall be provided to the Employer or their inspecting Authority by manufacturer.

11.3 Adequate means of identification either by identification mark or other record shall be provided to enable each weld to be traced to the welder(s) by whom it was carried out.

11.4 All metal arcs welding shall be in compliance with IS: 9595 provisions.

11.5 The method of inspection shall be in accordance with IS: 822 and extent of inspection and testing shall be in accordance with the relevant standards or in the absence of such a standard, as agreed with the Employer.

12 PROCEDURE TESTS

12.1 The Destructive and Non-Destructive test of weld shall be carried out according to IS: 7307 (Part I).

12.2 One or more of the following methods may be applied for inspection or testing of weld:

(i) Visual Inspection: All welds shall be visually inspected, which should cover all defects of weld such as size, porosity, crack in the weld or in the HAZ (Heat Affected Zone) etc. Suitable magnifying glass may be used for visual inspection. A weld shall be acceptable by visual inspection if it shows that:
   (a) The weld has no cracks.
   (b) Thorough fusion exists between weld and base metal and between adjacent layers of weld metal.
   (c) Weld profiles are in accordance with requisite clauses of IS: 9595 or as agreed with the Employer.

12.3 The weld shall be of full cross section, except for the ends of intermittent fillet welds outside their effective length.

12.4 Magnetic Particle and Radiographic Inspection: Welds that are subject to radiographic or magnetic particle testing in addition to visual inspection shall have no crack.

12.5 Magnetic particle test shall be carried out for detection of crack and other discontinuity in the weld according to IS: 5334.

12.6 Radiographic test shall be carried out for detection of internal flaws in the weld such as crack, piping porosity inclusion, lack of fusion, incomplete penetration, etc. This test may be carried out as per IS: 1182 and IS: 4853.

12.7 Acceptance Criteria: The weld shall be unacceptable if radiographic or magnetic particle testing shows any of the type of discontinuities indicated in the code.

(g) Ultrasonic Inspection: The Ultrasonic testing in addition to visual inspection shall be carried out for detection of internal flaws in the weld such as cracks, piping porosity inclusion, lack of fusion, incomplete penetration etc. Acceptance criteria shall be as per IS: 4260 or any other relevant IS Specification and as agreed to by the Employer.

(h) Liquid Penetration Inspection: The liquid penetrant test shall be carried out for detection of surface defect in the weld, as per IS: 3658, in addition to visual inspection.

12.8 Any lamination, lamellar tearing or other defect found shall be recorded and reported to Employer for his decision.

J PROTECTIVE COATINGS FOR STEELWORKS

1 INTRODUCTION

1.1 Purpose

1.1.1 This Specification defines the technical requirements for protective coatings for the Steel and Civil Works.

2 SCOPE

2.1 This Specification covers the surface preparation and application of protective coatings to steel surfaces. Steel items to which protective coatings are to be applied include but are not limited to building roof frames and trusses, pipes, pipe and cable supports, platforms, walkways, ladders, stairs and handrails, grating, bollards, miscellaneous steel, holding down and anchor bolts, U bolts for fenders and bolts, nuts and washers.

2.2 Surface of grade 316 stainless steels are not required to be protected with a paint system.

3 REFERENCE DOCUMENTS

3.1 Codes and Standards

3.1.1 The following documents are referred to in this Specification:

IS 1367 (Part 13)	Hot-Dip Galvanised Coatings on Threaded Fasteners
IS2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
IS4759	Hot-Dip Zinc coating on Structural Steel and other Allied products
IS8629 (Parts I to III)	Code of Practice for Protection of Iron and Steel Structures from Atmospheric Corrosion
ISO8504:1992	Preparation of steel substrates before Application of Paints and Related Products
ISO8501-1:1988	Preparation of steel substrates before Application of Paints and Related Products-Visual Assessment of surface cleanliness
SSPC-SP10	NACE No. 2, Near white blast cleaning (Sept 1, 2000) (SSPC: The Society for Protective Coatings - US

4 TECHNICAL REQUIREMENTS – PROTECTIVE COATINGS

4.1 General

4.1.1 Surface Preparation and Application of Coats: Application of coatings shall not take place in adverse conditions which shall include:

(i) Relative humidity greater than 85%
(j) Substrate temperatures within 3°C of dew point
(k) Temperatures below 10°C
(l) Substrate temperatures above 40°C

(m) High Winds
(n) Rain
(o) Possibility of overspray to any property

4.1.2 Prime coatings over bare metal shall be applied within six hours of abrasive blasting and before discolouring or flash rusting occurs.

4.1.3 Intermediate and finish coats shall be applied over previous coats as soon as practical, but within the paint manufacturer's recommendations.

4.1.4 Thinners to enable application of protective coatings, if required, shall be used in the minimum quantity that enables correct application. The Contractor shall obtain approval in writing from the paint manufacturer, for the type of thinners to be used in each type of protective coating.

4.1.5 Safety Protective clothing and equipment shall be used at all times.

5 TRANSPORT AND HANDLING

5.1 During transport and handling of coated components, non-chaffing slings, tie downs and supports shall be used to prevent damage to coatings.

6 SITE WELDING

6.1 After the completion of any site welding undertaken only with the prior written permission of the Employer, the coating system shall be repaired as per the relevant specified paint system for each component. These repairs shall include abrasive blasting.

7 INSPECTION AND TESTING

7.1 The Contractor shall employ an experienced Quality controller approved by the Employer to undertake all quality inspections and testing of preparation and application of protective coatings whether on or off site.

7.2 The contractor shall provide certification to the Employer that all surface preparation and application of protective coatings is in accordance with the Specification and Drawings.

7.3 The paint manufacturer shall be kept informed of all coating applications.

8 INSPECTION

8.1 The following inspection requirements shall apply:

(p) Five (5) working days' notice is to be given to the Employer prior to the commencement of work;
(q) Two (2) working days' notice is to be given to the Employer prior to abrasively blasting each item;
(r) The Employer, or quality inspector and paint manufacturer shall be afforded free access to inspect work at all times;
(s) Surface profiles outside the specified range will not be accepted;
(t) Dry film thickness as specified is an absolute minimum. Measurements shall not be averaged. Areas found to be outside the specified dry film thickness shall be rectified to the satisfaction of the Employer.

8.2 The wet film thickness of each coat of paint shall be measured to enable modification of the rate of application of the paint, if necessary, before a coating has hardened.

8.3 The dry film thickness of the coats and/or completed coating system shall be measured as often as deemed to be necessary to determine whether or not such thickness conforms to the requirements for the particular coating system specified. The dry film thickness of a coat or of a coating system may be measured by pull-off or direct reading instruments based on magnetic attraction or by instruments utilizing electromagnetic induction and eddy current.

9 WORKMANSHIP

9.1 Workmanship shall be of a standard that will ensure coatings of uniform thickness, free of runs, bubbles, dry overspray, cracking, holidays, inclusions of foreign materials and other defects.

10 QUALIFICATIONS

10.1 Painting contractors shall be professional applicators qualified to an acceptable industry standard approved by the Employer

11 PROTECTIVE COATING

11.1 Surface Preparation

11.1.1 Blast Abrasive Cleaning to Sa2.5 Swedish Standard. Solvent cleaning to be done in case of any oil stains on the surface.

11.2 PRIMER

11.2.1 Two pack epoxy Phenylkamine Primer with min Vol. Sold of 63% to give 100 mic DFT per cost having salt spray resistance of 1500 hrs Epilux FRX A/C Coating of Berger or Equivalent

11.3 INTERMEDIATE

11.3.1 Two pack epoxy cured with aliphatic amine and having a min vol. solids of 85% to give DFT of 150 microns in single coat. The product must possess 2000 hrs of Slat Spray resistance. Epilux 950 Super HB Coating of Berger or equivalent.

11.4 FINISH

11.4.1 Two pack aliphatic acrylic PU paint with a min vol solids of 52% and giving a DFT of 50 microns. Product should have 80% gloss level after 1000 hrs of exposure to UV B Lamp.BR ACR PU High Gloss Enamel of Berger or equivalent

12 INSPECTION & QUALITY ASSURANCE

12.1 General

12.1.1 The Contractor shall have in place and use a Quality Assurance system that conforms to ISO 9000 Quality Standards.

12.1.2 The Contractor shall nominate a suitably qualified person to the Employer as the Contractor's Quality Assurance officer for this part of the Works.

13 INSPECTION AND TEST PLAN

13.1 The Contractor's ITP shall nominate the following minimum hold and witness points:

(i) Upon receipt of the fabrication to check for all surface defects, including cracks, laminations, deep pitting, weld spatter slag, burrs, fins, sharp edges, coarse welds, porosity, undercuts, slag, weld roughness and other defects. These shall be removed prior to the preparation of the surface to be coated.
(ii) Carry out a visual surface check for oil and other contamination and degreasing as necessary prior to surface preparation.
(iii) After surface preparation as required in the specification
(iv) After the application of each coat of paint to determine thickness, quality and any repairs needed.

14 INSPECTION

14.1 The Contractor shall inspect each individual coating layer of the coating system and shall ensure that the following conditions are satisfied:

(i) The uniformity, colour, gloss and opacity are satisfactory.
(ii) The coating is free from sags, runs, wrinkles, fat edges, mud cracking, blistering, pinholes, dry spray, heavy brush marks and excessive film builds.
(iii) Adequate coverage has been achieved on corners, crevices, edges and surface where the spray gun cannot be positioned so that its spray impinges on the surface at 90° to the surface.
(iv) There is the required adhesion to the substrate and between coating layers.
(v) The coating is free from defects, discontinuities, insects, dry spray, spent abrasive media and other contamination.
(vi) The individual coats of the coating system and the complete coating system has the specified dry film thickness.
(vii) The coating has not been adversely affected by rain or any other agency during curing.

14.2 The Contractor shall maintain proper records of the coating activities as required by the Specification. These records shall include pro-forma inspection records and reports similar in content to those contained in Australian Standard AS3894 Parts 10, 11, 12, 13 and 14 or Indian Standard and any additional records as required by the Employer. Such records shall be available for inspection at any time by the Employer or

authorized representative and become the property of the Employer upon completion of the Contractor's obligation.

14.3 The Contractor shall advise the inspector in sufficient time to enable attendance at the work site without causing unnecessary delay or hindrance to the progress of work.

14.4 The absence of the Employer and / or authorized representative does not absolve the Contractor from carrying out the tasks and the required quality inspection and documentation in accordance with these specifications.

14.5 Work deemed by the Employer as non-conforming to these specifications shall be corrected to conform to the requirements of these specifications. All costs associated with rectification work shall be borne by the Contractor.

14.6 The Contractor shall provide all coating and environmental testing equipment to meet the Contractors quality procedures. Where appropriate, such equipment shall be certified as being calibrated as required by the standards.

15 SCOPE OF WORK

15.1 All steelwork to be incorporated into the completed works shall be given protective treatment (unless specified otherwise) as specified herein. These specifications cover the surface preparation and application of protective coatings to all steelwork except piles.

15.2 The different systems of protective treatment required for steelwork are described in the following clauses. The table below generally describes the system type and the items to which it shall be applied.

15.3 **PROTECTIVE TREATMENT SCHEDULE**

Coating System	General Description	Structural Item
A	Epoxy Zinc Rich and High Solids Epoxy MIO Paint	- Mooring bollards
B	Ultra-High Build Epoxy Paint	- Fender frontal frames

16 SUMMARY OF HOLD POINTS

(i) Pre-Works. Acceptance of Contractor’s submissions regarding proposed protective coatings sub-contractor and proposed paint manufacturer, products, SWMS and ITP.
(ii) At the conclusion of the surface preparation. Visual acceptance to photographic standards as per and recording of surface profile.
(iii) At the conclusion of primer coat. Visual acceptance and dry film thickness testing.
(iv) Conclusion of intermediate coat. Visual acceptance and dry film thickness testing

(v) Conclusion of finish coat. Visual acceptance and dry film thickness testing.

(vi) Conclusion of any repairs to damaged coating or repairs to pinhole defects. Visual acceptance and dry film thickness testing

17 TESTS AND STANDARDS OF ACCEPTANCE

17.1 General

17.1.1 The materials shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. Additional tests, if required, shall be got carried out by the Contractor at his own cost.

17.1.2 The fabrication, furnishing, erecting, painting of structural steel work shall be in accordance with these specifications and shall be checked and accepted by the Employer.

K MISCELLANEOUS

1 RUBBER FENDERS AND ACCESSORIES

1.1 General

1.1.1 The Contractor shall supply and install rubber fender units to the jetty.

1.1.2 Fenders shall be of the required types and rated capacities.

1.1.3 In addition to fenders for berthing, suitable type edge fenders shall be provided at the corners of jetties, which are exposed to sea to protect vessels from hitting jetty structure accidentally.

1.1.4 Fenders shall be proprietary units manufactured by a specialist marine bollard and mooring equipment manufacturer. The fender manufacturer shall demonstrate by way of project references a minimum of 10 years successful experience in the manufacture of rubber fender units and accessories of similar nature to those to be supplied under this Contract.

1.1.5 All fenders shall be grey in colour and shall be given a unique serial number which can be traced back to the manufacturer's quality control and testing records.

1.1.6 The fenders shall be supplied together with all the necessary frontal frames, resin facing pads, bolts, inserts chains, brackets, shackles and other accessories.

1.1.7 The fixing details shown on the Drawings are indicative only and the Contractor shall install each element of the fender units including inserts, bolts, fender body, fender face, chains, brackets, shackles and other accessories, in accordance with the fender manufacturer's specific requirements for each type of fender.

1.1.8 The supplier of the fenders should be actively involved in erection of fenders

1.2 Design Life

1.2.1 To ensure maximum life and to minimize maintenance, all accessories and fittings shall be made of stainless-steel grade 316 L and marine grade aluminium alloys.

1.2.2 Values for the design life, and maintenance intervals, of various components of are presented in Table.

Element	Design Working Life (Years)	Maintenance Interval (Years)
Fenders and Fender Panels	**30**	**15**
Fender Chains and Fixings	**25**	**15**

1.2.3 The Contractor shall submit O&M manuals, warranty details and the manufacturer's concurrence for the required design life for all fenders from the manufacturer.

1.3 **Submittal Requirements**

1.3.1 The Contractor shall submit full details of the proposed fender units and accessories to the Employer along with associated calculations justifying the suitability of the proposed fenders and their distribution for the indicated use at the jetty for approval prior to the procurement of these items including but not limited to the following;

(i) Details of the manufacturer and supplier of the unit including details of the manufacturers quality control system, evidence of project experience and statement regarding the suitability of the product in this application and its conformance to the requirements of the Specification;

(ii) Shop drawings showing the general arrangement and principal dimensions of the unit including all the necessary frontal frames, resin facing pads, bolts, inserts chains, brackets, shackles and other accessories;

(iii) Specifications detailing the features of the unit, the manufacturing or fabrication process, the materials used, requirements for installation and use and all relevant design or manufacturing standards or regulations;

(iv) Rated Performance Data and PIANC Type Approval certificate for the proposed fender unit in accordance with the requirements of PIANC "Guidelines for the Design of Fender Systems: 2002: Appendix A";

(v) Detailed calculations and analysis demonstrating the structural capacity of the steel frontal frames, chains shackles and accessories and associated hold down bolts and anchorages; and

(vi) Where the frontal frames and accessories are proposed to be supplied coated in blue colour by the manufacturer, all details pertaining to the proposed coatings as specified for Protective Coating of Structural Steelwork in section B1200;

vii) Warranty for fenders shall be specified and submitted to the employer.

1.3.2 The Employer's acceptance of the above submission shall be taken on the procurement of the item(s) to which the submission refers.

1.4 **Fender Unit Performance Requirements**

1.4.1 The Contractor shall provide the Rated Performance Data (RPD) and copy of current PIANC Type Approval certificate for the proposed fender units for

testing in accordance with the requirements of PIANC "Guidelines for the Design of Fender Systems: 2002: Appendix A".

1.4.2 The allowable performance tolerance shall be ± 10%.

1.4.3 Each fender unit shall meet the minimum energy absorption and maximum reaction requirements as specified on the Drawings for;

(i) RPD with the application of the manufacturers temperature factor corresponding to +0°C; and

(ii) RPD with the application of the manufacturer's temperature factor corresponding to +39°C.

1.5 **Fender Bodies**

1.5.1 Rubber fender units shall be compression moulded from natural rubber. The substance shall be reinforced with carbon black for resistance to ageing, abrasion, weathering, wearing and stability when repeatedly in contact with seawater.

1.5.2 The rubber for fenders shall be homogeneous in quality, free from foreign materials, air bubbles, pores, injuries, cracks, defective impurities and other harmful defects.

1.5.3 Steel plates shall be fully embedded and fully adhered to the rubber during the vulcanization process to avoid separation between the rubber and steel.

1.5.4 The rubber for fenders shall comply with the specification stipulated below.

Property	Value	Test method & condition (Part No. of BS 903)
Density	1100 kg/m^3 to 1300 kg/m3	Part A1
Hardness (International rubber hardness degrees)	$\leq$72	Part A26 Method N
Tensile strength	$\geq$16 N/mm2	Part A2
Elongation change	$\geq$ 350%	Part A2
After accelerated air ageing test: - Hardness (increase in IRHD) - Reduction in tensile strength - Reduction in elongation	$\leq 8^o$ $\leq$ 20% $\leq$ 20%	Part A19 Method A at 70^{o}C x 96 hours

Property	Value	Test method & condition (Part No. of BS 903)
Oil resistance (measured by volume change percentage); - Industrial gasoline - Heavy oil	 ± 60% ± 20%	 Part A16 Method A at 70°C x 96 hours
Compression set	≤ 30%	Part A6 Method A at 70°C x 22 hours using type 2 test pieces
Ozone resistance	No crack visible	Part A43 at 40°C x 100 hours
Tear resistance	≥ 60 kN/m	Part A3 Method C at 23°C
Abrasion resistance (volume loss at 3,000 revolution)	≤ 1500 mm3	Part A9 Method C

1.5.5 The fender body fixing bolts, washers and cast-in anchorages shall be stainless steel grade 316 / 316L complying with the requirements of either the relevant ASTM or BS EN standards governing the applicable method of fabrication / manufacture.

1.5.6 Calculations demonstrating the adequacy of the fender anchorages shall be submitted to the Employer for approval. This shall include checking of concrete pullout (if applicable), edge failure or other concrete failure for all loads on cast in anchorages and fixings.

1.5.7 All cast-in fixings or anchorages etc. shall be supplied with mill certificates or other certification in accordance with the applicable materials or manufacturing standards for the various items. The Contractor shall submit this certification to the Employer for approval prior to the installation of the cast-in items.

1.5.8 The Employer acceptance of this submission shall be taken in advance, on the installation and casting in of these items.

1.6 **Support Chains, Fixings and Bolts**

1.6.1 All fenders units shall be supplied with weight support, tension and shear chains and associated shackles, tensioners, chain brackets and U-anchors etc. as necessary to ensure the fenders perform in accordance with the requirements of these specifications.

1.6.2 All such items shall comply with requirements for marine mooring or anchor chains complying with ASTM, BS EN or ISO standards or Bureau Veritas, DNV, American Bureau of Shipping certification requirements, Lloyds Register Anchor and Chain Cables Act or similar as nominated by the

fender unit manufacturer. The grade of material under the nominated standards shall be nominated by the fender unit manufacturer to ensure the fenders perform in accordance with the requirements of these specifications.

1.6.3 All non-stainless-steel bolts, fixings, brackets, anchorages etc. shall be hot dip galvanized in accordance with BS EN ISO 1461.

1.6.4 Calculations demonstrating the adequacy of all chains, shackles, fixings, bolts and anchorages shall be submitted to the Employer for approval. This shall include checking of concrete pull out or other concrete failure for all loads on cast in anchors and fixings.

1.6.5 All cast-in fixings, anchorages or U-anchors etc. shall be supplied with mill certificates or other certification in accordance with the applicable materials or manufacturing standards for the various items. The Contractor shall submit this certification to the Employer for approval prior to the installation of the cast-in items.

1.6.6 The Employer's acceptance of this submission shall be taken on the installation and casting in of these items.

1.7 Testing and Inspection

1.7.1 The materials properties for fender rubber and UHMW-PE facing panels as specified in this section shall be certified by the fender unit manufacturer based on the results of regular production quality control testing on representative samples taken from each batch or lot from which the Contract fender units were manufactured. Any properties not subject to regular production quality control testing shall be sampled and tested specifically for the purposes of satisfying the requirements of this Contract. The actual test results shall be submitted along with the certification.

1.7.2 At the time of manufacturing the fender a 5mg rubber strip should also be cast monolithically with the fender so as to enable the Engineer In-charge to remove the piece and test the chemical composition in NABL lab before its installation at the cost of Contractor.

1.7.3 All steel fabricated items, chains and associated shackles, tensioners, chain brackets and U-anchors, fender bolts and anchorages etc. shall be supplied with mill certificates or other certification in accordance with the applicable materials or manufacturing standards for the various items.

1.7.4 All protective coatings shall be tested in accordance with and shall fully conform to the requirements specified for Protective Coating of Structural Steelwork in section B1200.

1.7.5 In addition, the Contractor shall carry out energy/reaction compliance testing on each fender body to be supplied under this Contract in accordance with the requirements of “Guidelines for the Design of Fender Systems: 2002: Appendix A”.

1.7.6 Full details of the manner in which the supplier proposes to conduct this test shall be provided prior to testing.

1.7.7 The Contractor shall provide the Employer with at least 28 days’ notice of commencement of the above tests such that the Employer can make arrangements to witness the tests or to arrange for third party witnessing of these tests. The Contractor shall arrange for all necessary access to the manufacturer’s testing facilities to be provided to the Employer or his delegate for this purpose.

2 BOLLARDS

2.1 General

2.1.1 The Contractor shall supply and install bollards to jetty in accordance with the details shown on the Drawings.

2.1.2 Bollards shall be of the required types and rated load capacities.

2.1.3 Bollards shall be proprietary units manufactured by a specialist marine bollard and mooring equipment manufacturer. The bollard manufacturer shall demonstrate by way of project references a minimum of 10 years successful experience in the manufacture of ductile iron mooring bollards of similar nature to those to be supplied under this Contract.

2.1.4 Capacity of bollard shall be indicated in legible font either on top or side of the bollard.

2.2 **Materials**

2.2.1 Bollards shall be manufactured from ductile cast iron (also known as spheroidal graphite cast iron) complying with the requirements of either ASTM A536 or BS EN 1083 or equivalent. The grade of material under either of the nominated standards shall be nominated by the bollard manufacturer.

2.3 **Design Life**

2.3.1 To ensure maximum life and to minimize maintenance values for the design life, and maintenance intervals, of various components of are presented in table given below:

Element	Design Working Life (Years)	Maintenance Interval (Years)
Bollards and Cleats	50	15

2.3.2 The Contractor shall submit O&M manuals, warranty details and the manufacturer's concurrence for the required design life for all bollards from the manufacturer.

2.4 **Design Requirements**

2.4.1 Load capacities shown on the Drawings indicate the minimum safe working load capacity or rated load capacity of the bollard and shall be applicable to loading angles within 180 degrees of the wharf cope line alignment in the horizontal plane and within the range -10 degrees to +70 degrees from horizontal in the vertical plane.

2.4.2 The Contractor shall submit details of the proposed bollard / assembly and associated anchorage system with calculations and analysis demonstrating that the following minimum factors of safety (on the un-factored safe working load and un-factored capacities) are achieved under the most severe load case(s);

(i) 3.0 on yield of cast-in hold down bolts;

(ii) 2.5 on ultimate failure of bollard base plate and body/stem;

(iii) 1.66 on yield of bollard base plate and body/stem;

2.4.3 Design calculations shall be supplemented with finite element analysis results for irregularly shaped items for which representative hand calculations cannot be accurately performed. The calculations and analysis shall be prepared and certified by a chartered professional structural Engineer conforming to the requirements specified for the Contractor's Designer in the Specification before Employer's approval submission.

2.5 **Protective Coatings**

2.5.1 Bollards shall be painted in accordance with the requirements of these specifications. Coatings may be either applied by the manufacturer or can be applied by the Contractor's specialist protective coating subcontractor

but in either case shall fully conform to the requirements specified for Protective Coating of Structural Steelwork in section B1200.

2.6 Hold-down Bolts and Anchorage Details

2.6.1 The cast in anchorage and hold down bolt details shown on the Drawings are indicative only. Cast in anchorage and hold-down bolt details shall be strictly in accordance with the requirements of the manufacturer.

2.6.2 Hold down bolts, cast in plate washers or anchor plates, and all other fasteners shall be minimum ISO 898-1 Grade 8.8 or equivalent and hot dip galvanized in accordance with BS EN ISO 1461.

2.6.3 All fittings including bolts, nuts, washers shall be tested and certified in accordance with the relevant materials standards. All relevant materials tests results and certificates shall be supplied with the hold down bolts and anchorage accessories and shall be submitted to the Employer for approval prior to the installation of the hold down bolts.

2.6.4 The Employer acceptance of this submission shall constitute a HOLD POINT on the installation and casting in of the hold down bolts.

2.6.5 The Contractor shall install the hold down bolts strictly in accordance with the manufacturer's specific requirements for each type of bollard. A temporary plywood template shall be used at the top of the bolts to prevent movement or dislocation during concreting.

2.6.6 The exposed ends of the bolts shall be coated with an approved petrolatum paste and wrapping tape upon completion of the bollard installation and tightening of the bolts to prevent corrosion and facilitate the future removal of the bollard if necessary.

2.7 Grouting of Base Plates

2.7.1 The Contractor shall install each unit in accordance with the supplier's specific requirements for each type of bollard. The clear gap between the underside of the base plate and the top surface of the concrete deck shall be as specified by the bollard unit manufacturer.

2.7.2 Following installation and levelling of each bollard unit and tightening of the hold down bolts, the Contractor shall grout the base plates so as to completely fill the void between the underside of the base plate and the top surface of the concrete deck.

2.7.3 The grout shall be an approved free flowing, high strength cementitious grout, Fosroc “Conbextra HF” or equivalent.

2.7.4 The grout shall be shrinkage compensated by way of volumetric expansion of the grout in the plastic state as well as formulated to compensate for longer term expansion in the hardened state. The compressive strength of the grout must exceed 60MPa at 28 days. The storage, handling, placement and curing of the grout shall be strictly in accordance with the manufacturer's instructions.

2.7.5 **Markings on Bollard:** Each casting shall be legibly marked with Capacity of Bollard in projected bold letters with letter size not less than 100mm

2.8 **Submittal Requirements**

2.8.1 The Contractor shall submit full details of the proposed bollard to the Employer for approval prior to the procurement of these items including but not limited to the following;

(i) Details of the manufacturer and supplier of the unit including details of the manufacturers quality control system, evidence of project experience and statement regarding the suitability of the product in this application and its conformance to the requirements of the Specification;

(ii) Warranty for bollards shall be specified and submitted to the employer.

(iii) Shop drawings showing the general arrangement and principal dimensions of the item including the hold down bolt layout and anchorage arrangement; Scale sketches demonstrating that the proposed hold down bolt arrangement can be installed without compromising the requisite concrete reinforcement at the installation location, including illustration of any proposals for localised displacement of reinforcement as may be required;

(iv) Specifications detailing the features of the unit, the manufacturing or fabrication process, the materials used, requirements for installation and use and all relevant design or manufacturing standards or regulations;

(v) Detailed calculations and analysis demonstrating the structural capacity of the unit and the hold down bolts with reference to the specified safe working load and the requisite factors of safety; and

(vi) Where the units are proposed to be supplied coated by the manufacturer, all details pertaining to the proposed coatings as specified for Protective Coating of Structural Steelwork

2.8.2 The Employer's acceptance of the above submission shall constitute a HOLD POINT on the procurement of the item(s) to which the submission refers.

3 LADDER

3.1 Design Life

3.1.1 To ensure maximum life and to minimize maintenance, all accessories and fittings shall be made of stainless-steel grade 316. The values for the design life and maintenance intervals of various components are presented below:

Element	Design Working Life (Years)	Maintenance Interval (Years)
Ladders and Curbs	50	10

3.1.2 Rubberized stainless steel ladder shall be provided on the structure for the access. The ladder shall be provided with stringer / foot holds having shock absorption & shape restoration characteristic. The contractor shall submit manufacturer catalogue for approval and satisfy the Employer about its performance.

Description	Material
Stringer	Rubber &SS 316
Rung	Rubber &SS 316
Mounting Bracket	SS 316
Resin Anchor Bolt	SS 316
Ladder Fixing Bolt	SS 316
Hand Grip (Pipe)	SS 316
Hand Grip Plate	SS 316
Plate Fixing Bolt	SS 316
Rung Fixing Nut & Washer	SS 316

4 STAINLESS STEEL MOORING RINGS

4.1.1 Mooring rings shall be made from 32 mm dia.SS316 grade stainless steel bars with an inner diameter of 150mm. 32 mm dia eyebolts shall be SS316 grade, which shall be used for fixing mooring rings.

5 RUBBING STRIP

5.1.1 'D' type rubber fender of sizes 150mm H x 150mm W (overall) shall be provided at all bollard locations. The rubber used for manufacturing rubber fender shall be as per ASTM-D-2000-98c. Necessary test certificates, chemical composition of rubber tested in a NABL approved laboratory shall be produced by the contractor.

6 CABLE TRENCH

6.1.1 The contractor shall provide the cable trench of suitable dimension below the deck structure connecting the pile muffs. The cable trench shall be suitably provided with separators and other supports for fixing cables, water pipelines, bunkering lines and other service facilities. The cable trench shall be at an appropriate location preferably as an extension to th eapproach trestle.

7 HANDRAIL POSTS AND HANDRAILS

7.1.1 RCC handrails shall be provided along Approach Trestle. Finished concrete shall be free of cracks, spalls, honey combing, or other defects, and exposed vertical and top surfaces shall be given a rubbed surface finish. Micro silica may be used in the concrete to be used for handrails.

8 DRAIN HOLES

8.1.1 For main jetty and approach, the Contractor shall provide drain holes in the deck to drain surface water as shown in the drawings. Drain holes shall be by CPVC pipes through the deck.

9 EDGE ANGLES

9.1.1 Stainless steel of SS316 edge angles shall be provided, wherever required.

LIST OF APPROVED MANUFACTURERS / VENDORS

Civil & Structural

S. No.	Description /Material	Manufacture's Name
1	Cement	Ultratech, Birla, ACC, Malabar Cement, Ambuja, Dalmia, Penna, Coromandel
2	Reinforcement Bars	TATA, SAIL, RINL, JSW, JSPL, Shyam Steel
3	Structural Steel	TATA, SAIL, RINL, JSW & JSPL

S. No.	Description /Material	Manufacture's Name
4	Mechanical Splicing Couplers	Dextra, Bartec, Lenton, Dayton superior & JB rebar couplers
5	Fly ash	Thermal plants, ashcrete, Ultra Pozz & Star Pozz or equivalent
6	Micro Silica	Sika, Elkem, FOSROC, MAPEI, Corniche
7	Admixtures for Concrete	BASF, FOSROC, Sika, Eurobuild Construction Chemicals & Coating, MYK Schomburg, MAPEI
8	Bollards & Fenders	Trelleborg, IRM, Hitech Elastomers, Brahans polymers

Note: The list of vendor/make is furnished here with shall be used in the works. The contractor shall have to obtain prior approval from the Employer for the list of items those are not indicated/specified in the list for use in the works.

The Bidder may also use materials from other manufactures subject to the same conforming to relevant B S Standards with prior approval of Employer.

L DEMOLITION AND BREAKING-OUT WORKS

1 PRE DEMOLITION WORKS

1.1 Before starting any demolition or breaking-out work the Contractor shall examine all available information, carry out surveys as he considers necessary, and submit method statements to the Employer covering the proposed works. Structural calculations in support of method statements shall be provided. All demolition work shall be carried out in accordance with Indian Standard Code of Practice IS 4130-1991 and any other relevant codes.

1.2 The Contractor shall study the drawings of the existing structures. Based on these, the Contractor shall make his own assessment of the structures to be demolished. The Contractor may at his own cost undertake further investigations on site and carry out further tests if he so requires to satisfy himself as to the correctness or otherwise of the conditions of the structures to be demolished.

1.3 The methodology of demolition, and the appropriate equipment and plant for carrying out the required demolition shall be decided by the Contractor based on the data made available and/or on his own further site investigations.

1.4 The Contractor shall familiarize himself with the existing conditions at the site, tidal, wind, wave and other environmental conditions, prior to submission of his Tender.

1.5 The Method Statement shall clearly show how the Contractor intends to carry out the required demolition, the form and condition of the structures to be removed, removal methods of any flammable or toxic material, sequence and method of demolition (with particular attention to working near or over water), and lines and levels.

2 EXTENT OF DEMOLITION

2.1 The extent of the demolition and breaking-out works are shown on the Drawings or mentioned in the scope of work. Piles are to be cut to existing bed level. Piles of mooring dolphin are to be extracted.

3 CONTROL OF DEMOLITION

3.1 The Contractor is reminded that many parts of the site must remain in operation during the demolition works. The Contractor shall take all necessary precautions to ensure that dust, noise or falling debris do not constitute a hazard to personnel, equipment, the structure, vehicular traffic, vessel and any shipyard activity. Effective means of cleaning and removal of dust and debris away from the working area shall be implemented continuously. Demolished material and debris shall not be permitted to fall into the sea where any work is carried out over water. Demolished material shall not be allowed to accumulate on scaffolding.

4 SERVICES AFFECTED BY DEMOLITION

4.1 It is generally the intention that the Employer shall remove all services that may be affected by the demolition prior to a section of works being handed over to the Contractor such that demolition may commence. The extent and number of sections/areas of work shall be agreed with the Employer prior to the work commencing.

4.2 There may be occasions where services cannot be removed by the Employer without the co-operation of the Contractor. Therefore, the Contractor shall be deemed to have allowed for liaison with the Employer and receive Employer approval prior to any demolition work being carried out in the vicinity of services. Before starting demolition, ensure that all removals and disconnections have been carried out.

5 SERVICES WHICH ARE TO REMAIN

5.1 Notify the Employer of any damage arising to services that remain from the execution of the works. Make all arrangements for repair to the satisfaction of the Employer. The Contractor shall bear any costs arising.

6 WORKMANSHIP

6.1 Demolish structure(s) in accordance with IS 4130-1991 and any other relevant codes

- Operatives must be appropriately skilled and experienced for the type of work.
- Site staff responsible for supervision and control of the work shall be experienced in the assessment of the risks involved and in the methods of demolition to be used.

7 GAS OR VAPOUR RISKS

7.1 Take adequate precautions to prevent fire or explosion caused by gas or vapour.

8 DUST

8.1 Reduce dust by periodically spraying demolition works with water and in accordance to the EIA report requirements. The Contractor shall refer Section 14 of the tender documents for the EIA requirements.

9 HEALTH HAZARDS

9.1 Take adequate precautions to protect all persons from health hazards associated with vibration, dangerous fumes and dust arising during the course of the Works.

10 STRUCTURE(S) TO BE RETAINED

10.1 Adequately protect parts of existing structure(s) which are to be kept in place. Cut away and strip out the minimum necessary, as shown on the drawings, and with care to reduce the amount of making good to a minimum.

10.2 Prevent debris from overloading any part of the structure which is not to be demolished.

11 DANGEROUS OPENINGS

11.1 Illuminate and protect with barricades as necessary.

12 UNFORESEEN HAZARDS

12.1 Inform the Employer of any unrecorded voids, tanks, chemicals, etc. discovered during demolition work.

12.2 Agree with the Employer, methods for safe removal, filling, etc.

12.3 The Contractor is expected to familiarise themselves with the existing record drawings, sketches, documentation etc. and to remove, fill etc. such items shown shall be deemed to be included.

13 COMPLETION

13.1 Clear away all debris in accordance with a “Environment Management Plan”, or similar approved plan, and leave the demolition site in a tidy condition on completion.

14 MATERIALS ARISING

14.1 All material obtained as a result of jetty demolition shall be crushed so as to be able to use as fill for reclamation or subgrade. Steel reinforcement could be taken by the contractor for selling outside.

14.2 In undertaking demolition and Site clearance works, the Contractor shall comply with all environmental legislation and regulations applicable to the Works, including that debris/waste materials are only disposed of in approved landfill sites. The Contractor shall obtain at his own cost any approvals to be obtained from the relevant authorities prior to the commencement of demolition. The successful bidder is required to identify the dump area and take permissions, if necessary. Fee / charges, if any, will be borne by the Contractor.

14.3 If required by any authority, and prior to disposal, the Contractor shall at his own cost arrange for the testing of materials arising from demolition for that may be classified under existing regulations as hazardous waste/materials.

15 TEMPORARY SUPPORTS

15.1 The possibility of temporary loss of strength of members during repair shall be taken into account by the Contractor in his work methodology. Temporary propping and alternative load-bearing supports may be required prior to cutting back and removal of defective concrete and reinforcement. If temporary propping is required it shall remain in place until such time as the repair(s) to the member has gained its specified strength. The Contractor shall submit details any of proposed temporary works and supports to the Employer at least one week before installation of such temporary works.

15.1.1 The anticipated need for any temporary propping shall be brought to the attention of the Employer. The actual need for temporary propping shall be agreed following discussion between the Employer and the Contractor.

16 BREAKING OUT

16.1.1 The method of breaking out shall minimize damage to the concrete areas that remain. The Contractor shall submit for approval, details of the proposed methodology of removal for the different elements, together with details of his proposed equipment and staff, at least two weeks in advance of the proposed operation. Mechanical breakers may be used after careful consideration of current Health and Safety requirements and shall only be used in a manner that avoids damage to the retained concrete, structure and reinforcement. The Contractor must ensure that no material arising from the breaking out is allowed tofall into the sea/watercourse but should be collected at source for correct disposal to the maximum extent.

16.1.2 Any damage caused to the structures that are to remain shall be made good at the contractor's cost to the satisfaction and within a timescale agreed with the Employer.

17 PILE REMOVAL

All existing piles affected by the proposed works shall be removed or cut back to the approval of the Employer. The proposed method shall be agreed with the Employer on a structure by structure basis.

All existing piles affected by the proposed works shall be cut and removed upto the levels mentioned in this tender elsewhere. Demolished material is to be progressively removed, as quickly as practically possible and area of work maintained presentable at all times.

M WORKS NOT SPECIFIED

1.1 The list of the items mentioned in this section is not exhaustive and only indicative.

1.2 All materials not herein fully specified and which may be offered for use in the Works shall be subject to the approval of the Employer, without which they shall not be used anywhere in the Permanent Works.

1.3 The workmanship of works not herein fully specified shall be carried out as per relevant IS Specifications and in absence thereof shall be as per the best standard practice as approved by the Employer.

1.4 The contractor shall design and execute all other miscellaneous facilities for functional requirement as directed by the Employer during execution and the quoted rate shall deemed to cover cost of such contingent works.

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SECTION 6C

SPECIFICATIONS FOR MEP WORKS

TABLE OF CONTENTS

A ELECTRICAL DISTRIBUTION SYSTEM

1 GENERAL REQUIREMENTS

1.1 All equipment shall be designed to minimize the risk of fire and any damage, which may be caused in the event of fire.

1.2 All apparatus, equipment and works shall be so designed that they provide satisfactory service and without any harmful effects for prolonged and continuous periods in the worst climatic conditions, stated herein before.

1.3 The equipment rating and SLD provided in the specification are to provide idea about the power distribution system to the contractor. However, the contractor shall carry out detailed load study and accordingly to prepare the SLD and to size the electrical equipment.

1.4 In case the Contractor intends to subcontract the electrical works, the Subcontractor who will be employed shall be a Class A contractor / EHT contractor issued by State Electrical Inspectorate/ Central Electricity Authority. The Contractor shall submit all the required credentials of the subcontractor to the Employer for approval of the appointment of subcontractor

2 SCOPE OF WORK INCLUDES

2.1 Detailed scope of work

The existing 11 KV distribution system already available at a distance of 300m from the project location may be modified by providing and commissioning the new 4 panel RMU after replacing the old RMU and to provide the foundation, fencing, housing, roofing with Al powder coated sheet etc. for the 4 panel RMU.

Supply &Laying of 11 KV cable of 3C x 300Sq. mm FRLS XLPE, Aluminum cable(E) from the existing substation/Feeder point at about 300M to the proposed/new substation near the berth through open trenches in loose soil / hard surfaces / HDD etc. as required with straight joints for extending the existing cables for terminating etc. as per requirements.

Set up a new 11 KV substation near the project location/berth ,Supply, Installation, testing and commissioning of 11 KV grade 3 panel RMU, 500 KVA distribution transformer, LT panel of 800A , providing end termination for HT/LT cables etc. as per specifications in the tender.

SITC of cope points in the berth, separate light control panel for berth lights , Junction boxes etc. at berth as per requirements and as per specifications in the tender.

Supply and laying of AL /Cu conductor LT cables to the berth for shore power, cope points, High Mast / Street light poles etc. including its termination with junction boxes, LT panels etc. as required and as per annexure.

Providing illumination to the berth, trestle, approach road area of berth and substation area with LED luminaries by providing GI octagonal poles , Polycarbonate JB boxes for cable looping , MCB' s for protection , RYB connector ,light timer controls panels with energy meter etc. as specifications in the tender.

SITC of LED lamp fittings by replacing the existing SON/MH lights etc. with 200W LED flood lights (12 No's),aviation light fittings etc. in the existing High Mast near to the berth/proposed substation.

Supply and laying of HDPE pipes (110mm) in the berths , at road crossings, area in front of new berth approach bridge to substation road crossings area (Minimum 3 Run) at suitable depth for laying HT/LT cables as per requirements.

Supply and fixing of GI/FRP cable tray of minimum size 3mm thick and 375MM width in the berth for laying cables along the along the berth.

Earthing of the installations with plate /pipe earthing such as at existing 11 KV substation / feeder point , RMU, Transformers, LV panels, Cope points, light poles etc as per requirements. Preparation of drawings of installations and its submission, Getting approval from CEA, GoI and curing the defect if any noticed by the statutory body etc.

2.2 Standards and regulations

The design and manufacture of the electrical equipment shall conform as a minimum to applicable codes, regulations and standards published by the following bodies: The design life of the Electrical equipment's are 30 years.

BIS: Bureau of Indian Standards

BSI: British Standard Institution

ISO: International Organization for Standardization

IEC: International Electro-Technical Commission

IEEE: Institute of Electrical &Electronics Engineers

NFPA: National Fire Protection Association

NEC: National Electrical Code

ECBC: Energy Conservation Building Code

CEA: Central Electricity Authority Regulations applicable for safety, construction, metering etc. with its latest amendments

Following is the list of some of the directly applicable Standards particular to the equipment. Any other relevant Indian Standard not covered shall also be applicable.

IS: 375	Marking and arrangement of Switchgear Bus
IS:13118	Specification for high voltage alternating current circuit breaker
IS: 12729	Switchgear and Control gear for voltages exceeding 1000V - General Requirements
IS: 2705	Current transformers
IS: 3156	Voltage Transformers
IS: 335	New Insulating oils

IS: 1180 level -2	Power transformers
IS: 3639	Fittings and accessories for Power transformers
IS: 4257	Dimensions of clamping arrangement for porcelain transformer bushings
IS:11171	Specification for Dry-Type Power transformer
IS: 10028	Code of Practice for selection, installation and maintenance of transformer
IS: 3427	A.C. Metal enclosed switchgear and control gear for rated voltages above 1kV and up to and including 52kV
IS:8623	Specification for low voltage switchgear and control gear assemblies of switchgear & control gear for voltages not exceeding 1000V AC.
IS: 13703	Low Voltage fuses
IS: 13947	Low Voltage switchgear and control gear
IS: 1651	Stationary cells and batteries, Lead Acid Type (with tubular positive plates) – Specification
IS: 266	Specification for Sulphuric acid
IS: 3895	Mono crystalline Semi-conductor rectifier cells and stacks
IS: 4540	Mono –crystalline Semi-conductor rectifier assemblies and equipment
IEEE:484	Recommended Design for Installation design and installation of large lead storage batteries for generating stations and substations.
IEEE:485	Sizing large lead storage batteries for generating stations and substations.
IS: 1554	PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.
IS: 7098 -I	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100 volts.
IS: 7098 -II	Cross linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV up to and including 33 kV.
IS: 10810	Methods of tests for cables.
IS: 418	Tungsten filament general service electric lamps
IS: 1777	Industrial luminaire with metal reflectors.
IS: 1947	Flood Lights
IS: 10322	Luminaires for street lighting.
IS: 1944	Code of practice for design of Street lighting
IS: 2206	Flame proof electric lighting fittings

IS: 2215	Starters for fluorescent lamps.
IS: 2418	Tubular fluorescent lamps for general lighting services
IS: 4013	Dust-light electric lighting fittings
IS: 8224	Specification for Electric Lighting fittings for Division 2 areas
IS: 9583	Emergency lighting units
IS: 2713	Specification for Tubular Steel Poles for Overhead Power Lines
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 kV rating.
IS: 732	Electrical wiring installation (system voltage not exceeding 1100 V).
IS: 2309	Code of practice for the protection of building and allied structures against lightning.
IS: 3043	Code of practice for earthing.
IS:15885 (Part2/Sec13)	2012 Safety of Lamp Control Gear, Part 2 Particular Requirements Section 13 D.C or A.C, Supplied Electronic Control gear for LED Modules
IS:16101: 2012	General Lighting - LEDs and LED modules – Terms and Definitions
IS:16102 (Part 1) : 2012	Self- Ballasted LED Lamps for General Lighting Services Part 1 Safety Requirements
IS:16102 (Part 2) : 2012	Self- Ballasted LED Lamps for General Lighting Services Part 2 Performance Requirements
IS:16103 (Part 1) : 2012	Led Modules for General Lighting Part 1 Safety Requirements
IS:16103 (Part 2) : 2012	Led Modules for General Lighting Part 2 Performance Requirements
IS:16104: 2012	D.C. or A.C. Supplied Electronic Control Gear for LED Modules - Performance Requirements
IS:16105: 2012	Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources
IS:16106: 2012	Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products
IS:16107(Part1): 2012	Luminaires Performance Part 1 General Requirements
IS:16107-1: 2012	Luminaires Performance Part 2 Particular Requirements Section 1 LED Luminaire
IS:16108: 2012	Photo biological Safety of Lamps and Lamp Systems

IS:60470-2000	High-Voltage Alternating Current Contactors
IS 14286 /IEC 61215	Crystalline silicon terrestrial photovoltaic modules-Design qualification and type approval.
IS/IEC: 61730 – part I	Photovoltaic module safety qualification Requirement for construction
IS/ IEC: 61730 – part II	Photovoltaic module safety qualification-Requirement for testing
IS/IEC 61701	Salt mist corrosion test of the module
IS 16221(Part1)	Safety of Power Converters for use in Photovoltaic Power Systems Part 1-General Requirements
IS 16221(Part2)	Safety of Power Converters for use in Photovoltaic Power systems.
IS 16170 : Part 1 /IEC 61853-Part 1	Photovoltaic (PV) module performance testing and energy rating
IEC 62804	Photovoltaic (PV) Modules Test methods for the detection of potential induced degradation. IEC TS 62804-1 : Part 1 : Crystalline silicon
IEC62716	Photovoltaic PV modules: Ammonia(NH3) corrosion testing

In addition to Codes and standards, the installation works shall also conform to the requirements of following:

- Indian Electricity Act
- Fire insurance regulations
- Regulations laid down by Chief Electrical Inspector of Kerala
- Regulations laid down by the Factory Inspector
- Regulations for the electrical equipment of Tariff Advisory committee
- Any other regulations laid down by the authority
- Regulation of Pollution Control Board of Kerala
- Power and Telecommunication Co-ordination Committee (PTCC)
- Kerala State Electricity supply code
- Local Municipal/ Panchayat Authority guidelines
- Guidelines for Conservation and Preservation, KSTD

2.3 Standardization

Care shall be taken so that the materials and equipment are standard catalogued products of manufacturers regularly engaged in manufacturing of such products and shall be of the latest standard designs conforming to specification requirements. Design shall also be based on similar types of electrical equipment supplied from one manufacturer, utilizing interchangeable parts wherever practicable. Materials and equipment incorporated shall be of a type for which spare parts and replacements are readily available in India. The contractor has to always select the Energy Efficient equipment such as Transformers, Pumps, Lights, Refrigerator, etc. in the whole of the project.

2.4 Supply of Materials

All materials required to complete the work as per given specifications & drawings etc, must be manufactured and supplied using fresh raw materials. Re- molded, re–circulated materials are not acceptable. The procurement of materials must be made directly from manufacturer or through authorized dealer / distributors. Documentary evidences to this effect are to be made available to the Employer for necessary checks / verification of source of supply of materials. Second hand materials / partial used materials / used materials would not be acceptable. The offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the Deviation Schedule with reasons duly supported by documentary evidences during pre-bid meeting. Such deviations suggested may or may not be accepted by the employer. Any deviations projected after the pre bid meeting shall not be entertained at any cost.

2.5 Statutory Approvals

The installation shall be in accordance with the CEA regulation and Indian standard as updated time to time and various national and international standards furnished above. The contractor shall arrange to obtain all necessary approvals for the electrical installation as required by the prevalent laws of the state of Kerala. The layout plans including the Earthing and Lightning Protection schemes, etc. shall be approved by the CEA/Regional Electrical Inspectorate Office/any other statutory body prior to taking up the work. Approval for the installation as a whole from the CEA/Regional Electrical Inspectorate Office/any other statutory body after the installation is complete shall also be the responsibility of the Contractor. Necessary application forms as required to be filled up and submitted to the CEA/Regional Inspectorate Office/any other statutory body shall be procured, filled and submitted for approval and the required approval obtained by the electrical contractor prior to asking for the HT/LV line to be energized. Specialized “A” grade licensed Electrical contractor to be appointed by the main contractor for liasioning and for getting statutory safety approval from the inspectorate.

All expenses towards the overall approval of the installation including the statutory fees will be borne by the contractor. The statutory fee shall be reimbursed by Client on production of actual bill.

Pollution control Board approval (Consent to Establish & operate) also to be obtained by the contractor for DG set. The statutory fees to be paid by the contractor.

2.6 Employer Approval

The contractor is required to submit the total scheme for electrical distribution system in three sets for approval to the Employer after award of contract, prior to commencement of work. These shall include all the Single line diagrams, design calculations, Vendor drawings for Switch boards and other Electrical Equipment's, detailed drawings for earthing layout, lighting and lightning protection, cabling, methodology of cable laying, cable schedules, Equipment Erection methodology etc.

2.7 Submittal of data for approval

The contractor shall submit to the Employer complete information regarding details of materials and equipment involved, prior to any purchase or manufacturing operation. Any purchase or manufacturing operations carried out prior to obtaining such approval shall be at the contractor's sole responsibility.

Information of equipment shall be separately submitted by listing all the details and with attached catalogue indicating at least the model, series, size and performance. Such data shall be in sufficient detail to enable the employer to identify the particular product and to form an opinion to its conformity to the specification.

The contractor shall stamp the name of his company and sign all documents to be submitted for approval.

2.8 Approval of materials

Only new materials and equipment shall be incorporated in the works. All materials and equipment furnished by the contractor shall be subject to inspections and approval of the employer. The materials and equipment used for works shall be of approved makes. Any materials which, in the opinion of the employer, have lower quality than the approved makes shall promptly be removed from the job site.

Whenever requested by the employer, the contractor shall send materials to be tested by an independent institute selected by the employer.

Submittals of Materials: Manufacturer drawings, catalogues, pamphlets and other documents submitted for approval shall be in three sets. Each item in each set shall be labeled properly, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted. The format of submittals shall be approved by employer's representative.

2.9 Shop drawings

As soon as the contract is awarded, the contractor shall prepare shop-drawings comprising complete details of items to be fabricated and works to be installed. These shop-drawings shall be submitted to the employer for approval.

In case shop-drawings require modifications for any reason, the contractor shall clearly identify the portion that was modified and shall indicate the running number of revisions every time that a revised shop drawing is submitted.

Size and scale of the shop-drawings shall be at least 1:100 scale except for enlarged scale details done for clarity, which shall be in conformity with international standards or as directed by the employer.

Where required by the employer, the contractor shall prepare additional drawings, diagrams, etc., which in opinion of the employer are considered necessary for a proper execution of the works.

The contractor shall not proceed with his work for a certain part or section, prior to the approval of the shop-drawings. Therefore, expense incurred because of modifications that have to be made as a result of lack of approved shop-drawings shall be borne by the contractor.

Approval of the shop-drawings by the employer shall not be construed as a complete check but will indicate only the general method of installation and its details are satisfactory.

The approval of the employer shall not release the contractor from his responsibility or his liability regarding the exact dimensions and further properties of the installations.

Shop-drawings submitted without sufficient detail shall be rejected and new submittal shall be required.

The contractor shall submit 3 blueprint copies of all shop-drawings for approval. If approved by the employer, one copy shall bear the employer's stamp indicating the date of approval and shall be returned to the contractor. After approval, 6 copies and a softcopy of blueprint are required, and additional copies may be requested by the employer as necessary.

The Employer shall issue the approval for the documents / drawings submitted by the contractor based on the recommendations of TPIA engaged by the Employer.

2.10 Field testing

Test all equipment upon completion of installation to ensure that the equipment operates satisfactorily and to conform to contract documents.

Field testing shall be required for all equipment furnished, installed or connected by the contractor to ensure proper installation, setting, connection, and functioning in accordance with the plans, specifications and manufacturer's recommendations.

Testing shall be conducted in the presence of the employer and, when necessary, under the supervision of equipment manufacturers field employer.

All tests recommended by the equipment manufacturer whether specified in this specification or not, shall be included, unless specifically waived by the employer.

Testing shall include any additional tests required by the employer to determine the conditions of that equipment, material and system to meet requirements of the specifications.

The contractor shall maintain in triplicate, a written record of all tests showing date, personnel making test, equipment or material tested, tests performed and results. Three copies of test records shall be given to the employer within the following day.

The contractor shall notify the employer two weeks prior to commencement of any testing, except for metering.

Contractor shall be responsible for any damage to equipment or material due to improper test procedures or handling test apparatus, and shall replace or restore any damaged equipment or material to original condition.

Safety devices such as rubber gloves and blankets, protective screens and barriers, danger signs, etc. Shall be provided by the contractor and shall be used to protect and warn adequately all personnel in the vicinity of the tests.

The contractor shall furnish all testing equipment and provide proper temporary power source for testing purposes when normal supply is not available at the time of testing.

Submission of Material Quality Plan (MQP) & Field Quality Plan (FQP): The Contractor shall submit MQP and FQP of all materials and works to the Employer before commencement of procurements action / engaging work force for erection of equipment.

2.11 Operation and maintenance instructions manual

The manual shall be prepared in hard cover binding in sets to be submitted to the employer on acceptance of the completed work.

Section 1 – comprises submittal data of all equipment and materials that have been approved.

Section 2 – comprises catalogues, categorized in groups, complete with installation operations and the maintenance manuals from the manufacturers.

Section 3 – comprises filled out field test reports.

Section 4 – comprises spare parts list and recommended spare parts.

Section 5 – comprises maintenance and services schedule, and service and maintenance procedures for individual equipment listed daily, weekly, monthly, quarterly and yearly.

Section 6 – comprises system operations manual

A draft copy of the manual shall be submitted to the employer for approval first.

2.12 Works to completion

The contractor shall commission, clean down, and leave in full working order the works as specified.

As the installation proceeds the contractor shall prepare ‘As built drawings’. It shall be sufficient to modify these contract drawings showing any revisions which have been made and submit the marked-up prints to the employer for approval.

The contractor shall deliver to the employer on completion of the works, manufacturer's literature, specifications, technical information and ‘As built drawings’ for all equipment installed.

2.13 Quality assurance

The contractor shall operate his own quality assurance system BS EN 9001 or equivalent acceptable to Employer. The contractor shall prepare a Quality assurance plan and submit for approval of the Employer before carrying out Construction, installation, inspection and testing of items. This quality assurance plan shall be submitted to the Employer within two weeks of issue of order to commence the works.

On award of contract, the contractor shall submit (with in two week) the detailed Design, Procurement, Manufacturing and Delivery and Installation Plan for complete E&M systems.

2.14 Drawing and Documentation required along with Bid

The Bidder shall submit in his Technical Bid the drawings, diagrams and all such information which are necessary to fully understand the offer both technically and commercially.

As a minimum requirement the following information shall be supplied with the technical bid in sufficient detail to fully describe the scope of work and the services offered:

- Duly filled-in data sheets and the schedules.
- Terminal point details.
- Time schedule for the design, manufacture, delivery, erection, testing, commissioning and trial operation indicating important milestone activities.
- Dimensioned General Arrangement Drawings of each equipment.
- Bill of quantities all items
- Switchyard and substation layout with plan & sections.
- Quality Assurance Plan.
- Catalogues of all equipment.
- List of sub-suppliers.
- Design calculations
- Typical drawings for switchyard equipment, structures and substation equipment.

2.15 Drawing and Documentation required after award of contract

The drawings and documents to be furnished by the supplier after the award of the contact shall include but not limited to the following.

- Detailed time schedule in the form of network or bar chart for the design, manufacture, delivery, erection, testing and commissioning period with critical milestone activities and other important intermediate dates for uninterrupted progress of the project.
- Duly filled-in revised technical data sheets.
- Quality Assurance Plan.
- List of manufacturers and specifications of all standard equipment.
- Dimensioned General Arrangement Drawings, wiring diagrams, name plate details, terminal details, cable box / bushing details and drawings, for all equipment.

- Detailed single line diagrams & schematic drawings.
- Substation layout with plan & sections.
- Type and routine test certificates of all items.
- Any other drawings/documents, as required by CEA/statutory body, for getting approval of complete 11 kV systems.
- Catalogues of all equipment.
- Design calculations for the following: Load list, Maximum demand calculation, Relay setting calculations & co-ordination charts, Earthing calculations, Lighting calculation, Bus bar sizing calculation, cable sizing calculation etc.
- Construction drawings as listed below: Equipment supports /, Transformer foundation arrangement drawings, Cable trench & tray drawings, Details of equipment earthing, Final approved cable routing diagram, Cable schedules, Cable interconnection diagram, Approved lighting layout drawing with circuit numbers, Test certificates & inspection reports of all equipment, Other drawings & documents as indicated in various sections of this document, Erection manuals & installation procedures for all equipment, Operation & maintenance manuals for all equipment & systems

2.16 Equipment Warranty

All equipment supplied under this technical specification shall be required to be guaranteed against defective and/or faulty materials/ workmanship or faulty design. Contractor shall maintain all the systems in a comprehensive manner including all kinds of spares, consumables and tools without extra charge during DLP. Preventative maintenance for all system during DLP shall be under the scope of contractor. Tools and consumables except diesel or oil shall be borne by the contractor.

3 SPECIFICATION

3.1 Distribution Transformer Technical Specification:

500 KVA Oil Cooled Transformer Out door

1	Reference Standard	IS 1180 Level-2
2	Type	make Oil cooled Type
3	Normal continuous Rating (KVA)	500
4	Voltage Ratio	11kV/433 V
5	Rated Frequency	50HZ
6	Number of Phases	3
7	Type of Cooling	ONAN(Oil Natural Air Natural)
8	Vector Group	Dyn 11

9	Connections	(HV / LV) Delta / Star
10	Winding Material	Copper
11	Tap changer type	Off circuit tap changer
12	Tappings on HV side	+5% to -5% in steps of 2.5%
13	Class of insulation	Class A
14	Lamination	CRGO (M-4 Grade)
15	Temperature rise at ambient Temp. Windings Oil	45°C above ambient 40°C
16	Terminal Arrangement (HV/ LV)	Cable box / Cable box
17	Type of Installation	Outdoor
18	Fittings and Accessories	➢ Rating and Diagram Plate ➢ Top Filter Valve ➢ Bottom Filter cum drain valve ➢ Lifting lugs for whole Transformer ➢ Earthing Terminals 2 Nos. ➢ Thermometer Pocket with plug ➢ Air Release Plug on tank cover ➢ Oil Conservator tank with drain plug, filing holes and cap ➢ Oil Level Indicator ➢ Drain-cum Filter valve with Plug ➢ Silica-gel breather ➢ Air Release plug ➢ Radiators ➢ Al other items as per latest IS standards/ specification.

3.2 Tests and Measurements

Type Test: In addition to routine Tests mentioned above the transformer shall be subjected to all kinds of Type in accordance with Relevant I.S. 1180 level 2 with latest amendment if any. Type test certificates to be submitted for Employer approval.

Routine Tests: All transformers shall be subjected to the following routine tests at the manufacturer's works. The tests shall be carried out in accordance with the details specified in IS: 1180 level -2. Vendor shall give minimum of 15 days advance intimation to purchaser with regard to readiness of equipment for inspection. Test certificates shall also be submitted to Employer/Consultant for review and approval. Equipment will be dispatched only after clearance by Employer. Witnessing the inspection by Employer/Consultant shall not relieve the manufacturer of his responsibility to supply suitable functional trouble free operation of the equipment.

a. Visual inspection

b. Measurement of winding resistance

c. Measurement of Voltage ratio and check of voltage vector relationship.

d. Measurement of impedance voltage

e. Measurement of load losses

f. Measurement of no. load loss and current (at normal tap).

g. Measurement of insulation resistance

h. Induced over voltage withstand test

i. Separate source voltage withstand test.

j. Di-electric test

k. Oil leakage test

l. Vacuum & pressure test on tank

INSPECTION AND TESTING: Inspection and testing as already mentioned the equipment shall be subjected to routine and other acceptance tests as per provisions in the relevant I.S. The Client reserves the right to send its Employers if so desires to witness manufacturing process and to reject either raw materials or finished products found to be not complying with the requirement of the specification and also shall have the right to select any/all equipment from the lot offered for tests.

The manufacturer shall give at least (15) fifteen days" advance notice regarding readiness of such inspection and testing and shall submit six sets of the works test certificates of the materials/equipment offered for inspection and testing indicating probable date of inspection and testing.

The Supplier shall arrange all possible facilities for such inspection and testing at any time during the course of manufacture free of cost.

4 11KV SF6 RMU PANELS

4.1 Scope of work

This specification covers design, Engineering, manufacture, shop testing, inspection, painting, packing, supply, forwarding and delivery to site with all accessories, storage, installation, Testing and commissioning of the 11kV SF6 RMU as detailed below.

4.2 Design Requirement & Standards

This specification covers design, manufacture, shop testing, inspection, packing, delivery to site, erection, testing and commissioning of 11KV Metal Enclosed, panel type, Outdoor SF6 LOAD BREAK SWITCH RING MAIN UNIT (RMU) fully type tested according to IEC 62271-200 standards.

The RMU should be complete with all components necessary for its effective and trouble free operation along with associated equipment etc. such components should be deemed to be within the scope of supplier's supply.

The design of the switchgear should be exclusive and specific responsibility of supplier and should comply with current good engineering practice, the relevant codes and recommendation, the project specific requirements.

The RMU should be fixed type SF-6 insulated both side extensible. It should be maintenance free equipment, having stainless steel robotically welded enclosure.

4.3 STANDARDS AND REFERENCE DOCUMENTS

The RING MAIN UNIT (RMU) should be designed, manufactured and tested according to the latest version of:

IEC 60694: Common specifications for high-voltage switchgear and control gear standards.

IEC 62271-200: A.C metal-enclosed switchgear and control gear for rated voltages above 1KV and up to and including 72KV and the IEC Codes herein referred.

IEC 62271-102: Alternating current isolators and earthing switches

IEC 60529: Classification of degrees of protection provided by enclosures

IEC 60265 High-voltage switches-Part 1: Switches for rated voltages above 1kV & less than 52 kV

IEC 60056: Circuit breakers

IEC 62271-105: High-voltage alternating current switch-fuse combinations

IEC 60185: Current transformers

IEC 60186: Voltage transformers

IEC 60255: Electrical relays

Any other codes recognized in the country of origin of equipment might be considered provided that they fully comply with IEC standards.

The design of the switchgear should be based on safety to personnel and equipment during operation and maintenance, reliability of service, ease of maintenance, mechanical protection of equipment, interchangeability of equipment and ready addition of future loads.

4.4 SPECIFICATION FOR RMU‘s

Item No.1

11KV SF6 Outdoor, Extensible, Ring Main Unit (RMU), +CCCC+ should comprise of 4 nos. 630A Load Break Switches. RMU LBS shall be configured as 2 No. LBS as incomer and 2 Nos. LBS as outgoing , motorized with battery , live line indicators etc. as specification given below.

Item No.2

11KV SF6 Outdoor, Extensible, Ring Main Unit (RMU), +CCV+ shall be configured as 2nos. LBS and 1 no. VCB (T-OFF), 630A, motorized with battery, live line indicators etc. as specification given below.

4.5 11 KV, 630A VCB Feeder

Vacuum circuit breaker module with vacuum circuit breaker, three position isolator/ earthing switch, bus bars, interlocking, earth bar and stored spring energy mechanism (A-mech.).

1	Vacuum circuit breaker 12kV, 630A, 21kA
1	Stored energy mech. for motorized operation
1	Control Voltage 24 V DC for Motor Operation
1	Bushings for connection of external bus bar
1	Bus bar cover
1	Optical indication of latch function
1	Self-powered Microprocessor based 2 O/C + 1no. E/F Relay
3	Ring core current transformer of suitable ratio
1	Cable bushings 400 series bolted, 630A
1	Arc proof cable cover complete incl. Interlocking
1	Capacitive voltage indication fixed type VPIS 9-15 kV
1	Shunt Trip Coil
1	Aux. switch for vacuum circuit breaker position 2NO + 2NC
1	Vacuum circuit breaker tripped signal 1NO

4.6 Load break switch (630A)

Load break switch should have the following components

Manually operated 12 KV, 630A Load Break switch and Earthing Switch with making capacity

“Live Cable” LED Indicators through Capacitor Voltage Dividers mounted on the bushings.

Mechanical ON/OFF/EARTH Indication

Operating handle

Cable Testing facility inside cable boxes without disconnecting the Cable terminations

Cable end boxes suitable for 1 run of 3 C x 300 sq mm XLPE Cable with right angle Cable Termination Protectors.

Cable boxes should be Arc Proof and interlocked with respective Earthing Switches. For safety of operator it should not be possible to open the cable box unless the earth Switch is ON.

Switch module with a three position load break switch and earthing switch, bus bars, interlocking and earth bus.

Cable switch 12kV, 630A

Cable bushings 400 series bolted, 630 a, standard

Arc proof cable cover complete incl. Interlocking

Capacitive voltage indication fixed type VPIS 9-15 kV

Aux. switch for load break switch position 2NO + 2NC

4.7 Service Conditions

The Ring Main unit shall be suitable for operations in the sea facing area and shall be suitable for marine environment.

The RMU shall be capable of operating normally within the following temperature ranges up to 50◦C:

The Compact switchgear shall be capable of being exposed to high relative humidity (max 95%) and ambient air pollution.

The Compact switchgear shall be capable of being operated in electrically exposed locations.

4.8 Design Parameters: Electrical data

1.	Rated voltage	11 KV
2.	Rated frequency	50 Hz
3.	Rated current bus bars	630 A
4.	Rated current (cable switch)	630 A
5.	Rated current (T-off)	630 A

4.9 General data, enclosure and dimensions

1. Standard to which Switchgear complies	:IEC
2. Type of Ring Main Unit type.	:Outdoor, Metal Enclosed, bolted
3. Number of phases	:3
4. Whether facility is provided with pressure relief	:Yes
5. Insulating gas	:SF6
6. Nominal operating gas pressure	:1.4 bar abs. 20° C
7. Gas leakage rate / annum %	:0.1 % per annum or as per IEC 62271
8. Expected operating lifetime	:30 years or as per IEC.
9. Whether facilities for gas monitoring	: Yes, temperature compensated Manometer
10. Material used in tank construction	:Stainless steel sheet, 2.5/3 mm

4.10 No. of Operations, degree of protection and colours

Means of switch operation Separate handle

Degree of protection:

SF6 tank	IP 67
Front cover	IP 2X
Cable cover	IP 3X
Outdoor Enclosure	IP 54
Bus bars	240 mm2 Cu
Earth bar (external):	120 mm2 Cu - Bolt dimension: M10

Thickness of Stainless Steel Tank: 2.5 mm or above.

Colours:

Front cover	RAL 7012
Side and cable cover	RAL 7035

4.11 STANDARDS AND MECHANICAL DATA

Metal Enclosed switchgear	: IEC 60298
General Purpose switches	: IEC 60265
Disconnectors & Earthing switches	: IEC 60129
Switch Fuse Combination	: IEC 60420
Circuit Breakers	: IEC 60056
Common clauses	: IEC 60694
Pressure of SF6 gas	: 1.4 bar at 20 °C
Cable bushings	: DIN 47636
Temperature class	: -25 °C to 40°C Outdoor

4.12 ELECTRICAL DATA – 12 kV - 28kV-1min

Rated current bus bars	: 630 A
Rated current cable switch disconnector	: 630 A
Short time withstand current (3 sec) cable switch disconnector	: 21 kArms
Short time withstand current (3 sec) vacuum circuit breaker	: 21 kArms
Rated current for transformer T-off	: 630 A
Impulse withstand voltage	:
To earth and between phases	: 75 kV
Insulation level:	
Power frequency 1 min	: 28 kV

4.13 General Structural and Mechanical Construction

The offered RMU should be of the fully arc proof metal enclosed, free standing, floor mounting, flush fronted type, consisting of modules assembled into one or more units. Each unit is made of a robotically welded sealed-for life stainless steel tank of thickness not less than 2.5 mm or above, filled with SF6, containing all high voltage components sealed off from the environment with Ingress protection IP67. The enclosure should meet the 'Sealed Pressure System' criterion in accordance with IEC 62271-200 standard (i.e a system for which no handling of gas is required throughout the 30 years of service life), so that no refilling of gas is required. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1% per year. The overall design of the switchgear should be such that front access only is required. It should be possible to erect the switchboard against a substation wall, with HV and LV cables being terminated and accessible from the front.

The design of the units should be such that no permanent or harmful distortion occurs either when being lifted by eyebolts or when moved into position by rollers.

Sheet metal for outdoor enclosure must be suitably treated and painted with about 70 micron thickness, to achieve outdoor worthiness and corrosion protection and should pass salt spray test for not less than 500 Hours

Enclosure must be suitably ventilated for ambient conditions and shall have IP54 class of protection.

RMU must have a pressure relief device at the bottom of the stainless steel housing to ensure that in the rare case of an internal arc, the high pressure caused by the arc will be released and the hot gases are allowed to be exhausted out at the bottom of the cubicle towards back side to ensure complete safety to the operator. A controlled direction of flow of the hot gas should be achieved.

4.14 Load Break Switch (630 Amp cable feeder)

It should consist of an SF6 cubicle housing a switch disconnector and an earthing switch. Bus bars and all electrical connections are located inside the tank. The switch positions are closed – open – earthed. The operating shafts for the switches should have rotary seals where they enter the SF6 cubicle. The operating mechanisms should be located outside on the front of the SF6 tank. Cable bushings should be located on the front of the SF6 cubicle in a separate cable compartment. Front covers containing the mimic diagram and having a degree of protection IP2XC close the fronts.

4.15 Earthing of the Main Circuit

Each disconnector shall be provided with an integral earth switch. Earthing switches should be rated equal to the switchgear rating. Earthing switches should be quick make type capable of making Rated Fault Current. Earthing switch should be operated from the front of the cubicle by means of a removable handle. The earthing switch can be operated only when the main isolator or circuit breaker are open.

Mechanical interlocking systems shall prevent all operator errors such as closing the earth switch when switch is closed.

The HT cables are terminated in the dedicated cable. At the bottom of the cable compartment, an earthing bar system made of copper with a minimum cross section of 200 sqmm(50x4 mm/40x5 mm) should be fitted. In each compartment the earthing bar should be fitted with 4 screws M10. The earthing system is connected to the tank by a copper bar, which rises up to the connecting point of the tank behind the rear partition wall on the middle of the switchgear.

4.16 Operating Mechanisms

All mechanisms should be situated in the mechanism compartment behind the front covers outside the SF6-tank. The mechanism for the switch and the earthing switch is operating both switches via one common shaft. The mechanisms provide independent manual operation for closing and opening of the switch, independent closing of the earthing switch and dependent opening of the earthing switch.

The mechanism for the T-off switch and earthing switch is operating both switches via one common shaft. The mechanisms has stored spring energy and provide independent manual operation for closing and opening of the switch, independent closing of the ear thing switch and dependent opening of the earthing switch. The mechanism for the disconnector earthing switch provide independent manual operation for closing and opening of the disconnector, independent closing of the earthing switch and dependent opening of the earthing switch.

The operating mechanism shall be designed in such a way that in case of failure of operating mechanism the same shall be possible to repair without any gas refilling.

4.17 Interlocking

The mechanism for the cable switch should be provided with a built in interlocking system to prevent operation of the switch when the earthing switch is closed, and to prevent operation of the earthing switch when the switch is in the closed position.

Further is should not be possible to Open the Cable doors unless the Earthing Switch is Turned ON. In case the Cable door is accidentally left open a positive interlock shall prevent operation of Load Break Switch and Isolators / Breaker from any operation.

4.18 Bus-bars

The bus bar shall comprise of 3 single phases copper bus bars and the connections to the switch or circuit breaker. The bus bar should be integrated in the cubicle. Bus bars should be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.

4.19 Front Covers

The front cover contains the mimic diagram of the main circuit with the position indicators for the switching devices. The voltage indicators are situated on the front panels. Access to the cable bushings is in the lower part of each module.

4.20 Position Indicators

The position indicators shall be visible through the front cover and must be directly linked to the operating shaft of the switching devices. The operator shall be able to confirm the closing of earth switch. Same can be accomplished either by providing a viewing window for earth switch or by means of true position indication duly type tested as per IEC 62271-102 sub clause A.6.105 to verify proper functioning of position indicating device.

4.21 Voltage Indicators

The Voltage Indicators/Live Line Indicators through capacitor dividers or with VT supported indicators shall be provided on the front cover, one for each module, and indicate the voltage condition of each incoming cable. Identification of the phases is achieved with labels L1, L2 and L3 on the front of the voltage indicators. The voltage indicator with capacitor dividers shall satisfies the requirements of IEC 61243.

4.22 Cable Compartment

It should be possible to terminate up to a 1x 3c x300 sq mm core HV cables in each cable compartment. The cable compartments should be in front and cable entry shall be from bottom. The access to the compartment will be possible by removing the cable cover, hinged to the main frame only when earth switch is ON. Cable Compartments should be Arc Proof and interlocked with respective Earth Switches. Each module has a separate cable compartment that is segregated from each other by means of a partition wall. A partition wall should be fitted to divide the cable compartment from the rear side of the switchgear. In case of an arc inside the tank, followed by the opening of the pressure relief, the partition wall prevents the hot

gases flowing out from the pressure relief to enter the cable compartments. All covers are removable. The ground continuity is achieved when the covers are in place by means of hinged connections. It should be possible to perform cable testing inside the cable boxes without disconnecting the cables.

4.23 Padlocking Facilities

The circuit breakers, isolators and the earthing switches can be locked in open or closed position by padlocks 6 to 8 mm in diameter.

4.24 Auxiliaries

The switchgear should be prepared for options like motor operation, auxiliary contacts and short-circuit indicators. Necessary terminal blocks and wiring etc. should be placed behind the front cover of each module.

4.25 Base Frame

Suitable base frame shall be supplied along with the RMU unit

4.26 Earthing system.

The equipment shall be supplied with earth bus of 200 Sq mm, tinned copper (50x4 copper or 40x5 copper). The earth bus of the equipment shall also be interconnected to the existing earth pit with same size of strips provided for the equipment. GI strips are also acceptable with sufficient size so as to withstand the fault current of 25 KA for 3 sec. The existing earth strips may also be used for interlinking purpose, however if the existing strip is not sufficient, the additional quantity shall be supplied by the contractor without any extra cost.

4.27 TESTING AND CERTIFICATION

Type Tests.

Units should be type tested in accordance with IEC standards 60056, 62271-102, 60265, 62271-200, 62271-105, 60529 and 60694. The following type tests have been performed and available if required

Short time and peak withstand current test

Temperature rise tests

Dielectric tests

Test of apparatus i.e. circuit breaker and earthing switch

Arc fault test

Measurement of resistance of main circuit.

Mechanical endurance test.

Duty cycle test.

Internal arc test for HT chamber.

Degree of protection for IP –54 for Outdoor enclosure.

Tests to verify true position indication devices as per IEC 62271-102.

Type test reports for above tests shall be submitted with the offer.

Routine tests

Routine tests should be carried out in accordance with IEC 62271-200 standards. These tests should ensure the reliability of the unit.

Below listed test should be performed as routine tests before the delivery of units:

Withstand voltage at power frequency

Measurement of the resistance of the main circuit

Partial discharge test for the tank

Withstand voltage on the auxiliary circuits

Operation of functional locks, interlocks, signaling devices and auxiliary devices

Suitability and correct operation of protections, control instruments and electrical

connections of the circuit breaker operating mechanism

Verification of wiring

Visual inspection

Time travel characteristics measurement facility for Breaker should be available with the manufacturer to assess the quality of RMU.

4.28 DOCUMENTATION

An instruction manual should be provided with necessary information for receiving, handling, storage, installation, operation and maintenance.

Routine test certificate should be follow each unit, and standard schematic drawings should be delivered for Ring Main Units. Compact Switchgear should have drawings that consist of system single line drawings, general arrangement and schematic drawings for order specific units.

All drawings shall confirm to International Standards Organization (ISO) “A” series of drawing sheets/Indian Standards Specification IS : 11065.. All dimensions and data shall be in S.I. Units.

4.29 List of drawings and Documents

The bidder shall furnish four sets of relevant descriptive and illustrative published Literature, pamphlets and the following drawings for preliminary study along with offer.

General outline drawings showing dimensions and shipping weights, quantity of Insulating media.

Sectional views showing the general constructional features of the circuit breaker

Including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance.

Drawings showing control cabinets and circuit diagrams for operating mechanism.

Schematic diagrams of breaker offered for control and supervision

 Structural drawings for support structures.

Foundation plan and loading data and foundation design.

Drawings showing the complete operation cycle of the Ring Main Unit with description.

5 LT PANEL BOARDS & ACCESSORIES

5.1 Scope

This specification covers design, manufacture, supply, Installation, testing and commissioning of outdoor type L.T. Panel Board as given below. Make shall be CPRI approved. All bus bar shall be tinned copper with1.2A/Sq.mm rating.

- The main LT panel shall include minimum SITC of 800 A LV panel with ACB , MCCB etc. (I/C- . ACB 800A with all std protections) (O/G- MCCB's (LSIG)- 630A-1no.,200A-4nos , 63A- 2 nos.) including , 40A light timer control cubicle, energy meters and other std metering arrangements in each cubicle.
- 63 A polycarbonate body light timer control cubicle for berth lights.

5.2 General

This Section covers the detailed requirements of low voltage switch gear Panel for 440V, 3 phase 50Hz/60 Hz, 4 wire system. All switchgears shall be fully rated at an ambient temperature of 45°C.All the switch boards are to be factory assembled, fabricated by a firm having CPRI type test certificate for short circuit rating, temperature rise and IP classification for similar panels. These type test certificates shall be submitted to the Employer for verification. The LT Panels shall be suitable for connectivity of SCADA and BMS interfaces. There shall be space provision for CO2 flooding fire trace tube system inside the panel. Sufficient potential free contacts (minimum of 8nos) shall be provided in Main LT panels for future interfacing with other systems. Illumination lamp shall be provided for all floor mounted Panels.

In LT metering for Commercial purpose, energy meters shall be tested from NABL accredited lab or Kerala state Electrical Inspectorate.

5.3 Switch Board Construction

The switch boards are to be manufactured / assembled as per the latest BIS/IEC specifications, IP54 classification for indoor duty, IP65 with double door for outdoor duty, including special requirements of Kerala state Electrical Inspectorate and the detailed specifications mentioned. The panel shall be floor mounted, free standing type, suitable for indoor installation in dust, vermin proof construction and extensible type. The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IS: 8623/1993 for factory assembled switch board, form 4B construction. The manufacture shall be CPRI approved firm.

5.4 Housing Details

The Switch Board shall be fabricated out of 14 SWG (2mm) CRCA sheet for frame and 1.5mm for door and internal partitions (except load bearing members). It shall be

provided with hinged doors on the front with necessary handles and earthed using flexible copper conductor. The doors shall be provided with neoprene gaskets. Suitable channel base frame should be provided for the panel board.

Detachable gland plates of 3mm thick shall be provided at the bottom and top of the cable chamber, suitable for the termination of cables with double compression type glands to the sizes as specified. Adequate space should be provided in the cable chamber for safe bending and termination of runs of cables and size as required.

The enclosure shall be provided with lifting hooks, supporting legs and double earth terminals with double washers.

The switch board shall be in cubicle design (Form 4B) and fully compartmentalized having total segregation between each cubicle. Suitable cable and bus bar alleys shall be provided. All components of the switch board shall be approachable from front. The Bus bar chamber cover should be bolted type. The maximum operating handle/push button height of any feeder shall not be more than 1800 mm with reference to panel bottom. Supporting arrangement for dressing of power and control cables in cable alleys also shall be provided. The front openable/lockable door shall act as a cover for the switch boards. When door is open no live parts are accessible from the front door open case.

The bus bar shall be tinned copper with 1.2A/Sqmm rating and should be extendable at both ends. No bus bar should protrude in the cable alley. General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Overall height of the panel shall not exceed 2.1 meters. Multi-tier mounting of feeder is permissible. The general arrangement for multitier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look.

The general arrangement and design of panels shall be got approved by client/consultant before fabrication. Cable entries for various feeders shall be either from top or bottom. Through cable alleys located in between two circuit sections, either in the rear or in the front of the panel. All cable terminations shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when new feeders are added. Cable entry plates shall therefore be sectionalized. The construction shall include necessary cable supports for clamping the cable in the cable alley or rear cable chamber.

Cubicle panels with more than 1000 Amps Bus bar shall be made of suitable structural modular sections.

5.5 Powder coating

All metal sheets shall undergo 9 tank metal treatment thorough degreasing, water rinse, de-rusting, water rinse, phosphating, water rinse and then passivation.

All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dirt. Fabricated structures shall be pickled and treated to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking powder coating.

The colour of the Panel shall be colour of paint light grey to shade RAL 7035, however the contractor shall obtain details of approved colour from the Employer before powder coating. Panel finish shall be free from imperfections like pin holes, orange peels, run-off paint, etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust, corrosion, etc.

5.6 Bus bar sizing, connection and supports

The bus bars shall be made from high conductivity Tinned Copper. The bus bars and supports shall be capable of withstanding the rated and short circuit current as per the single line diagram/ feeder details. Minimum size of main power bus bars shall be of incomer switch rating and interconnecting bus bar to feeders should be rated to switch rating. The neutral and phase bus bars shall have the same rating.

Maximum current density permissible for CU bus bars shall be 1.2 Amps/Sq.mm without considering de-rating factors. An earthing bus bar of copper suitable for withstanding the fault current for 3 seconds or 150 sq.mm section copper whichever is higher shall be provided outside panel at bottom throughout the length of the panel.

The bus bar system may comprise of a system of main horizontal bus bars and ancillary vertical bus bars run in bus bar alleys on either side of which the circuit could be arranged with front access cable entries. In the case of rear access, horizontal bus system shall run suitably either at the top or bottom. All connections to individual circuits from the bus bar shall preferably be solid connections.

The bus bars shall be provided with heat shrinkable PVC insulating sleeve (FRLS). Supports for bus bars shall be made of suitable size cast resin insulators or SMC/DMC solid block type base and these should be adequate in number so as to avoid any sag in the bus bars. (Hilum supports may not be used). Minimum clearance between phase to phase shall be as per IS/IEC standards. The entire panel shall have a common earth bar of size as specified with two terminals for earth connections. For panels, Bus bars, risers and droppers and cable terminations including cable lugs bolts and nuts shall be fully insulated. This shall be achieved by applying heat shrinkable materials to the bus bar and shrouds at the bus bar joints and cable terminations. All insulation materials shall be FRLS PVC.

5.7 Power Connection

For power interconnections within the panel board rigid Copper conductor, with PVC insulation, of adequate cross section i.e., current carrying capacity not less than the outgoing switches rating shall be used. Cable lugs/ sockets of suitable size and type shall be used for all interconnections.

For incoming and outgoing feeders of the switch boards, copper conductor cable will be used and hence the panel has to be designed for receiving these and wherever required cable boxes shall be provided in panel by removable gland plates and shall be provided on top/bottom of panel, for cable entries.

In case of panel boards having bus duct as incomer, the panel board should be designed to accommodate proper connection/termination of the bus duct. Adequate cable termination facility shall be made in the panel boards to terminate required runs and size of cables.

To prevent accidental contacts, all interconnecting cables/ bus bars and all terminals also shall be shrouded. Provision for clamping the cables inside the cable alley should be provided.

Standard colour code of red, yellow and blue for phases and black for Neutral to be followed for all bus bars/conductors.

5.8 Auxiliary wiring and Terminals

Wiring for all controls, protection, metering, signaling, etc. inside the switchboard shall be done with 650 volts' grey colour minimum1.5sqmm HFFR (Halogen free fire retardant) copper conductor cables. Control wiring to components fixed on doors shall be flexible type. CT wiring shall be done with minimum 2.5 sq.mm copper wires with colour code.

Wiring shall be suitably protected within switch board. Runs of wires shall be neatly bunched, suitably supported and clamped. All control wiring meant for external connections are to be brought out of terminal board.

The complete panel would be sub-divided into different sections and each section shall have its own control circuit with fuse and indication.

All control wiring should be provided with necessary cable sockets/ lugs at both ends. Conductors shall be terminated using compression type lugs. Each termination shall be identified at both the ends by PVC ferrules.

The identification termination numbers should match with those on the drawings.

Minimum 8 numbers of potential free contacts shall be provided in Main HT /LT panels for future interfacing with other systems.

5.9 Component of switch boards

The panel shall be provided with ACB, MCCBs, SDFUs, fuses, meters, relays and instruments, energy meters in all cubicle with .5S specification etc. of size, capacity as specified in specification, schematic drawing and design calculation. The switch gears should be positioned inside the panel board as per manufacturers' standards.

5.10 Air Circuit Breaker (ACB)

The ACB shall be Microprocessor based, quick make, quick break, trip free horizontal draw out type electrically operated, provided with shunt releases. The cradle used for movement of draw out type ACB shall be suitable for smooth withdrawal on steel balls or rollers. ACB should be suitable for remote communication capability and protection with microprocessors. The Breaker shall be suitable for line load reversibility, without any deration. The ACB shall conform to IS 13947-1&2 /IEC60947-1&2 for circuit breakers & shall be suitable for Isolation as per IEC. The breaker shall offer double insulation on the front face (Class II deg. of operating safety). Contact wear erosion indicator should be available in the ACB for maintenance schedule.

The microprocessor based trip units should be of withstanding high ambient temperatures, switching surges, electromagnetic interferences, vibrations and switching arcs. The trip units should be of self-powered by the built in CTs or capable of operation with auxiliary power supply (230 V AC). Indication system should be provided for the functionality of the trip unit system and microprocessor fault. The trip

units should have LCD display. The CT operated release should provide accurate and versatile protection, viz. Over load, short circuit and earth fault/LSIGprotection. The breaker shall comply with service, test, isolation and maintenance position setting with locking facility in any position. Test socket shall be provided to check through test kit the microprocessor trip unit operations/actual trip time on the protections. The release shall have push to reset button for anti-pumping function.

The microprocessor release shall have IDMTL curve for co-ordination of overload curve with HT switchgear.

5.11 Communication

The communication port shall be used to read and set the parameters for the protection function. It should be able to transmit the causes of tripping and alarms. It should be possible to access the trip history and maintenance indications.

5.12 Protection

Overload protection in phase:	0.4 to 1In in steps 0.05 with time delay from 0.5seconds to 30 seconds minimum in stages.
Overload protection in neutral:	0.5to 2In in steps 0.05 with time delay from 0.5seconds to 30 seconds minimum in stages.
Short circuit protection:	0.6 to 10In in steps of .05 with 20 to 400milli seconds minimum in different stages.
Instantaneous:	1.5 to 15In in steps of 1 with provision to enable or disable.
Earth fault:	0.2 to 0.6 in steps of 0 .1 minimum with 100msec to 400milliseconds minimum in stages

5.13 Thermal Memory

Thermal memory shall be provided for overload with provision to disable. The breaker shall have in-built battery backup for minimum 12 hours. Trip devices require a thermal memory function suitable for resistance welding loads on appropriate Substation. Two spare “a” and “b” auxiliary contacts (3 NO+3 NC) for each circuit breaker wired to terminal block.

Shunt trip with 230 V AC, rated coil for remote tripping.

5.14 Specifications of Air Circuit Breakers:

1	Operating voltage	380V to 690V AC
2	Insulation voltage	1000V AC
3	Dielectric strength	2.5 kV for 1 minute
4	Current ratings	As required/ as per SLD
5	Rated Service short circuit	As required/ as per SLD
6	Breaking capacity (Ics)	As required/ as per SLD

7	Rated short time withstand capacity (Icw)	As required/ as per SLD
8	Rated ultimate short breaking capacity (Icu)	As required/ as per SLD
9	Spring charging motor	self-powered
10	Protection	3 O/C and 1 E/F release/LSIG
11	Protection device	Microprocessor based release with wide selection of Current & time settings for highest degree of system discrimination & co-ordination with downstream MCCBs.
12	Features of protection device	Current setting can be changed to 40% of base - current by base - current select switch without switching OFF ACB and without changing CT tapings. Built in operation check function eliminates need for separate test instruments. Earth-Fault element incorporated in trip device with adjustable threshold: I2t (ON & OFF) time setting eliminates need for separate earth fault relay. LED/FLAG indication to show discrimination between over load, short circuit and E/F tripping. Trip unit malfunction/ failure (self-diagnostics) shall be available on the breaker.
13	Accessories for Draw out type ACBs	Safety shutter, position switch, short circuiting contact, Mal-insertion prevention device, rating interlock padlocking, shunt trip coil, closing coil, close open cycle counter. It shall have door defeat interlock facility.
14	Shunt Trip	230V AC

15	Interlocking	OFF position Pad Lock / Door Interlock.
16	Standards & Tests	ASTA / IEC 60947-2 Category "B" IS13947-2 suitable for isolation as defined by relevant clauses in IEC 60947-2/ IS13947-2, Indian Register of Shipping Certified for shock resistant up to 70g vertical 30g horizontal for 6 msec, vibration resistant for 10-55 Hz 0.75 displacement. Rated short time withstand current (Icw) for 1 sec should be equal to the rated service breaking capacity (Ics) and equal to the ultimate breaking capacity (Icu).

5.15 Molded Case Circuit Breakers

General: Molded case circuit breakers (MCCBs) shall be incorporated wherever required and shall be of current limiting type and preferably double break. MCCBs shall confirm to IS 13947-1/IEC 60947-1 for general rules and IS 13947-2/IEC 60947-2 for circuit breakers in all respects. MCCB shall be suitable for isolation as per standard, single phase 240V or three phase 380V or 415V or 440V, 50Hz, AC and shall have a rated insulation voltage of 690 V AC. The MCCBs shall have thermal memory and shall have no Line-Load restriction. All the breaker shall have tropicalisation as a standard feature.

Construction: The MCCB case & cover shall be made of high strength heat resistant and flame retardant thermosetting insulating material. The operating handle shall be quick make, quick break trips free type and the operating handle shall have suitable 'ON','OFF','TRIPPED' indicators. Three phase MCCBs shall have a common operating handle for simultaneous operation and tripping of all the three phases.

5.16 Rating & Breaking Capacity

The rating of the circuit breaker shall be as per the drawings and schedule of quantities. The MCCB shall have Service Breaking Capacity (I_{cs}) equal to Ultimate Breaking capacity (I_{cu})

5.17 Protection

All MCCB breakers including and above 200A shall have LSIG Micro Processor trip as per standards.

All breakers below and including 160 A shall have thermal magnetic based trip unit as required with adjustable overload protection 80% to 100% based of the nominal current(I_n).

MCCB should have the flexibility of connecting the load either on the top or on the bottom side without deration.

5.18 Accessories

MCCBs shall be provided with the following accessories and all these devices shall be fitted at site. The accessories shall be separated from Power circuit. Preferably the Shunt trip release and under voltage release shall be snap-in type and fitted with terminal blocks.

- Shunt trip
- Auxiliary switch
- Extended rotary Handle.
- NO + 2NC auxiliary contacts

5.19 Spreader

All the MCCBs terminals should be fitted with spreaders for accommodating Aluminum cable termination.

5.20 Interlocking

MCCBs shall be provided with the following interlocking devices for interlocking the door of the switchboard.

- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent door being opened when breaker is in ON position.
- Door-interlock defeat to open the door even if the breaker is in ON position.
- Front operated rotary handle should have OFF-position pad-locking facility.

5.21 Measuring instruments

These shall be of square pattern having dimensions of 96x96 mm flush mounting type. Instruments like Multifunction Meter, ammeter, Voltmeter, frequency meter ,energy meters(.5S for LT). and instrumental transformers/ transducers etc. are also included in the scope of supply. The accuracy class of all AC meters shall be .as per schedule of quantity.

Voltmeter shall be suitable for direct line connection. Voltmeters shall be connected through MCBs only.

All voltmeters shall be provided with selector switches as per schedule of quantity.

Ammeters shall be CT operated wherever specified.

5.22 Current Transformers (CTs)

CTs shall be cast resin insulated type. Primary and secondary terminals shall be marked indelibly. CTs shall preferably be mounted on stationery parts. CT rating and ratios shall be as per feeder ratings. These shall be capable of withstanding

momentary short circuit and symmetrical short circuit current for 1 second. Neutral side of CTs shall be earthed. Protection CTs shall have low reactance, accuracy class “5P” and an accuracy limit factor greater than “10”. Instrument CTs shall be of accuracy class as per latest CEA/KSERC standards.

CTs used for REF protection in transformers and LT panel shall have same ratio, compatible excitation and saturation characteristics required for reliable operation.

5.23 Connection

Connections to the bus bars shall be made by drilling holes. However, no holes shall be left in the bus bars except at the both ends of the main bus bar for panel extension. The bolts & nuts used for connections to bus bars shall be of tinned forged brass. For tapping of connections from bus bars suitable size PVC sleeved (FRLS) copper conductor (minimum size 4.0 Sq.mm) shall be used with suitable size and type of crimped lugs/cable sockets. For connection of feeder only rigid connections with heat shrinkable PVC sleeve (FRLS)shall be used. For all outgoing cables, cable alleys of suitable sizes in sides and tops, as required for proper cable connections/laying inside the panel, shall be provided. Switch board shall be suitable for Aluminium conductor PVC insulated incoming and outgoing cables. Removable gland plates shall be provided for cable entries.

5.24 Earthing

Two independent earthing points shall be provided outside the panel near bottom and these shall be inter-connected with Cu earthing bus bars of minimum size 25 x 6 mm. All earthing points inside the distribution board shall be interconnected to these earthing points with suitable size copper conductor.

5.25 Name plates

Switch board/distribution board shall be provided with danger plate and name plates for all incoming and outgoing feeders. These name plates shall be of PVC (blue colour base & white letters engraved) screwed to panel. The size of each letters shall be 15mm x 10mm for Panel Board Identification name and remaining details shall be appropriate size and it shall be clearly visible from 1.5 meter away from the panel.PVC identification ferrule numbers shall be used for all internal wiring. The name plate shall contain the following information.

- Panel Board Identification name & number
- Feeder name.
- Switch/ fuse rating.
- Cable size.
- Feeder Cable from …. / to…….

5.26 Supports

Bus bars shall be rigidly fixed to the supports, of SMC/DMC solid block type base. Bus bars shall be firmly held within the slots in sheet type supports, which in turn shall be rigidly fixed to the chamber. The minimum clearances to be maintained for

enclosed indoor air insulated bus bars for medium voltage applications shall be as IEC/IS standards.

5.27 Indicating Lamps

On all the incomers of L.V panels, ON/OFF/TRIP indicating LED lamps shall be provided, wherever specified and shall be suitable for operation on AC supply. Phase indicating LED lamps shall be associated with necessary control MCB.

Type: Panel mounting wide band LED type with inbuilt surge suppressor to protect LED against switching surges

Standards applicable	:IEC 947-5-1
Diameter	:22mm
Operating voltage	:240V AC
Illumination Level	:Minimum 100 lux on the front face of the lens.
Colour of lamps	:as per standards

5.28 Arrangement of bus bars and main connections:

Bus bars and main connections, which are substantially in one plane, shall be arranged in the order given below for AC System

- The order of phase connections shall be red, yellow and blue.
- When the run of the conductors is horizontal, the red shall be on the top or farthest away as viewed from the front.
- When the run of the conductors is vertical, the red shall be on the left, or farthest away as viewed from the front.
- When the system has a neutral connection in the same plane as the phase connections, the neutral shall occupy the bottom position if horizontal and extreme right if vertical, or nearest position when viewed from the front.
- Unless the neutral connections can be readily distinguished from the phase connections, the order shall be red, yellow, blue and black.

5.29 Approval of Installation

The complete system shall be tested to meet the approval of Employer. The entire system shall be got approved from TAC (Tariff Advisory Committee, India) accredited agency by the Vendor. Only listed or approved equipment and devices shall be used in the systems i.e. all equipment shall be approved by UL/FM/Vds/LPC and cylinders along with cylinder valve assemblies shall be seamless and PESO/CCE approved.

All critical equipment such as cylinders, cylinder valves, directional valves, pressure reducers, nozzles, actuation controls, pressure gauges etc. shall have approvals from UL/FM/VDS/LPC. In order to determine that the system has been properly installed and will function as specified, the following tests shall be performed:

- A thorough visual inspection of the installed system and hazard area. The piping, operational equipment and discharge nozzles shall be inspected for proper size and location. The locations of alarms and manual emergency releases shall be confirmed. The hazard area shall be inspected closely for un-closable openings and sources of agent loss.
- A check of labelling of devices for proper designations and instructions. Name plate data on the storage cylinders shall adhere to specifications
- The cylinder along with cylinder valve assembly shall be PESO/CCE, Nagpur approved.

5.30 Factory Acceptance Tests

All routine tests as per IS/IEC standards shall be conducted on the Panels. CPRI test certificate for short circuit rating, temperature rise and IP classification for similar panels shall be produced. Client/consultant shall have the right to inspect the progress of work, quality of materials used/ workmanship and to witness the Routine tests after completion of work at the premises of the manufacturer. The contractor shall give at least 15 days advance information to client/consultant about the manufacturing and routine tests plan so that client/consultant can attend the same. FAT shall at least include the following tests.

- High voltage test of the bus bar system and the circuit breakers
- Functional test

5.31 Installation, Testing and Commissioning

Switchgears shall be installed in accordance with specified code of practice and the Consultants instructions. The panels shall be delivered in convenient shipping section by the contractors. The Contractor shall be responsible for final assembly and inter-connection of bus bars/wiring. Foundation channel shall be grouted in the flooring by the Contractor. Switchgear panels shall be aligned and levelled on their base channels and bolted or tack welded to them as per the instructions of the Employer. The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on the switchgear. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panel have been erected and aligned.

After erection the switchboard shall be inspected for dust and vermin proof. Any hole, which might allow dust or vermin etc. to enter the panel, shall be plugged suitably at no extra cost.

If the instrument transformers are supplied separately they shall be erected as per the direction of the Employer. The Contractor shall fix the cable glands after drilling the bottom/top plates of all switch boards with suitable holes at no extra cost.

Range of overload relays/timers (digital) etc. shall be checked with requirement of purchaser actually to be connected at site and if the same is under-sized/over-sized, it shall be brought to the notice of Employer and shall arrange procurement of correct rated components. However, the Contractor shall not charge anything extra for cost/ labour for such replacements.

The Contractor shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of the interconnections between

various items of the equipment. This shall be done by applying normal ac or dc voltage to the circuits and operating the equipment for functional checking of all control circuits, E.g. Closing, tripping, control interlock, supervision and alarm circuits.

All connections in the switchgear shall be tested from point to point for possible grounds or short circuit. All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

The Contractor shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets etc. shall also have to be arranged by the Contractor. Payment for above work shall be deemed to have been included in the erection of switch boards/control panels.

After supply and installation of panels, the contractor shall carry out following tests before switching on the power to installation and the results shall be recorded and submitted to the Employer. If results are not satisfactory/as per the standard, the contractor shall identify the defects/short coming and shall rectify the same.Nothing extra shall be paid for carrying out these tests and contractor has to arrange all necessary instruments.

Insulation resistance tests shall be carried out by following rating insulation tester:

a) Control circuits up to 220 V : 500V
Insulation tester

b) Power circuits, bus bars, connections up to 11kV : 1000V
Insulation tester

c) Power circuits, bus bars, connections up to 33kV : 5000V
insulation tester

Before electrical panel is energized, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contact open. Before switchgear is energized, the insulation resistance of all DC control circuits shall be measured from line to ground.

The following tests shall be performed on all circuit breakers after completion of Erection:

- Contact alignment and wipe shall be checked an adjusted where necessary in accordance with the breaker manufacturer's instructions.
- Each circuit breaker shall be closed manually and its insulation resistance measured from phase to phase and phase to ground.
- All adjustable direct acting trip devices shall be set using values approved by the Employer/manufacturer.
- Before switchgear is energized the following tests shall be performed on each circuit breaker in its test position and the same to be witnessed by the Employer
- Close and trip the circuit breaker from its local & remote control switch, push button or operating handle.
- Test operation of circuit breaker for micro process release using simulation kit (supplied along with panel).

- Test proper operation of lockout device in the closing circuit, wherever provided by simulating conditions, which would cause a lockout to occur.
- Before switchgear is energized, the test covered above shall be repeated with each breaker in its normal operating position.
- All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

The Contractor shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets etc. shall also have to be arranged by the contractor. Payment for the above work shall be deemed to have been included in the erection of switch boards/control panels.

5.32 Proforma for Panels

Circuit (breaker or Supplier module designation/bus no.)

1	Insulation resistance tests (contacts open, breaker racked in position)		
1.1	Between each phase of bus	:	Mega ohm
1.2	Between each phase and earth	:	Mega ohm
1.3	DC and AC control & auxiliary circuits	:	Mega ohm
1.4	Between each phase of CT/PT and	:	Mega ohm
1.5	CT & PT circuit if any	:	Mega ohm
2	CT checks	:	
3	CT ratio	:	
4	CT secondary resistance	:	
5	CT polarity check	:	
6	Check for contact alignment and wipe	:	
7	Check/test all releases/relays	:	
8	Check mechanical interlocks	:	
9	Check switchgear/control panel wiring	:	
10	Check electrical interlocks	:	
11	Checking of breaker/control circuits for	:	
12	Closing-local and remote (wherever applicable)	:	
13	Tripping-local and remote (wherever	:	

	applicable)		
14	Opening time of breaker/contactor	:	
15	Closing time of breaker/contactor	:	

(This Performa shall be jointly signed by the Employer and the Contractor.)

6 COPE BOX PANEL AT JETTY(200A)

6.1 Scope

This specification covers the technical requirements for design, manufacture, supply, Installation, Testing and commissioning of the outdoor type Stainless steel(316 grade, 2mm thick) Cope box supply point panel with receptacle at jetty.

6.2 General Construction

The item shall be surface mounted receptacle combination enclosure with stainless steel grade of 316 suitable for marine environmental use. The panel is for use in the marine environments and shall have grater resistance to pitting. The item shall be compact austenitic chromium – nickel stainless and heat resistance steel with superior corrosion resistance. Hinged lockable doors with door switch interlock will be provided for all feeders/panels, door opening in front and canopy and having IP 55 degree of protection for enclosure. The receptacles/ sockets shall be high resistance polycarbonate material.

The rating of cope box be 200A with incomer 4pole MCCB of 200A and outgoing shall be 5 pin receptacle/socket with rating of 125A, 63A and 32 A . The outgoing shall be provided with individual MCB's for protection. **The panels shall be supplied with one set of plugs with respective rating for taking output supply**. The makes of receptacle shall be Menekes, Cape or equivalent brand .The panel shall be manufactured in the CPRI approved firm.

Cope box on suitable foundation, bolts, connect test and commissioning independent, floor mounted fabricated of 2 mm stainless steel sheet including electrolytic copper 3 phase bus bar of suitable capacity .

7 CABLES & CABLES INSTALLATION

7.1 Scope

The scope under this section covers the sizing of power cables as per load current and fault level, preparation of cable schedule, manufacture, supply, factory testing, transportation, storage and installation of power & control cables.

Incoming 11kV cable from Port substation to SCB shall be of Aluminium Cable

The cables less than and including 10sq.mm shall be of copper and stranded above 16sq.mm shall be of Aluminium including 16sq.mm

Power cables shall be sized to satisfy the following Criteria:

Short circuit withstand capacity for applicable fault current and duration.

Full load current carrying capacity under installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.

Permissible voltage drops limits under steady state/transient state as applicable.

Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Cables shall be sized for the following short circuit rating.

- Outgoing cables from 11kV Switchboards: 26.3 kA for 0.16 sec.
- Incoming cables to 415V/380V Main Panels: 50 kA for 1 sec.(Breaker operated)
- Incoming cables to 415 V MCC/DB : Fuse cut-off current for 10 milli second (MCB protected)
- Cables from 415 V MCC to Motors: 50 kA for 0.16 sec ACB operated
- Feeders from MCC/DB : Fuse cut-off current for 10 milli second (MCB protected)
- To maintain voltage at motor terminals / equipment end with in desirable limit, it is proposed to limit the voltage drop in the cables within the following limits:

  Steady state Voltage drop (Continuous running condition): 2.5%

  Transient state voltage drop (During Motor Starting) : 10 %

7.2 Standards

The following standards, amended up to date, shall be applicable:

IS: 1753:Specification for Aluminium conductors for insulated cables.

IS: 2982:Specification for copper conductors in insulated cables.

IS: 5831:Specification for XLPE insulated and PVC sheath of electric cables.

IS: 6474:Polythene insulation and sheath of electric cables.

IS: 3975: Specification for mild steel wires, strips and tapes for armouring of cables

IS: 694:PVC insulated cables.

IS: 7098:Specification for XLPE insulated PVC sheathed cables.

IS: 3961:Recommended current ratings of cables.

IS: 5819: Recommended short circuit ratings for high voltage PVC cables.

IS: 8130: Conductors for insulated electric cables

IS: 1554: Specification for PVC insulated (Heavy duty) Electric cable

7.3 Armoring and Serving

All multi core cables liable for mechanical damage shall be armoured.

The armouring for cables above 16 sq.mm shall be galvanized steel strips and 16sqmm & below shall be with galvanized steel round wire.

8 STORAGE AND HANDLING

8.1 Storage

- The cable drums shall be stored on a well-drained, hard surface, so that the drums do not sink in the ground causing rot and damage to the cable drums paved surface is preferred, particularly for long term storage.
- The drums shall always be stored on their flanges, and not on their flat sides.
- Both ends of the cables should be properly sealed to prevent ingress/absorption of moisture by the insulation during storage.
- Protection from rain and sun is preferable for long-term storage for all types of cables. There should be enough ventilation between cable drums.
- Damaged battens of drums etc. should be replaced, as may be necessary.

8.2 Handling

- When the cable drums have to be moved over short distances, they should be rolled in the direction of the arrow marked on the drum.
- For manual transportation over long distances, the drum should be mounted on cable drum wheels, strong enough to carry the weight of the drum, and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.
- For loading into and unloading from vehicles, a crane or a suitable lifting tackle should be used. Small sized cable drums can also be rolled down carefully on a suitable ramp or rails, for unloading, provided no damage is likely to be caused to the cable or to the drum.

8.3 Power cables (HT) 11 kV grade XLPE insulated FRLS cable

The conductors shall be screened by extruded compound and XLPE insulated. The cores shall be screened by extruded compound in combination with non- metallic tape. The inner sheath over laid up cores and outer sheath over the armour shall be extruded black PVC compound type ST-2, FRLS type. Core identification shall be by printed numerals. The inner and outer sheath should be separated by steel armouring. The construction, performance and testing of the cable shall comply with IS: 7098-part-2. Dry cure (Radiant curing process) technology should be used for the manufacturing of cross-linked polyethylene cable.

Bi-metallic plate washers should be provided wherever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible.

8.4 General details

Cross sectional area of conductor : as per design calculation

No. of cores	:	3
Conductor	:	Aluminium

8.5 Insulation

The thickness of insulation shall be on the basis of insulation material, voltage and conductor size conforming to the relevant standard specification. The cores shall be colour coded to IS specifications. The XLPE insulation & sheathing shall be of high quality.

8.6 Sheathing

The sheathing shall be PVC and shall be before and after the armouring, the thickness of the sheathing shall be based on the conductor size and overall diameter below the sheathing.

8.7 Armouring

Single core cables shall be armoured with earthed at one end and if insisted it shall be of nonmagnetic material. Multi core cables shall be with armouring.

8.8 Power Cable termination

Cable termination shall be heat shrinkable type and the bushings shall be covered with adequate insulation with a provision for using the cable test rods for cable testing. 11kV cable compartments for each circuit shall be separately enclosed. Cable termination shall be suitable for Aluminium conductor. Suitable cable termination kits and other accessories shall be included in the scope of supply. Bi-metallic plate washers should be provided where ever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible. The cable should be properly terminated to avoid stress on end termination.

End termination must be done by an authorized cable jointer approved by the manufacturer or a qualified cable jointer.

8.9 Power cables (LV) 1.1kV grade XLPE insulated FRLS cable

Power cables for use on 440V system shall be of 1100 volt grade, Aluminium/Copper conductor, XLPE insulated, PVC sheathed, armoured and overall PVC sheathed cable of FRLS type, strictly as per relevant IS specification. Bi-metallic plate washers should be provided where ever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible.

The size of these cables shall be as per design calculation.

8.10 Control Cables

Control cables for use on 415V system shall be 1100 volts grade, copper conductor, FRLS insulator. Un-armoured cables to be used only if specifically required. Control cable carrying current should be black colour and voltage circuit shall be of grey colour and shall be segregated.

The size of these cables shall be as per design requirement. No cable of size less than 1.5 sq.mm, shall be used.

Inter tripping control cable to be considered between the SCB and Port substation for interlock with the upstream breakers.

8.11 Cable Glands

Cable glands shall be of heavy duty double compression type of brass, chrome plated. These shall have a screwed nipple with conduit electrical thread and check nut. These shall be suitable for armoured/ unarmoured cables, which is being used.

8.12 Cable Connectors

Cable connectors, lugs/sockets, shall be of copper/ Aluminium alloy, suitably tinned, solderless, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments, etc.)

8.13 Cable Indicators

These shall be 0.5 mm thick stainless steel/Cu strap for overall cable. PVC identification numbers, ferrule shall be used for each wire.

8.14 Cable Route Markers

RCC Cable route markers shall be provided at 50-meter interval for underground cables.

8.15 HDPE Pipes for Cables

For laying of cables underground, road crossings areas floor, ground etc. HDPE pipe of 110Dia and Min. 5mm thick pipes shall be used. All accessories for laying pipes shall be supplied Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe. No G.I pipe less than 40 mm dia. shall be used. To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

8.16 Factory Acceptance Test

Representative of the Employer shall have free access to vendor's works to inspect, expedite and witness shop tests. Any materials or works found to be defective or which does not meet the requirements of this specification will be rejected and shall be replaced at Vendor's cost.

All routine tests shall be carried out on the cables as per relevant Indian Standard/

specifications and will be witnessed by the Employer.

Routine test certificates as well as Type test certificates for the type tests carried out on identical cables shall be furnished to the Employer for reference and records.

8.17 Installation, Testing and Commissioning

Cable network shall include power, control and lighting cables, which shall be laid in underground trenches, Hume pipes, open trenches, cable trays, HDPE/GI pipes, as detailed in the relevant drawings cable schedules or as per the Employer instructions. Supply and installation of GI/FRP cable trays, HDPE/GI pipes/conduits, cable glands sockets at both ends, isolators, junction boxes, remote push buttons stations, etc. shall be under the scope of the Contractor.

8.18 General requirements for handling of cables

Before laying cables, these shall be tested for physical damage, continuity, absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500/1000 volt in the insulation tester.

The cables shall be supplied at site, wound on wooden drum as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable shall be rolled on, as it produces kinks which may damage the conductor.

Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall not be less than 15 D Where 'D' is overall diameter of the cable.

While drawing cables through GI pipes, conduits, RCC pipe, ensure that size of pipe is such that, after drawing cables, 40 % area is free. After drawing cable, the end of pipe shall be sealed with cotton/bituminous compound.

High voltage (11 kV and above), medium voltage (230 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes/trays.

Armoured cables shall never be concealed in walls/floors/ roads without GI pipes, RCC pipes.

Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of the Employer shall be taken. If allowed, proper straight through epoxy resin type/ shrinkable joint shall be made, without any additional cost.

A minimum loop of 3 M shall be provided on both ends of the cable, laid in ground. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.

Cable shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor.

All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings is indicative only and the same may be rechecked with the Employer before cutting of cables. While selecting cable routes, interference with structures, foundations, pipe line, future expansion of buildings, etc. should be avoided.

All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

Wherever cable rises from underground/ concrete trenches to motors/ switchgears/ push buttons, these shall be taken in GI pipes of suitable size, for mechanical

protection up to 300 mm distance of concerned cable gland or as instructed by the Employer.

Where cables pass through foundation/walls of other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical Contractor shall determine their location and obtain approval of the Employer before cutting

8.19 Installation of Cables

Wherever cables are taken through masonry works and road crossings etc., they shall be protected by running through GI pipes or Hume pipes. Depth shall be 1200 mm from top of finished road surface and it shall extend for about 1070 mm on both sides of the roads.

Utmost care shall be taken to avoid scratches, kinks and cuts on the conductor while transporting the cables to site or during installation. Suitable inhibiting grease shall be liberally applied to bare conductors, wherever they exist.

The junction boxes, cable end boxes etc. wherever required to be provided shall have sufficient wiring spaces with regard to the sizes of cables indicated in the drawings. Wherever required, the items to be supplied for electrification shall be complete with requisite type of cable glands, cable boxes, termination etc. and other accessories which are necessary for the satisfactory installation/operation of the installations as per relevant statutory rules and regulations.

Installation of all cables should be as per Standards. Fuses should be graded properly and should be selected based on the rating of cables. The cables shall be laid in trenches/overhead racks wherever available. The cables from cable trenches to the switcher shall be buried (as per standard practices and or taken through GI pipes to 1.2 m above ground/racks floor level. The cables taken over racks/ walls/ columns/ Transformers shall be properly clamped using aluminium clamps, the width varying from 12.5 to 25 mm at intervals of 750 mm. Suitable and permanent type of cable markers is to be provided indicating the route and position of joints of cable. Loops should be provided at either ends of the cable..

Supply and installation of danger notice boards, where required, and other provisions under the statutory rules and regulations shall be in the scope of this work.

The Contractor has to provide materials and carry out the wiring work including earthing according to IS 3043 unless otherwise specified and get it approved before using for work, by the Employer.

Sufficient number of earth pits shall be provided, if found necessary and inter-connected so as to have the resistance of the earthing installations not more than 0.5 ohm. In case the soil resistivity is found to be very high, a high sensitive relay may be used to co-relate the relay setting with high earth resistance.

The complete installation work shall be conforming to NEC-2014 and complying with the Safety Regulations 2010 and to meet the approval of the State Electrical Inspector. Installation of all switch boards and distribution boards should be in conformity with Safety Regulations 2010 and I.S. 732/1989.

The cable terminations and earth terminations, wherever required, shall only be using double compression type cable glands and suitable lugs.

All the materials to be supplied for this work shall be got approved by the Employer.

The work will be considered complete only if the following tests are conducted, by the contractor at his own cost, satisfactorily in the presence of the Employer and are:

- Insulation test
- Earth resistance test and
- Continuity test
- High pot test (for High voltage cable only)

8.20 Laying of Cables (underground system)

Cables shall be so laid in ground that these will not interfere with other underground structures. All water pipes, sewage lines or other structures, which become exposed by excavation, shall be properly supported and protection from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded diverted as directed by the Employer.

Cables shall be laid at minimum depth of 750 mm in case of LT & 1000 mm in case of HT, from ground level. Excavation will be generally in ordinary alluvial soil. The width of the trench shall be sufficient for laying of required number of cables.

Sand bedding using quarry sand of 75 mm thick shall be made below and above the cables. A layer of protecting covering with solid RC concrete block of 300 X 200 X 50 mm shall be laid breadth wise, above quarry sand bedding to cover cable completely. More than one cable can be laid in the same trench as per standards. However, the relating location of cables in trench shall be maintained till termination. The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounded ground and to the entire satisfaction to the Employer. If obstruction /hindrance is noticed in the path of laying the cable , HDD has to be done for the same for maintaining proper distance with the installations at contractor cost.

For all underground cables, route markers should be used.

Separate RCC cable route markers should be used for LT, HT and telephone cables.

Route markers should be placed in ground with 1:2:4 cement concrete pedestal

Cable markers should be installed at an interval not exceeding 50 M along the straight routes of cables at a distance of 0.5 M away from centre of cable with the arrow marked on the cable markers plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.

HDPE pipes for crossing road in cable laying shall be provided by Contractor. GI pipe at the ends shall be sealed by bituminous compound after laying and testing of cable by the Contractor without any extra charge.

8.21 Laying of Cables (Under floors)

GI class-A pipe shall be used for laying of outgoing cables from distribution boards to various equipment. Preferably one cable shall be drawn through one pipe. Size of pipe shall be such that after drawing of cable, 40 % area is free. If length of pipe is more than 30 M, free area may be increased to 50 %.

Use of elbows is not allowed at all and number of bends shall be kept minimum. Instead of using bends with sockets, pipe bending machine shall be used for making long smooth bends at site.

Ends of pipe shall be sealed temporarily while laying with cotton/jute/rubber stopper etc. to avoid entry of building material, without any additional cost.

Exact locations of equipment shall be ascertaining prior to laying of pipe.

8.22 Laying of Cable in Masonry Trenches

Masonry/concrete trenches for laying of cable shall be provided by Contractor inside substation . However, steel members such as MS angles/flats etc. shall be provided & grouted by electrical Contractor to support the cables. Cables shall be clamped to these supports with aluminium saddles/ clamps. More than one tier of cables can be provided in the same trench if the number of cables is more.

Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches, without any additional cost.

8.23 Laying of Cables in Cable Racks

Cable Racks to be used for cables laid indoors except for single cables. The cable racks shall be of ladder type fabricated out of GI tray 3mm thick or aluminium perforated as indicated. The cable racks shall be of adequate strength to carry the weight of cables without sagging. Structural bracket grouted in the build-up trenches to support the cable such supports shall be at intervals of not less than 750 mm centres. All the structural steel work shall be finished with two coats of paint over primer.

Cables shall be fixed in cable trays in single tier formation and shall be clamped with aluminium flat clamps and galvanized bolts/unit.

Earthing flat/wire can also be laid in cable tray along with cables.

After laying of cables minimum 20 % area shall be available for future use.

8.24 Laying of Cable in HDPE pipe

For road, entry into buildings and paved areas cables shall be drawn through HDPE pipes . Pipe shall be of 110mm dia and wall thickness not less than5mm. Top of pipe shall be not less than 750 mm from the top surface..

All pipes shall be provided with a fish wire. Where cables have been drawn the ends shall be plugged with bituminized tape over the cables for water proofing. For longer distances and at bends draw-pits of adequate size shall be provided to facilitate drawing in of cable, if necessary. The HDPE pipes shall be joined together, if necessary, with PVC/HDPE coupling or through the Butt joint. Supply of the jointing material shall also be borne by the contractor.

8.25 General Information

Laying of cables shall be carried out by skilled and experienced labourers using adequate rollers to minimize stretching of the cable/external damage to cables. Cables shall not be bent below the minimum permissible limit.

The permissible limits are as follows:

Type of cable & voltage grade	**Minimum bending radius Power cable**
Power cable	12D
Control cables	10D
Note: D is overall diameter of cable	

In each cable run some extra length shall be kept at a suitable point to enable one (for LT Cables) or two (for H.T cables) straight through joints to be made, should the cable develop fault at a later date. Metal screen and armour of the cable shall be bonded to the earthing system of the station on the receiving and the sending end.

The erection work shall be carried out in a neat workman like manner and the areas of work shall be cleaned of all scrap materials, etc. after the completion of work in each area every day.

In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost, and to the satisfaction of the Employer. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable, at no extra cost i.e. the Contractor shall not be paid for installation and removal of the damaged cable. All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs with insulating tape, sleeve or paint.

8.26 Drawing of cable by HDD & Method of Drilling

There are 3 road crossings and one rail crossing in the cable routes. Cable shall be drawn through these crossings by horizontal direct drilling at a minimum depth of not less than 3m except at both ends. The length of the route for providing HDD shall be minimum possible and shall be finalized after the approval of Employer.

HDD shall be done with 110 mm HDPE pipe having thickness of not less than 5mm as referred in ASTM D 1505.

The pipe shall be pulled through the borehole of sufficient depth & size after successfully reaming the borehole. Once pull back operations have commenced, the operation must continue without interruption until the pipe is completely pulled through the reamed hole.

The Contractor shall take all care and necessary precautions to protect existing structures, utilities and services in planning and execution of the Works for which the contractor shall carry out proper sounding before starting the HDD work.

Any damage to adjacent properties that are not part of this work shall be repaired and restored to its original condition at the Contractor‘s expense. The Contractor

shall be responsible for the identification and protection of services where these are crossed by construction activities.

Where crossing of roadways and railways are involved, the Contractor shall be required to record and report any ground settlement to the satisfaction of the controlling agencies. Where utilities and pipelines are involved the Contractor shall monitor ground settlement or heave directly above and 3m before and after the utility or pipeline intersection. The Contractor shall cease operations when monitoring points indicate any surface disruption. Necessary clearances from the concerned authority shall be obtained by the contractor.

All necessary measures must be taken to ensure that excavations are left in a safe condition, including the erection of suitable hard barricades, warning signs and hazard lights. The earthworks shall be set out in accordance with the design drawings.

All excavations shall be made to the depth and extent as shown on the Drawings with proper allowance for fill, additional cover (where required) and formwork. The excavations shall be kept free and clear of loose materials, water and rubbish.

After satisfactory completing, excavated materials for the HDD operations shall be removed, the Contractor shall prepare the bottom of all pits to the same specification as required for the pipe foundation. The Contractor shall ensure that the terminal sections of pipe that are joined are connected with Central Plastics Electrofusion Couplings, or connectors with tensile strength equivalent to that of the pipe being joined.

The Contractor shall undertake works in accordance with appropriate safety requirements by local & state regulations. Safety measures shall include, but not be limited to, personal protective equipment, operating of machinery within job site, and storage and transportation of materials and equipment.

After the HDD work, the HT cable shall be drawn through the pipe as per the schedule. Due Care shall be taken not to damage the cable while drawing.

Cable tags, Name plate for Panels, Equipment, schematic diagram of installations etc. and marker

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule. The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS: 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables. Alternately, the contractor may provide cable tags made up of nylon, cable marking ties of ‗TY-CAB or equivalent type with cable number heat stamped on the cable tags.

The name plate materials shall be flame proof and clearly visible and durable. Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanized iron plate. Location of underground cable joints shall be indicated with cable marker with an additional inscription—Cable joint.

Themarkershallproject150mmabovegroundand shall be spaced at an interval 100 meters and at every change in direction. They shall be located on both sides of road and drain crossings. Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing,

on each duct/conduit entry. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, such as where a number of cables enter together through a gland plate.

The price of cable tags, name plates, Schematic diagram and markers shall be included in the installation rates for Cables / Conduits / Equipment quoted by the Contractor. Specific requirements for cabling, wiring ferrules as covered in respective equipment section shall also be complied with. Schematic diagram of installations with cable routing shall be made in PVC material.

8.27 RCC Cable Route Marker

Route markers shall be provided along the runs of cables at locations approved by the Employer and generally at interval as suggested by Employer. Markers shall also be provided to identify change in the direction of the cable route and at locations of underground joints. Route markers shall be fixed firmly with cement concrete.

Route identifiers shall be made out of RCC in 1:2:4 (cement: 2coarse sand: 4graded stone aggregate of 20mm in size)of size 750x30x10 shall be laid and centred over the cable. The concrete markers, shall project over the surrounding surface so as to make the cable route easily identifiable. The reinforcement shall be with 10 SWG MS rod having the size of 50mmx50mm

The words **'11 KV CABLE/ JOINT-2020"** as the case may be, shall be engraved / inscribed on the marker.

9 TERMINATION AND JOINTING OF CABLES

9.1 Use of Glands

All PVC cable up to 1.1 kV grade, armoured or unarmoured shall be terminated at the equipment/junction box/ isolators/push buttons/control accessories, etc. by means of suitable size double compression type cable glands armour of cable shall be connected to earth point. The Contractor shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanised threaded reducing bushing shall be used for approved type.

In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, a close fit holes should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.

9.2 Use of Lugs/Sockets

All cable leads shall be terminated at the equipment terminals, by means of crimped type solder less connectors unless the terminals at the equipment ends are suitable for direct jointing without lugs/sockets.

The following is the recommended procedure for crimped joints and the same shall be followed:

Strip off the insulation of the cable end with every precaution, not to severe or damage any stand. All insulation to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.

The cable should be kept clean as far as possible before assembling it with the terminal/socket. For preventing the ingress of moisture and possibility of re-oxidation after crimping of the aluminium conductors, the socket should be fitted with corrosion inhibiting compound. For copper cables cu sockets has be used. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.

Correct size and type of socket/ferrule/lug should be selected depending on size of conductor and type of connection to be made.

Make the crimped joint by suitable crimping tool.

If after crimping the conductor in socket/lug, same portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape (FRLS).

9.3 Dressing of Cable inside the Equipment

After fixing of cable glands, the individual cores of cable shall be dressed and taken along the cableways (if provided) or shall be fixed to the panels with polyethylene straps. Cable shall be dressed in such a manner that small loop of each core is available inside the panel.

For motors of 20 HP and above, terminal box if found not suitable for proper dressing of an Aluminium cables, the Contractor shall modify the same without any additional cost.

Cables inside the equipment shall be measured and paid for.

9.4 Identification of Cables/Wires/Cores

Power cables shall be identified with red, yellow & blue PVC tapes (FRLS) for trip circuits' identification, additional red ferrules shall be used only in the particular cores of control cable at the termination points in the switchgear/control panels and control switches.

In case of control cables all cores shall be identified at both ends by their wire numbers by means of PVC ferrules or self-sticking cable markers, wire numbers shall be as per schematic/connection drawing. For power circuit also wire numbers shall be provided if required as per the drawings of switchgear manufacturer.

Brief Specification of reinstating of hard surfaced area if any specified:

(i) Back filling the trenches with crusher run screenings.

(ii) Tarred area - Providing thick rubble soling, wet mix macadam, applying priming coat with bitumen emulsion, applying tack coat over bitumen emulsion, laying 50mm thick bituminous macadam, laying 75mm thick bituminous concrete .

(iii) In Cement concrete area, re-concreting shall be done.

(iv) Transporting surplus earth to location as directed by Employer.

9.5 Testing of Cable at Site

- Before energising, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.
- Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Report measurements after splices and/or terminations are complete.
- DC High Voltage test shall be made after installation on the following:
- All 1100 Volts grade cables in which straight through joints have been made.
- All cables above 1100 V grade.
- For record purposes test data shall include the measured values of leakage current versus time.

10 PROFORMA FOR TESTING CABLES

10.1 Proforma – A, for Cable Preparation

1	Date of Test		
2	Drum No. from which cable taken	…….	
3	Cable	From…….	To…….
4	Length of run of this cable in metre	…….	
5	Insulation resistance test:		
	Voltage of Megger	…..….. Volts	
	Between core-1 to earth	.....Mega ohm	
	Between core-2 to earth	.....Mega ohm	
	Between core-3 to earth	.....Mega ohm	
	Between core-1 to core-2	.....Mega ohm	
	Between core-2 to core-3	.....Mega ohm	
	Between core-3 to core-1	.....Mega ohm	

6	High voltage test Between cores and earth Between individual cores	Voltage…….	Duration……..

Signature of Employer

Signature of Contractor

11 LIGHTING SYSTEM

11.1 Scope

This specification covers the requirements of Illumination system for efficient and trouble-free operation of SCB. All light fittings shall be LED of reputed make.

The scope of work shall cover lighting design/calculation, manufacture, assembly, inspection and testing at works, packing/dispatch, transportation to site, receipt, unloading/ storage at site, erection, testing and commissioning of illumination system complete with all accessories in all respects, for outdoor area of SCB. For berth and street lighting only copper cables shall be used.

LED lights shall have minimum lumens as follows:

- Flood lights Minimum 130 Lumens /watts
- Street light minimum 115 Lumens / watts

11.2 Codes and Standards

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant Indian Standards, IEC publications and other standards as listed, except where modified and/or supplemented by this specification. The design and testing shall follow the following standards.

IS: 10322	:	Specification for Luminaires
IS: 9583	:	Emergency lighting units.
IS/IEC 60079 -1	:	Equipment Protection by Flameproof Enclosures "d"
IS: 2206	:	Flame proof electric lighting fittings
IS: 732	:	Electrical wiring installation (system voltage not exceeding 650 v
IS: 12640	:	Residual Circuit operated Circuit breakers.
IS/IEC: 60947-1	:	low-voltage switchgear and control gear.
IS/IEC: 60898-1	:	Miniature circuit breakers
IS/IEC 60715	:	Dimensions of low-voltage switchgear and control gear.
IEC: 60309-1	:	Plugs, socket-outlets and couplers for industrial purposes
IS/IEC 60529	:	Degrees of protection provided by enclosures (IP code)
IS: 694	:	PVC insulated cables for working voltages up to and including 1.1KV
IS: 9537	:	Conduits for electrical installation.
IS: 3480	:	Flexible steel conduits for electrical wiring.
IS: 1239	:	Mild steel tubes, tubular and other wrought steel fittings.(For size above 63mm dia. of rigid conduits

IS: 14768	:	Fittings for rigid steel conduits for electrical wiring.
IS: 3837	:	Accessories for rigid steel conduits for electrical wiring.
IS: 14772	:	Boxes for enclosures of electrical accessories.

11.3 Design and Construction

Luminaires shall meet at least Electrical safety Class-I as per relevant IEC.

General:

9 Meter high GI octagonal flood lighting poles to be provided in the berth area with 3 nos, 200W LED flood lights in each poles - **4 nos.**

7 M high poles GI octagonal street lighting poles to be provided in road lighting with double arm 70W LED Lights . **-8 nos.**

Lighting pole shall be octagonal type, galvanized steel, supplied with base plate, foundation bolts, and necessary fixing-bracket for fixing the luminaire. Each pole shall be fitted with RYB connector, MCB for light protection, flexible cu cables for taking supply to fittings from below of poles and polycarbonate JB's with connectors 32Afor looping light supply UG cables. The main cables used for giving supply for the berth/street lighting shall be copper and min. size 4CX6 Sqmm. Polycarbonate JB shall be used at each poles for looping and tapping supply to the poles.

Street lighting pole shall have integral junction box.All poles shall be provided with heavy square nuts on the anchor bolts under the pole base plate and hex nuts on the top. GI conduits shall be embedded in muff for incoming and outgoing cables. Height of poles shall be as per design calculation. Junction box shall be integral to the pole, supplied along with MCB and neutral link. The pole shall be fitted with GI bracket/double arm etc. for fixing the light fittings as per standards.

Suitable RCC foundation shall be done for poles at berth and street lights. The pole foundations at berth shall be buildup /reinforced with berth slab with pedestal and for the poles in bridge shall be fixed in the hand rail supports/curb. For street light poles in the road the size of foundation shall be 50CM X50CM with pedestal with minimum 50 CM from ground level. Proper footing ,PCC, sand filling etc. has to done and shall be in accordance with the pole manufacture recommendations and site conditions.

Design: The Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3:2000, EN-40-3-3.

Pole Shaft: The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process. All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

Door opening: The octagonal Poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall bevandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing. The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Material: Octagonal Poles HT Steel Conforming to grade S355JO.Base Plate Fe 410 conforming to IS 226 / IS 2062. Foundation Bolts EN.8 grade.

Welding: The welding shall be carried out confirming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

Pole sections: The Octagonal Poles shall be in single section. There shall not be any circumferential weld joint.

Galvanization: The poles shall be hot dip galvanised as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

Fixing Type: The Octagonal Poles shall be bolted on a pre-cast foundation with a set of foundation bolts for greater rigidity.

Manufacturing: The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

Pole Testing Facility: The manufacturing unit shall have in-house pole testing facility for validation of structural design data. The pole testing facility shall conform to BS EN 40-3-2-2000 part 3-2.

Base Plate: Suitable size base plate to be supplied along with the lighting pole.

11.4 Tests

Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. For the various bought out item test certificates from equipment Manufacturer shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards.

12 CABLE TRAYS AND ACCESSORIES

12.1 Scope of Work

The scope covers the manufacture, supply, inspection, erection, testing and commissioning of FRP/G.I. pre-fabricated Heavy Duty cable trays, minimum 3mm thick GI Ladder cable trays and accessories/supports for drawing the LT/HT cables along the berth for giving supply to vessel points , cope box, light poles etc. 20% spare capacity to be considered in each cable tray.

12.2 Standards

The M.S. materials used in the manufacturer of cable trays and accessories shall conform to the requirements of ASTM – A36 / IS 2062 and the Hot Dip Galvanising shall be as per BS-729 or ASTM – A – 123 or IS – 2629. Regarding the FRP tray the standards shall be as per latest ASTM or equivalent and shall be manufactured at

reputed firm having latest standard facilities. Make shall be SUMIP, Fibre Tech, Ercon.

12.3 Introduction

This specification covers the requirements of cable trays, support structures, Cable laying etc.

12.4 General Requirements

While finalizing Cable routing layouts, consideration shall be given to the requirements of Safety, Reliability and Convenience of cable laying and termination.

Where duplicate drives/auxiliaries are provided for reliability, cable routing shall be segregated to the extent practically possible.

In cable trenches, distance between bottoms most tier and bottom of trench shall be 150 mm and clearance from top most tray to top of trench cover shall be 400 mm. Distance between two tiers shall be minimum 250 mm.

13 DESIGN AND CONSTRUCTION

13.1 Cable trays, Fittings & Accessories

Cable trays shall be ladder/perforated type as specified prefabricated (FACTORY MADE)made out of hot/cold rolled mild steel sheets, complete with matching fittings (like elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, Tray cover etc.) and hardware (like bolts, nuts, washers, GI strap, hook etc.) as required. All the items (including hardware) shall be hot dip galvanized. Thickness of galvanizing shall be not less than 610grams/sqm. The size of the trays shall be selected on the basis of maximum 40% fill criteria. Fabrication/cutting/welding of cable tray at site is not permitted.

Cable trays shall be standard width of 375/400mm Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 3mm. Rung spacing shall be 250mm maximum. The thickness of side coupler plates shall be minimum 3mm and of tray covers shall be minimum 1.6mm. Cable Trough shall be required for branching out few cables from main cable route. These shall be fabricated of mild steel sheets of minimum thickness 3mm and shall be hot dipped galvanized. Troughs shall be of standard width of 50mm & 75mm and 25mm height.

13.2 Cabling Installation

The work shall be carried out in the best workman like manner in conformity with relevant specifications / code of practices of the Bureau of Indian Standards. In addition, work shall also confirm to the requirements of latest editions / amendments of the following: -

- Indian Electricity Act and rules framed there under.
- Fire Insurance Regulations
- Regulations laid by the office of the Chief Electrical Inspector to Government/CEA
- Any other regulations laid down by the local authorities.

Support system shall be so designed that it is able to withstand weight of the cable trays, Weight of the cables (75 Kg/meter run of each cable tray), Concentrated load of 75 Kg between every support span without any permanent deflection. Factors of safety of at least 1.5 shall be considered.

Cable tray mounting structure shall be welded/ bolted to the plate inserts or to steel structure and the type of welding shall be of fillet type of at least 6mm size.

All cable way sections shall have identification, designations as per cable way layout drawings and painted/stencilled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stencilled with identification numbers at every floor.

Tray covers shall be provided for overhead cable trays on top most tier. The cable risers or vertical raceways shall also be covered by cable tray covers up to 1.5 meters from respective floor for mechanical protection. The sheet cover shall be of removable type.

13.3 Inspection & Test

The vendor shall carryout all the tests & relevant inspection & test reports should be submitted.

- The inspection /tests shall include the following:
- Verification of dimensions.
- Visual inspection for quality of manufacture, particularly smoothness of surface on both inside and outside.
- Deflection load test.
- Quality of fabrication.
- Galvanizing test.

Materials found not complying with the requirements of this specification will be rejected and shall be replaced by vendor at his own cost.

13.4 Data and Information:

Seller/contractor/vender shall furnish the following technical data along with the quotation/offer.

- Loading characteristics - permissible loading data for various sizes of cable trays. Supporting spans to be considered as 1M for both Ladder cable trays and perforated cable trays. Necessary test certificate shall be furnished.
- Dimensional G.A. drawings, indicating all components of cable tray.
- Method of Testing and corresponding standards.
- Installation Guidelines, such as fixing of cable trays on structural supports, clamping facility for the cables on the rungs of cable trays, etc.

14 SAFETY EQUIPMENTS

14.1 11 KV Grade Rubber Mat

HT grade high quality Rubber mat of width 1m shall be provided in front of HT/MV panels. The applicable standard is IS - 15652. It shall be laid throughout the length of the panels and properly pasted to the floor.

14.2 Fire Buckets

Bottom rounded Fire buckets (Min 3 nos) filled with clean dry sand along with stand shall be provided in convenient and accessible locations . They shall be neatly painted and conspicuously marked. sloping canopy shall also be provided over the fire buckets.

14.3 First Aid Boxes and chart

2 nos of fully equipped and conspicuously marked Fist Aid Boxes shall be provided at convenient locations. First Aid Charts having first aid instructions printed in English and local language shall be affixed in noticeable places.

14.4 Fire Extinguishers with enclosure .

shall be 1 numbers of portable fire extinguishers of DCP/CO2 type of 4.5/5kg shall be provided at suitable locations. All the extinguishers shall be of reputed make and should have been approved by Tariff Advisory Committee of India or any other international authorities like FOC - London/NFPA-USA.

All extinguishers shall be ISI marked. All the portable extinguishers shall be of free standing type and shall be capable of discharging freely and completely in upright position. Each extinguisher shall have the instructions for operating the extinguishers on its body itself. All extinguishers shall be supplied with initial charge and accessories as required.

Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns. All extinguishers shall be painted with durable enamel paint of fire red colour, conforming to relevant Indian Standards. Dry chemical powder type extinguisher shall conform to IS : 2171. Carbon Dioxide type extinguisher shall conform to IS:2878.

14.5 HT grade Rubber gloves

One set of high quality rubber gloves of HT grade conforming to relevant Indian Standards shall be provided at noticeable locations.

14.6 Earthing rods

One no. Earth rods with live line indicator shall be supplied .

14.7 Other safety equipment

A standard danger board notice in English, Hindi and local language with sign of skull &bones shall be affixed permanently at noticeable places. Warning strips —ISOLATE POWER SUPPLY BEFORE OPENING THE PANEL COVER shall be affixed at the rear side of each panel.

B WORKS NOT SPECIFIED

1.1 The list of the items mentioned in this section is not exhaustive and only indicative.

1.2 All materials not herein fully specified and which may be offered for use in the Works shall be subject to the approval of the Employer, without which they shall not be used anywhere in the Permanent Works.

1.3 The workmanship of works not herein fully specified shall be carried out as per relevant IS Specifications and in absence thereof shall be as per the best standard practice as approved by the Employer.

1.4 The contractor shall design and execute all other miscellaneous facilities for functional requirement as directed by the Employer during execution and the quoted rate shall deemed to cover cost of such contingent works.

VOLUME-II
SECTION - 7A
SCOPE OF WORK

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A GENERAL INFORMATION

1.1 The Key Plan of the proposed facilities is indicated in **Figure1.1**.

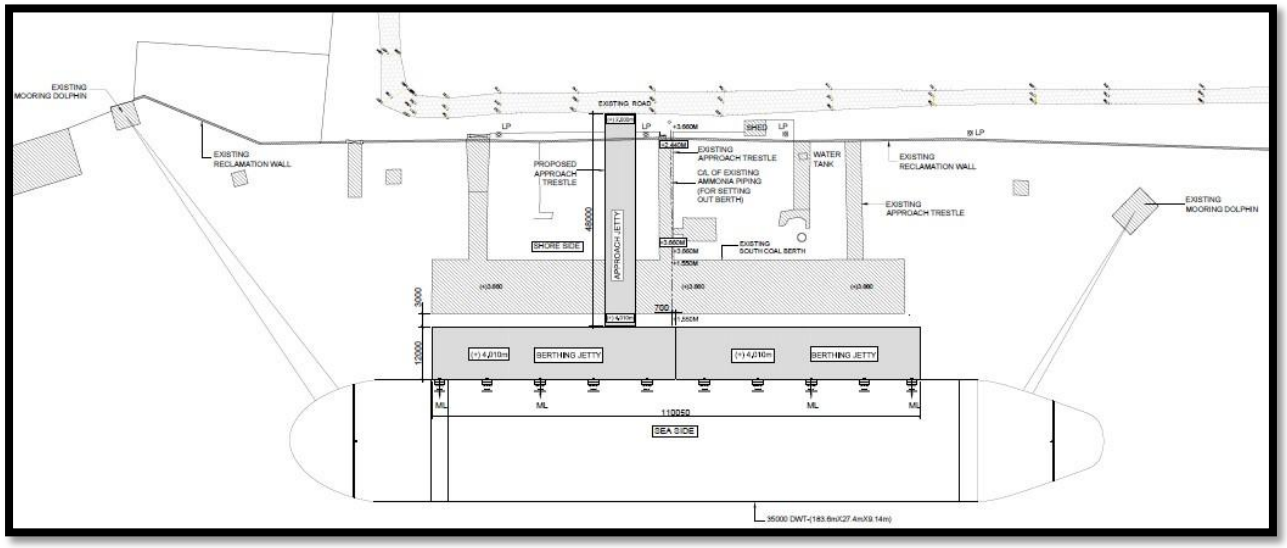

Figure 1.1 – Plan Layout of Proposed South Coal Berth

NOTE: CoPT has appointed NTCPWC/IITM for providing the Project Management Services for the Project, the scope of which includes assistance in the Tendering Process for the selection of EPC Contractor.

B GENERAL SITE DATA

1 TIDAL LEVELS

1.1 Cochin experiences semi diurnal tides. The tidal levels as per Naval Hydrographic Chart No.2004 are as follow:

Tidal Datum	Elevation (m, CD)
Highest Astronomical Tide (HAT)	+1.30m
Highest High-Water Level (HHWL)	+1.20m
Mean High Water Spring (MHWS)	+0.92m
Mean Low Water Spring (MLWS)	+0.80m
Mean Sea Level (MSL)	+0.582m
Mean High Water Neap (MHWN)	+0.60m
Mean Low Water Neap (MLWN)	+0.30m
Lowest Low Water Level	+0.20m
Lowest Astronomical Tide (LAT)	-0.20m

1.2 The above levels are with respect to Cochin Port's Chart Datum which is 0.582 m below the Mean Sea Level. Tides in the area are semidiurnal type with an average tide range of 0.6 m.

2 WAVE DATA

2.1 Wave action inside the Ernakulam Channel is insignificant because of narrow entrance to Cochin Port between Vypeen and Fort Cochin and the configuration of the land. Generally calm conditions prevail throughout the year except during the times of extreme wind action.

3 CURRENT DATA

3.1 The currents along the coast of Cochin consists of tide, wave and wind induced components. As per observations, the maximum current velocities at the Cochin Gut during the non-monsoon periods is of the order of 3 knots, which could increase to as high as 5.5 knots during the monsoon periods. Inside the Ernakulam Channel, the current velocities are low, of the order of 0.5 knots only, with directions varying at different locations.

4 WIND DATA

4.1 The wind speed and wind direction are determined by the season and by the daily temperature differences between land and sea. The predominant wind direction during the monsoon period, i.e., from June to September is west to south-west and the effect of land breeze is not dominant during this period.

4.2 During the non-monsoon periods, the predominant wind direction is from north-east during the morning and west during the evening, which shows influence of land breeze. The maximum wind speed observed was of the order of 112 Km/hr from WSW direction.

5 TEMPERATURE, HUMIDITY AND RAINFALL

5.1 Temperature

5.1.1 Temperature at Kochi varies from about 23º C to 33º C with no appreciable seasonal variations. The highest temperatures are recorded in the months of March to May. The average monthly maximum and minimum temperatures recorded at IMD station Kochi is presented below.

Month	Temperature (^{O} C)	
	Maximum	Minimum
January	31.9	23.0
February	32.0	24.2
March	32.6	25.5
April	33.0	25.9
May	32.4	25.7
June	30.3	24.2
July	29.6	23.8
August	29.5	24.0
September	30.2	24.2
October	30.7	24.1
November	31.3	24.1
December	31.9	23.2
Mean	31.3	24.3

Source: Climatological Tables (1981-2010), IMD

5.2 Humidity

5.2.1 The humidity is high all through the year. It is approximately 75% in the winter months and around 90% during the monsoon period. The average monthly relative humidity data recorded at Kochi IMD station is given below.

Month	Relative Humidity (%)	
	At 8.30 hrs	At 17.30 hrs
January	75	61
February	79	65
March	79	68
April	79	70
May	82	73
June	90	82
July	91	83
August	90	82
September	87	79
October	86	77
November	82	72
December	76	64
Average	83	73

Source: Climatological Tables (1981-2010), IMD

5.3 Rainfall

5.3.1 The average annual rainfall is reported as 3014.8 mm, and most of it is received in the period from May to October under the influence of south-west monsoons. June and July are the wettest months of the year, accounting for more than 50% of the annual rainfall. On an average, there are124.1 rainy days in a year. The average monthly rainfall and rainy days recorded at IMD station Kochi is summarized below.

Month	Rainfall (mm)	No. of Rainy days
January	24.3	1.1
February	27.1	1.2
March	45.0	2.6
April	113.1	6.9
May	284.5	11.0
June	700.3	23.0
July	575.5	22.8
August	378.8	19.0
September	310.3	13.4
October	366.6	14.2
November	150.4	7.2
December	39.0	1.8
Total	3014.8	124.1

Source: Climatological Tables (1981-2010), IMD

6 SEISMIC CONDITIONS

6.1 The Project Site (Cochin) falls in Zone III, “Moderate” seismic intensity, with an associated Zone factor (Z) of 0.16 as per IS 1893 (Part 1): 2002 Table 2 and Annex E. Response reduction factor for RCC structures shall be 3.0 as per Table 7 of IS 1893-2002.

7 GEOTECHNICAL INFORMATION

7.1 The geotechnical investigations at the location of the jetty have been conducted and two soil borehole details are placed in Section 10. In addition one more soil borehole is also planned and the details will be forwarded to all the prospective bidders for information prior to due date for submission of the bid. The investigation report(s) and the drawings attached and/or being forwarded are only for the information and guidance of the Tenderer and they cannot hold CoPT responsible for any variation between the Geotechnical information appended and/or being furnished and the actual soil encountered. If so desired, the tenderers may at their cost, carry out further investigations prior to submission of their bids. No claim in this regard shall be entertained for reasons whatsoever.

C SCOPE OF WORK

1 GENERAL

1.1 The Employer's Requirements are that the Contractor shall carryout the Engineering, Design, Procurement of materials & labour and Construction / installation of all the items listed along with associated works including testing and commissioning as outlined elsewhere in this Tender Document. For this purpose, the Tenderer shall conduct all necessary field tests and surveys to satisfy / verify himself regarding the correctness of the data furnished vis-à-vis actual condition. No claim whatsoever will be entertained for any variation between the actual site condition met with during the execution of the Work and those indicated in the Tender Document.

2 ITEMS TO BE COVERED UNDER THIS TENDER

2.1 The entire Scope of Work of the Contractor for this Tender is split into various groups for the purpose of monitoring. The broad items of works covered under each group are listed below:

2.2 Group A – Demolition of Existing Jetty

The new Jetty is proposed 15m in front of the existing dilapidated Jetty of existing SCB with approaches. A portion of the existing old Jetty to be demolished by removing the superstructure, to the extent required to accommodate the proposed approach trestle, and also cutting old piles that are interfering with the proposed construction shall be done alone, at least upto the existing bed level. Care shall be taken to remove a portion of superstructure and substructure to the level mentioned above and also it should be ensured that no underwater obstructions are created by leaving a portion of the structures unremoved to the specific depth and/or no foreign particles/debris are spilled in the area of construction and/or basin/waterfront.

2.3 Group B – Berth and Approach Trestle.

(a) Berth and Approach Trestle

(b) Jetty fixtures like fenders, bollards, safety ladders, mooring rings, D fender, handrails (RCC), etc., as required.

(c) Raising the existing road to match with approach trestle for a length of 15m

2.4 Group C – Electrical Distribution System

(a) The 11 KV distribution/Feeder system already available at a distance of 300M may be modified by replacing old RMU and providing new 4 panel compact SF6 LBS RMU +cccc+ and Supply and laying of 300M , 3CX 300sqmm HT cable from the existing substation/feeder point to proposed substation to be installed near the load point/berth.

(b) SITC of 11KV / 433V, 500KVA Transformer with latest IS/BEE standards.

(c) Supply, Installation and commissioning of 3 panel SF6 (+CCV+) RMU, in new substation .

(d) Drawing of 11 KV cable of 3C x 300 Sq mm FRLS/LSHS XLPE, Aluminum cable from the existing substation to the berth through trenches / hard surfaces / HDD etc as required with all interconnection arrangement with switch gears / tranformers etc

(e) SITC of MV panel in new substation, cope points in the berth, Junction boxes, as per requirement etc.

(f) Providing illumination to the berth and nearby area with 12nos. of 200W LED fittings in the existing High mast.

(g) SITC of LT cables to the berth cope points, high mast / Street light poles etc including its termination with junction boxes, MV panels etc.

(h) Earthing of the installations with plate /pipe earthing such as at existing 11 KV substation, , RMU's, Transformers, MV panels, Cope points, its submission, Getting approval of the installation from CEA, GoI and curing the defect if any noticed by the statutory body

(i) Civil works related to Electrical works such as cable trench, checkered MS trench cover inside S/S, Foundation for Electrical items, Excavation and refilling for cable work, HDPE pipes, Cable pull pits, Horizontal Direct Drilling (HDD) etc.

(j) SITC of flood light poles at berth , street light at approach road near berth, with foundation, light fiitings, RYB connector, MCB, Junction boxes etc,

(k) SITC of cable GI/ FRP cable trays along the berth/ trestle for laying the LT cables. The Contractor shall submit warranty/guarantee cards or receipts of the various parts used in the Works. In this regard, the Contractor has to enter into agreement with the suppliers, who have to pass on the said warranty/right to the Employer. The Contractor shall submit warranty / guarantee effective from the date of commissioning of the Works.

2.4.1 The Contractor shall submit warranty/guarantee cards or receipts of the various parts used in the Works. In this regard, the Contractor has to enter into agreement with the suppliers, who have to pass on the said warranty/right to the Employer. The Contractor shall submit warranty / guarantee effective from the date of commissioning of the Works.

2.4.2 The structures, equipment, system/sub-systems and components shall confirm in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous operation in a manner acceptable to the Employer and shall also be in line with the current practices for reliable and efficient functioning of facility.

2.4.3 In the event of conflict between requirements of any two clauses of the Specifications / Documents or requirements of different codes / standards

specified, the more stringent requirement as per the interpretation of the Employer shall apply.

2.5 The Contractor while executing the Works shall follow good industry practice, which however shall meet the Employer's Requirements. The Contractor shall adhere to and honour the Conditions of Contract, in all respects.

3 DESCRIPTION OF CONTRACTOR'S SCOPE OF WORK

3.1 General

3.1.1 The Specifications provided in the Tender together with enclosed Scope of wok and Drawings outline the functional requirements and the operating characteristics which the structures/facilities must fulfill. Alternative technical features/designs other than those specified may be acceptable subject to meeting the functional requirements and the operating characteristics and has the approval of the Employer. In any case, the performance of the system/ equipment, if any delivered, shall be guaranteed in every detail by the Contractor. Overall dimensions (boundary dimensions) and functional requirements as specified shall be strictly adhered to. The Scope of Work detailed below is for overall understanding of the Works and does not absolve the Contractor from successful commissioning and operation of the Works with best available latest technology. Any item/equipment not listed but required for completion of the Works shall be considered as included in the Scope of the Contractor.

3.1.2 The Contractor shall be deemed to have examined the Site and familiarized himself with all existing Site conditions. He shall accept the Site in the existing condition at the time of Award of Contract.

4 DETAILED SCOPE OF WORK UNDER THIS TENDER

4.1 The Detailed Scope of Work is given below. This shall be read in conjunction with the Tender Drawings provided as part of the Package:

4.2 Group A – Demolition of Existing Jetty

The Scope shall include the following:

(a) Demolishing the superstructure of existing jetty required for the construction of the proposed approach trestle.

(b) Cutting and removing of the piles interfering with the proposed new construction, in the jetty to the extent specified elsewhere in this contract, minimum upto the existing bed level.

(c) Crushing the demolished material after retrieving the reinforcement, and disposing off the unusable waste materials in the designated dumping ground within the Port premises upto a lead of 5 km.

4.3 Group B – Berth and Approach Trestle

The Scope shall include the following:

(a) Jetty of size 110m x 12m

(b) Approach Trestle of size 48m x 7m

(c) Berth fixtures like fenders, bollards, safety ladders, mooring rings, D fender, RCC handrails etc., as required.

(d) Kerb and screed concrete (wearing course) with secondary reinforcement with high quality Polypropylene fibres and primary steel reinforcement, as required.

(e) Suitable fenders adjacent to the ladders to avoid damage due to boats / vessels.

(f) Raising road surface to match with the Approach Trestle for a minimum length of 15m and to the existing width with CC or CC blocks set on 6mm aggregates..

Berthing and mooring facilities shall be provided on sea side of Berth as per Specifications and Drawings. All the steel sections to be used in the marine works (Group B works) shall be of Stainless steel of grade SS316.Warranty of five (5) years for fenders and bollards shall be obtained and a bank guarantee in the format provided in the Tender Documents shall be submitted in this regard for raising road surface to Approach Trestle and Contractor need to dismantle existing protective fencing without causing any damage and store the same for reuse. After completion of work, the contractor shall re-erect the fencing using the old dismantled materials with the addition of any new material required for completion of the job. While doing so, a 5m wide and 2.4m high tubular gate with GI tubes and GI welded mesh shall be provided at the Approach Trestle in line with the existing fencing as directed by Employer. No separate payment will be made for adding any new material or provision of the gate and rates quoted is deemed to cover this contingent work also.

4.4 **Group C – Electrical Distribution System**

The Scope shall include the following:

(1) SITC of 11KV /433V, 500 KVA transformer with latest IS/BEE standards.

(2) SITC of 4 Compact Panel SF6 LBS (RMU)+CCCC+ at old substation for taking supply to proposed area including removing the existing old RMU and temporarily connecting the supply HT supply during the work.

(3) SITC of 3 Panel SF6 (+CCV+) RMU.

(4) SITC of 800 A LV panel with ACB , MCCB etc. (I/C- . ACB 800A with all std protections) (O/G- MCCB's (LSIG) - 630A - ! No. 200A-4 Nos. , 63A- 2 Nos.) , street light control cubicle with E/M and including std meters in each cubicles.

(5) SITC of Cope point electrical plug box (SS -316) at berth made up of Stainless steel material for panel and sockets with 200A MCCB (MP) as input and 125A 5 pin socket (Receptable), 63A 5 pin socket, 32A 5 pin socket as output with 125A MCCB , 63A MCB, 32A MCB for respective outlets.

(6) SITC of 12 nos. 200W LED Light fittings by dismantling old son lamps , , aviation lamp fittings, etc, in the existing 25 M High mast in the location.

(7) SITC of 9 M hot dip GI flood Lamp poles with 3 Nos. LED 200 watts flood lights (2 Nos water side and 1 No. Lee side)with suitable fixtures etc., in the berth.

(8) SITC of with double arm 7 M GI street Lamp poles with 2nos 70 watts LED lamp etc.

(9) Supply of 3C X 300 sqmm HT, Aluminium, Armoured (E),UG cable.

(10) Supply of following LT, , AL, Armored UG cable.

a. 3.5C X 400 SQMM LT AL cable. For LT connection of transformer.

b. 3.5C X 150 SQMM LT AL cable.

c. 3.5C X 25 SQmm LT AL cable.

d. 4C X 6SQmm CU , stranded cable for lights poles.

(11) Laying of following LT, Armoured UG cable

a. 3.5C X 400 SQMM LT AL cable

b. 3.5C X 150 SQMM LT AL cable through the cable tray along the berth by clamping with Al/GI clamp etc.

c. 3.5C X 25 SQmm LT AL cable along the open trench at a depth of 60 CM including excavation etc.

d. 4C X 6SQmm CU , stranded cable for lights poles through the cable tray along the berth by clamping with Al/GI clamp etc.

e. 3.5C X 150 SQMM LT AL cable through the open trench etc.

f. 4C X 6SQmm CU , stranded cable for lights poles through the open trench at a depth of 60 CM including excavation etc.

(12) Laying of HT Cable

a. Construction of open trench at a depth of 1M and width of 600 mm along the road side in hard surface, loose sand etc and refilling the trench after laying of HT cables including RCC slab cover ,sand crushing, etc.

b. Laying of HT cables through build in trench , open trench , HDD, clamping along wall , pipes etc.

(13) Providing housing, Roofing, fencing, MS trench cover and foundation for transformers, VCB panels, HT panels, RMU, CMU etc. with half brick wall and above chain linked fencing.

(14) Supply and laying of HDPE 110mm pipe.

(15) STIC of HT heat shrinkable cable end termination kit of size 3c x 300 Sq mm/3CX240 Sq mm.

(16) STIC of LT cable end termination with brass glands, Lugs and sockets etc,

a. 3.5CX400sqmm Al cable.

b. 3.5CX150sqmm Al cable.

c. 3.5CX250sqmm Al cable.

d. 4CX6sqmm CU cable.

e. 3.5CX16sqmm Al cable.

(17) Providing plate earthing for HT equipments and Pipe earthing for LT as per IS 3043

(18) Supply and laying of 40mmX 5MM GI flat for earthing the HT/LT Equipment.

(19) Supply and laying of 8 SWG CU wire for earthing the poles etc.

(20) Supply and providing Heat shrinkable straight jointing of 11KV cable 3CX 300sqmm.

(21) supply and laying of 3 mm/4mm thick GI/FRP cable tray (35 CM width) by fixing along the berth ducts etc., with all items and accessories etc.

(22) SITC of polycarbonate body 63 A Street light control panel with timer , contactor, MCB,E/M etc.

(23) SITC of Safety items rubber sheet, Fire extinguisher, earth rod, rubber gloves etc. as per annexure and IS STD.

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SECTION 7B
DESIGN CRITERIA

A DESIGN CRITERIA

1 General

The Employer has provided concept details in the Tender Document to provide the Contractor with sufficient information so as to clearly understand the Employer's intent, goals and objectives in execution of the works. The Contractor will be required to adopt the general concepts, as provided, and expand and develop the same to produce complete, thorough, comprehensive and high quality designs, working drawings, and specifications for review and approval of the Employer.

While developing the complete and final designs and specifications, the Contractor shall review the concept details, planning and specifications provided by the Employer to become intimately familiar and fully understand the Employer's intent and also to identify betterments or improvements, if any, which may be considered, and incorporated, to better achieve the Employer's goals and objectives in providing highly efficient and functional facilities. These betterments, if any, shall be submitted by the Contractor for review and subsequent approval by the Employer prior to the commencement of final design.

2 Main Jetty and Approach Trestle

2.1 Codes and Standards

The codes and standards stated herein below or elsewhere shall be the latest editions. All materials, testing, design and execution shall be in conformity with these codes and standards unless otherwise stated in the specifications. Indian Standards shall generally be followed. In case, any work or item is not covered by the Indian Standards, following standards shall be adopted in order of preference.

1. British Standards
2. American Standards

3. General Standards

Error! Reference source not found. provides a list of the primary codes and guidelines which will be used for the structural design of the marine structures. A consistent set of standards will be used for each element of the works, with supplementary codes and guidelines used where additional requirements are needed.

Table7.1: Codes and Standards

IS 456: 2000	Plain and Reinforced Concrete – Code of Practice, Fourth Revision
IS 800: 2007	General Construction in Steel – Code of Practice, Third Revision
IS 875 (Part 1): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 1, Dead Loads – Unit Weight of Building Materials and Stored Materials, Second Revision Incorporating Amendment No.1, Reaffirmed 1997
IS 875 (Part 2): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 2, Imposed Loads, Second Revision, Reaffirmed 1997
IS 875 (Part 3): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 3, Wind Loads, Second Revision, Reaffirmed 1997
IS 1893 :1984	Criteria for Earthquake Resistant Design of Structures
IS 1893 (Part 1): 2002	Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings, Fifth Revision
IS 4651 (Part II): 1989	Code of Practice for Planning and Design of Ports and Harbours, Part II Earth Pressures
IS 4651 (Part III): 1974	Code of Practice for Planning and Design of Ports and Harbours, Part III Loading, First Revision, Reaffirmed 2012
IS 4651 (Part IV): 2014	Code of Practice for Planning and Design of Ports and Harbours, Part IV, General Design Considerations, Second Revision, Reaffirmed 2005
IS 4651(Part V): 1980	Code for Planning and Design of Ports and

	Harbours Part V, Layout and Functional Requirements, Reaffirmed 2012
IS 2911 (Part 1/Sec2)	Code of Practice for Design and Construction of Bored Cast In situ Piles
IS 2911 (Part 4)	Load Test On Piles
IS 13920 :1993	Ductile detailing of reinforced concrete structures subjected to seismic forces
IS 6403 :1981	Code of Practice for Determination of Bearing Capacity of Shallow Foundations
IRC: 6-2010	Standard Specifications and Code of Practice for Road Bridges, Section II: Loads and Stresses, Fifth Revision

2.2 Design Life

The permanent works shall be designed and constructed to give the following design lives:

- The design life of the proposed new facility is assumed as 50 years.
- This design life criterion is based on the maintenance system as follows:

  Frequency of inspection & repairs of work is 5 years.

  The design life of the fender is 15 years.

  The design life of the bollards is 15 years.

Above design lives are defined as a period within which the asset will continue to be serviceable for design loads without collapse.

2.3 Design Vessel Sizes

The design vessel size range and characteristics to be considered for the design of main jetty is provided in **Table A**.1.

Table A.1 Design Vessels for Main Jetty

Description	Vessel size in DWT.
Vessel capacity	35,000 DWT
Draft	9.14m
Overall Length	183.6m

Width	27.4m

2.4 Salient Levels

Deck level	:(+) 4.01 m CD
Highest High-Water Level (HHWL)	:(+) 1.20 m CD
Mean High Water Spring (MHWS)	:(+) 0.92 m CD
Mean Sea Level (MSL)	:(+) 0.582 m CD
Lowest Low Water Level (LLWL)	:(+) 0.20 m CD
Design dredged level at seaside of jetty	:(-) 9.700 m CD

2.5 Marine Growth

An allowance in dimension of the submerged structures due to marine growth shall be taken in to account. For design 50 mm thick marine growth shall be added to the dimension of any submerged element.

2.6 Loads

2.6.1 Dead Load

The dead loads shall be assessed based upon the volume of the material using the following densities:

a.	Water	1.0 T/cum
b.	Sea water	1.03 T/cum
c.	RCC	2.5 T/cum
d.	Soil	1.8 T/cum
e.	Steel	7.85 T/cum
e.	Sand	2.0 T/cum
g.	Concrete pavers	2.4 T/cum
h.	Foam Concrete	0.6 T/cum

The dead load due to the following shall be used in design:

- Substructure and Superstructure
- Superimposed Dead load
- Miscellaneous items such as fenders, services, ladder, railing, light poles, etc.

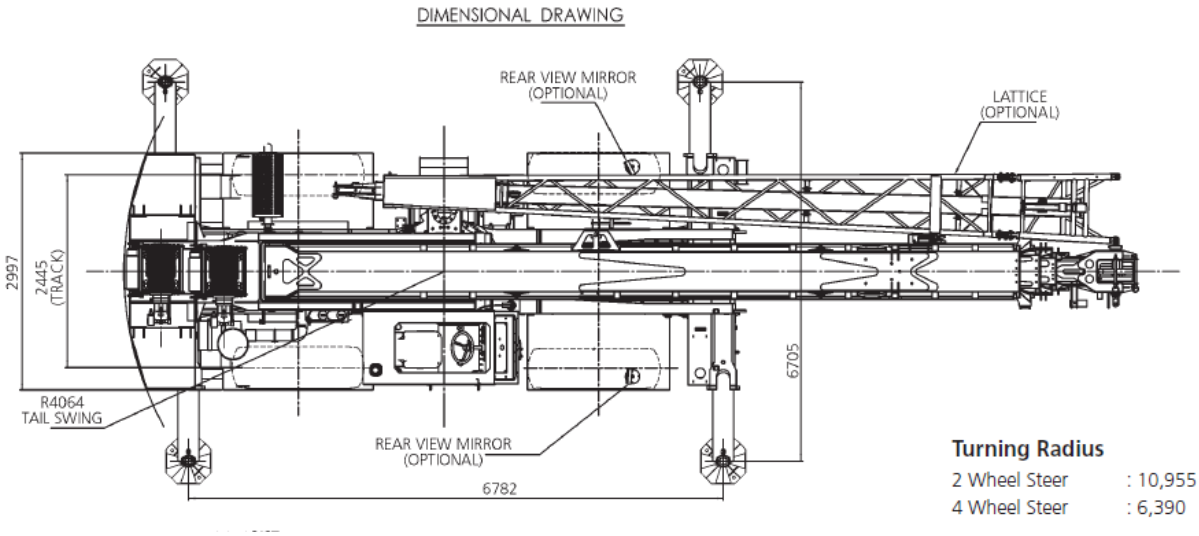
2.6.2 Live Load

The live load to be considered for Main jetty and Approach shall be 25kN/m2 or IRC Class AA, whichever governs. Impact for IRC vehicular load shall be as per IRC 6.

2.6.3 Equipment loads

The berthing and approach structure is designed for the loads of 40 Ton RT 740B capacity at minimum 16T and 3m radius. Principal dimensions of the proposed cranes shall be considered as follows.

1.0 40 Ton RT 740B



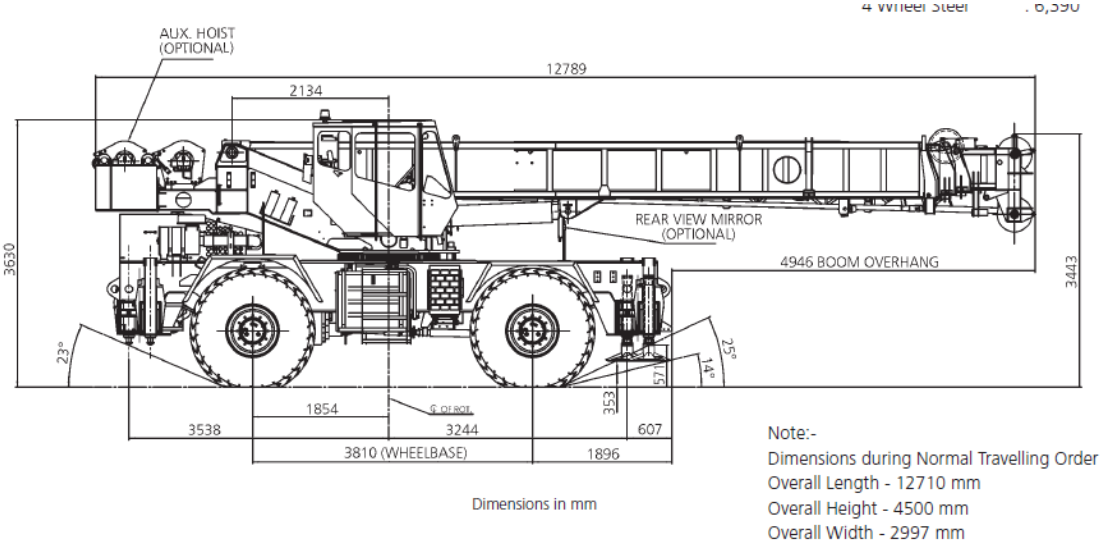


Fig 10: Technical data for crane.

Overall Length : 12.789m

Outrigger distance : 6.782m & 6.705m

Maximum vertical load coming on a single outrigger for 16MT

Capacity outrigger crane during 360 degree hoisting operation : 35T

Impact factor shall be considered as 1.15% outrigger of load.

Note: The jetty shall be designed for the above crane loads as a minimum.

2.6.4 Wind Load

Wind loads shall be considered in accordance with IS 875: Part3.

Basic wind speed of 21.0 m/s (2 mooring lines resisting the system) and 39 m/s (8 mooring lines resisting the system) shall be considered for operating (service) condition and survival (extreme) condition respectively.

2.6.5 Seismic Load

Seismic force shall be calculated according to IS 1893. As per IS code, Cochin is under Zone III. Following factors shall be considered in seismic force calculations:

Zone factor, Z = 0.16
Importance factor, I = 1.5
Response reduction factor, R = 3.0

2.6.6 Current Load

Water current force corresponding to current speed of 0.25 m/s in operating as well as storm conditions shall be considered. An allowance in dimension of the submerged structures due to marine growth shall be taken into account.

2.6.7 Berthing Load

Berthing Energy

Berthing loads shall be determined in accordance with IS: 4651 for the design vessels. Approach velocities and angles of approach for design vessels shall be considered as per table given below.

Table A.2 Parameters for calculation of Berthing Energy

S No	Description	Vessel Size in DWT 35,000
1	Berthing velocity (m/sec)	0.15
2	Berthing angle (degrees)	10
3	Mass Coefficient	1.28
4	Displacement Tonnage (Tonne)	44,100
5	Eccentricity Coefficient	0.66
6	Softness Coefficient	0.9
7	Normal berthing Energy (Tonne.m)	17
8	Factor of Safety	2
9	Manufacturing Tolerance	10%
10	Abnormal berthing Energy (Tonne.m)	34
11	Design berthing Energy	38
12	Fender Selected	SCN 950 F1.3(RPD)
13	Maximum Energy Absorption (Te.m)	39.1
14	Maximum Rated Reaction (Tonne)	69.17

The berthing energy calculations and associated details are to be submitted in support of the berthing schemes and associated fenders recommended by the contractor.

Fendering System

A suitable fender system shall be designed to absorb the design berthing energy of the vessel and to keep the vessel's hull pressure below the limit of 20 T/m2.

Fender spacing needs to be designed such that it prevents contact between the ship's hull and the face of the berth as well as providing a sufficient number of fenders while the ship is at berth on the jetty. The fender spacing shall not exceed 15% of the length of the smallest vessel to be berthed at the pier (BS:6349-4, 2014). Additionally, in order to prevent contact of the hull with the jetty at impact, a maximum spacing between fenders on the jetty shall be checked. The number and type of fenders and spacing as shown below shall be followed as a minimum requirement.

Table A.4 : Number and type of fenders and spacing

Jetty	vessel berthed	Type of Fender	Size of fender Dia x Length (mm)	Spacing of fender (m)
Main jetty/ Sea side	35,000DWT	SCN 950 F1.3(RPD)	1520 & 1200	12m
		D-Fender	150D x 3800	At bollard locations

RCC kerbs shall be provided on the edges of berth as per standards. Also, D-fenders shall be provided at the fender/bollard positions.

2.6.8 Mooring Load

Mooring load under operating condition shall be calculated as per IS: 4651 (Part 3). Mooring Pull under operating condition shall be applied at two Bollard points.

The jetties shall be designed for full capacity of the bollard in operating conditions.

Table A.5 : Capacity and Spacing of Bollards

Jetty	vessel berthed	Bollard capacity	Spacing of bollards (m)
Main jetty / Sea side	35,000DWT	50T	12m

2.6.9 Temperature Loads

Design temperature rise and fall of+36.5° C and 16.3°C shall be considered for analysis of structures.

The co-efficient of thermal expansion for concrete shall be considered as

$12 \times 10^{-}6 /^{o}C$.

2.6.10 Load Combinations

The load combinations shall be in accordance with IS:4561(Part 4):2014. Load combinations for assessing serviceability limit states and collapse limit states are provided below

Limit state of serviceability

1DL+1.1LL+1.1DYN+1.0WF+1.0B.F

1DL+1.1LL+1.1DYN+1.0WF+1.0M.F

1DL+0.5LL+0.5DYN+1.0TEM

Limit state of collapsibility

1.5DL+1.5LL+1.5DYN+1.2WF+1.5B.F

1.5DL+1.5LL+1.5DYN+1.2WF+1.5M.F

1.2DL+1.2LL+1.2DYN+1.0WF+1.0B.F

1.2DL+1.2LL+1.2DYN+1.0WF+1.2B.F

1.2DL+1.2LL+1.2DYN+1.0WF

0.9DL+0.9LL+0.9DYN+1.0WF+1.5B.F

0.9DL+0.9LL+0.9DYN+1.0WF+1.5M.F

0.9DL+0.9LL+0.9DYN+1.0WF+1.5S.F

Where,

D.L - Dead Load

L.L - Live Load

M.F - Mooring Load

B.F - Berthing Load

S.F - Seismic Load

DYN - Crane or LHM Load

TEP - Temperature

2.7 Materials

Material suggested for construction of new jetty structure and their specification is given in Table A.3.

Table A.3 Material Specifications

Structural Concrete	M-40
Levelling Concrete	M-30, 50-75 mm thick
Reinforcement	Thermo-mechanically treated corrosion resistant steel of grade equivalent to Fe550/Fe-500 conforming to IS1786 (Main Reinforcement), Fe 415 (Secondary reinforcement)
Cement	Portland slag cement conforming to IS455
Structural Steel	As per IS:2062 (Grade-A) with minimum thickness of 6 mm

2.8 Minimum Cover

Clear cover to any reinforcement shall be as mentioned here under but shall not be less than the diameter of such reinforcement.

Pile : 75 mm

Pile muffs : 60mm

Beams : 50 mm

Slab : 50 mm

2.9 Serviceability Checks

2.9.1 Deflection Limits

The deflection for reinforced concrete structures shall conform to IS 456: 2000, Clause 23.2.

Deflection of Pile at deck level shall be restricted to L/250.

2.9.2 Crack width Limits

Crack width of all the structural elements shall be calculated wherever necessary as per IS: 456. Crack width for reinforced concrete structures shall be as recommended in Table-3 of IS 4651: Part 4:2014 and presented in Table A.4.

Table A.4 Allowable Crack Width

S. No.	Exposure Zone	Crack Width Limit	
		Sustained Load	Transient Load
1.	Atmospheric Zone – Zone above HHWL	0.2	0.3
2.	Splash Zone – Zone between HHWL and LLWL	0.1	0.2
3.	Below splash Zone up to Bed level	0.2	0.3
4.	Below Bed level	0.3	0.3

Sustained Load = Long term load combinations for crack width

Transient Load = Short term load combinations for crack width

3 Onshore Facilities

Relevant codes for Utilities items like water supply, power supply, drainage, lighting as indicated in Specifications.

3.1 Electrical Distribution System

3.1.1 General Design Philosophy

The design shall provide the expected performance and be suitable for the purpose in accordance with the requirements. Earthing, lightning and protective devices to be designed for safe and efficient operation of the Electrical distribution system. Safety clearances to be provided as per the statutory requirement for free movement of operation and maintenance personnel. The design shall be suitable for the local environmental conditions of the site and shall incorporate energy efficiencies and installation practices which minimize damage to the environment.

a. GENERAL TECHNICAL PARTICULARS.

Fault level at W/Island at 11 KV : 25 KA

Anticipated Max. fault level : 50 KA

Rated system voltage : 11 KV

Rated frequency : 50 Hz

Neutral earthing : effectively earthed.

Installation of cable : Underground burial.

Rated short circuit current at 11 KV side :25 KA

Proximity of extraneous heat source : Nil

Max. Permissible operating temp. of conductor

under normal Operation : 90 0 C

Under short circuit : 2500 C

Ground temperature : 40_0 C

Type of installation : Earthed

Maximum temperature of air : 40o C

Minimum temperature of air : 22 o C

Maximum relative humidity : 95%

Minimum relative humidity : 10%

Average No. Of thunderstorm days : 40 days

Average number of rainy days per annum : 90 days

b. Type of soil along the cable route

General condition of the earth is soft marshy. Some portions are tarred with rubble soling. However Contractor shall conduct route survey before submitting their quotes.

c. General conditions

In addition to the above, the scope intends to cover but not restrict to the following activities, services and works.

(i) Complete design and engineering of all the systems, sub-systems equipment, material and services.

(ii) Providing engineering data, drawing and O&M manuals for Employer‘s review, approval and records.

(iii) Supply, testing, packing transportation and insurance the equipments from the manufacturer‘s work to the site.

(iv) Receipt, storage, insurance, preservation and conservation of equipment at

the site.

(v) Fabrication, pre-assembly (if any), erection, testing and putting into satisfactory operation of all the equipment/ material including statutory clearances & successful commissioning.

(vi) In addition to the requirements indicated in Technical Specifications, all the requirements as stated in relevant regulations stipulated for successful commissioning of the installation also be considered as a part of this specification and Contractor is bound for compliance the same.

(vii) The Contractor shall be responsible for providing all material, equipment and services specified or otherwise which are required to full fill the intent of ensuring operability, maintainability and the reliability of the complete work covered under this specification.

(viii) For individual equipment specifications reference shall be made to the relevant Technical Specification of the equipment as per contract condition.

(ix) The Contractor shall be responsible for the overall management and supervision of works. He shall provide experienced, skilled, knowledgeable and competent personnel for all phases of the project, so as to provide the Employer with a high quality system.

(x) A project execution schedule called Master Network (MNW) in the form of PERT / Gant chart/ network and based on ‗Work break down structure' shall be prepared by the Contractor for Employer's approval.

The MNW shall identify milestones of key events for each work/ component in the areas of engineering, procurement, manufacture, dispatch, erection and commissioning

3.1.2 Design Standards

The works and equipment shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India. The design concept and design guidelines shall comply with the following local and relevant standards and requirements.

- Indian Electricity Act
- CEA Regulation
- National Building Code
- Indian Standards
- Kerala State Inspectorate regulations
- Local Municipal Authorities
- Current Local Authority Regulations

Whenever necessary the list of standards shall be considered in conjunction with specific IEC / IEEE. City, State and Country rules and Safety Standards shall take precedence over these specifications in case of conflict. In case of conflict between Codes, Standards and this Technical Specification, the most stringent requirements shall apply, unless otherwise approved by the Purchaser.

3.1.3 Design Life& site conditions

The electrical system shall be designed to operate 24 hours/day, 365 days/year. The minimum economic life of the equipment shall be 30 years.

Site data given in the section 2 shall be used while designing the Electrical power distribution system. Electrical equipment and material to be selected to withstand the corrosive atmosphere.

3.1.4 Degree of Protection

The following degree of protection classes shall be applicable if the IP class is not specifically mentioned in the respective specification.

Installed outdoor	: IP65
Installed indoor in Air-conditioned area	: IP43
Installed in covered area	: IP54
Installed Indoor in non-A/C area where possibility of entry of water is limited	: IP41
LT Switchgears (AC&DC Distribution Boards)	: IP54

3.1.5 Maximum Demand calculation

Maximum Demand calculation has to be done as per BOQ

VOLUME-II
SECTION 7C
DRAWINGS

LIST OF DRAWINGS

S.NO	DRAWING NO	DESCRIPTION	DATE	REV
GENERAL LAYOUT DRAWINGS				
1	IITM - CPT - SCB - 001 - 01	DRAWING LIST & GENERAL NOTES (SHEET 1 OF 2)	27.03.2020	0
2	IITM - CPT - SCB - 001 - 02	DRAWING LIST & GENERAL NOTES (SHEET 2 OF 2)	27.03.2020	0
3	IITM - CPT - SCB - 002	GENERAL LAYOUT	27.03.2020	0
4	IITM - CPT - SCB - 003- 01	LAYOUT & CROSS SECTION (SHEET 1 OF 3)	27.03.2020	0
5	IITM - CPT - SCB - 003 - 02	LAYOUT & CROSS SECTION (SHEET 2 OF 3)	27.03.2020	0
6	IITM - CPT- SCB - 003 - 03	LAYOUT & CROSS SECTION (SHEET 3 OF 3)	27.03.2020	0
7	IITM - CPT - SCB - 004	TYPICAL EXPANSION JOINT DETAILS	27.03.2020	0
8	IITM - CPT - SCB - 005	CONSTRUCTION SEQUENCE OF STRUCTURE	27.03.2020	0
9	IITM - CPT - SCB - 006	TYPICAL DRAINAGE DETAIL	27.03.2020	0
10	IITM - CPT - SCB - 007	EXISTING BERTH DEMOLITION PLAN	27.03.2020	0
BERTHING JETTY GENERAL ARRANGEMENTS				
11	IITM - CPT - SCB - 101 - 01	GENERAL ARRANGEMENT (SHEET 1 OF 8)	27.03.2020	0
12	IITM - CPT - SCB - 101 - 02	GENERAL ARRANGEMENT (SHEET 2 OF 8)	27.03.2020	0
13	IITM - CPT - SCB - 101 - 03	GENERAL ARRANGEMENT (SHEET 3 OF 8)	27.03.2020	0
14	IITM - CPT - SCB - 101 - 04	GENERAL ARRANGEMENT (SHEET 4 OF 8)	27.03.2020	0
15	IITM - CPT - SCB - 101 - 05	GENERAL ARRANGEMENT (SHEET 5 OF 8)	27.03.2020	0
16	IITM - CPT - SCB - 101 - 06	GENERAL ARRANGEMENT (SHEET 6 OF 8)	27.03.2020	0
17	IITM - CPT - SCB - 101 - 07	GENERAL ARRANGEMENT (SHEET 7 OF 8)	27.03.2020	0
18	IITM - CPT - SCB - 101 - 08	GENERAL ARRANGEMENT (SHEET 8 OF 8)	27.03.2020	0
19	IITM - CPT - SCB - 102	FIXING DETAILS OF BOLLARD	27.03.2020	0
20	IITM - CPT - SCB - 103	FIXING DETAILS OF FENDER	27.03.2020	0
21	IITM - CPT - SCB - 104	FIXING DETAILS OF D-FENDER	27.03.2020	0
APPROACH TRESTLE GENERAL ARRANGEMENTS				
22	IITM - CPT - SCB - 151 - 01	GENERAL ARRANGEMENT (SHEET 1 OF 4)	27.03.2020	0
23	IITM - CPT - SCB - 151 - 02	GENERAL ARRANGEMENT (SHEET 2 OF 4)	27.03.2020	0
24	IITM - CPT - SCB - 151 - 03	GENERAL ARRANGEMENT (SHEET 3 OF 4)	27.03.2020	0
25	IITM - CPT - SCB - 151 - 04	GENERAL ARRANGEMENT (SHEET 4 OF 4)	27.03.2020	0

REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
			DRAWN		CHECKED		APPROVED	

ORIGINAL SIZE A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE DRAWING LIST & GENERAL NOTES (SHEET 1 OF 2)
DRAWING NO:	IITM - CPT - SCB - 001-01
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020

Scale as shown
REV 0

GENERAL NOTES :

1.0 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2.0 ALL LEVLES ARE IN METERS RELATIVE TO CHART DATUM (EL +.0.00m).
3.0 ALL DIMENSIONS AND LEVELS SHALL BE CHECKED AND VERIFIED AT THE SITE. .ANY DISCREPANCIES SHALL BE REPORTED TO THE ENGINEER IN-CHARGE IMMEDIATELY AND MODIFIED TO SUIT THE CONDITIONS, FABRICATIONS AND INSTALLATION TOLERANCES. ALL SUCH MODIFICATION SHALL BE SUBJECTED TO THE APPROVAL OF THE SITE SUPERVISOR.
4.0 ALL STRUCTURAL CONCRETE SHALL BE HAVE THE FOLLOWING MINIMUM COMPRESSIVE STRENGTH:

MEMBERS	7 DAYS AGES	28 DAYS AGES
CAST IN-SITU/PRECASTELEMENTS	(N/mm^2)	(N/mm^2)
IN PERMANENT WORKS (M40)	30	40
IN TEMPORARY WORKS(M30)	20	30
IN TEMPORARY WORKS(M20)	13.5	20

5.0 ALL MAIN REINFORCEMENT SHALL BE OF HIGH STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500 CONFORMING TO IS1786 UNLESS NOTED OTHERWISE AND SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415.

THE MINIMUM YIELD STRENGTH SHALL BE 500 N/mm^2/415 N/MM^2 RESPECTIVELY.

6.0 MILD STEEL BAR, IF ANY SPECIFIED, SHALL HAVE A YIELD STRENGTH OF 250MPA AND SHALL BE ACCORDANCE,WITH IS432 GRADE 1.

7.0 THE MINIMUM COVER TO ALL REINFORCEMENT SHALL BE AS FOLLOWS OR THE DIAMETER OF THE BAR WHICHEVER IS THE GREATER, UNLESS NOTED OTHERWISE.

PILES	-75mm
PILE MUFF	-75mm
BEAM	-50mm
SLAB	-50mm

8.0 ALL LAPS SHALL BE STAGGERED AT 1.30 TIMES LAP LENGTH. FOR SUPERSTRUCTURE SLABS AND BEAMS, NOT MORE THAN HALF THE BARS SHALL BE SPLICED AT A SECTION. SPLICES WHERE PROVIDED SHALL BE AS FAR AS POSSIBLE AWAY FROM SECTIONS OF MAXIMUM STRESS AND SHALL BE STAGGERED.
9.0 FORMS SHALL BE SELECTED TO ENSURE THAT FAIR FACED AND SMOOTH CONCRETE SURFACE ARE OBTAINED FOR ALL CONCRETE WORK.
10.0 FOR ALL BOLTS TO BE CAST INTO THE CONCRETE, THE LENGTH OF EMBEDMENT OF ANCHOR BOLTS SHALL NOT BE LESS THAN 250mm,UNLESS NOTED OTHERWISE.
11.0 ALL CONCRETE WORKS SHALL BE IN ACCORDANCE WITH IS456 (LATEST EDITION). THE CEMENT USED SHALL BE PORTLAND SLAG CEMENT CONFORMING TO IS455. THE MINIMUM CEMENT CONTENT FOR PERMANENT WORKS SHALL BE 400 kg/m, WITH A MAXIMUM WATER CEMENT RATIO OF 0.45. FOR PLAIN CONCRETE, THE MINIMUM CEMENT CONTENT SHALL BE 310 kg/m^3, WITH A MAXIMUM WATER CEMENT RATIO OF 0.5.
12.0 CUTTING,BENDING AND FIXING OF REINFORCEMENTS SHALL BE AS PER IS2502.
13.0 WELDING OF REINFORCEMENT MS BARS SHALL BE IN ACCORDANCE WITH IS2751 AND FOR DEFORMED BAR AS PER IS9417.
14.0 GROUTING FOR BASE PLATES AND OTHER MISCELLANEOUS STRUCTURES SHALL USE NON - SHRINK GROUTING OF PREMIX TYPE WITH A MINIMUM COMPRESSIVE STRENGTH OF 40 N/mm^2 AT THE END OF 28 DAYS.
15.0 FOR OTHER NOTES PERTAINING TO REINFORCED CONCRETE PILING WORKS, THE RELEVANT PILING DRAWINGS SHALL BE REFERRED TO.
16.0 FOR INSERTS, EMBEDMENT, ETC FOR ELECTRICAL, MECHANICAL,PIPING AND INSTRUMENTATION WORKS, THE RELEVANT DRAWINGS SHALL BE REFERRED TO.

.NOTES ON BORED CAST-IN-SITU PILES:

1.0 ALL BORED CAST-IN-SITU PILE SHALL BE INSTALLED PER CONTRACT SPECIFICATION AND IS2911(PART2)
2.0 PILE LINERS SHALL BE DRIVEN TO REFUSAL OR ATLEAST TO THE DEPTH SHOWING IN DRAWINGS AND SHALL BE OF MINIMUM THICKNESS 6mm.
3.0 PILES SHALL BE ADEQUATELY BRACED UNTIL SEVEN DAYS AFTER CASTING OF THE SUPER STRUCTURE.
4.0 REINFORCEMENT SHALL BE AS PER SHOW IN CONSTRUCTION DRAWINGS.
5.0 LAPPING OF REINFORCEMENT BARS SHALL BE AS PER IS456.
6.0 SPLICING OF BARS SHALL BE CARRIED OUT EITHER USING WELDING AS PER IS9417:1989 OR PHYSICAL SPLICING WITH 50 X BAR DIA AS LENGTH OF SPLICE. STAGGERING OF LAPS SHALL BE FOLLOWED IN CASE OF WELDED LAPS.
7.0 CONCRETING SHALL START IMMEDIATELY AFTER THE CLEANING OF THE BOTTOM OF PILE SHAFT AND AFTER REINFORCING BARS HAS BEEN INSTALLED. IF THE CONCRETING HAS NOT STARTED AFTER FOUR HOURS OF THE COMPLETION OF THE CLEANING OF THE BOTTOM OF THE BORE HOLE, THE CLEANING SHALL BE REPEATED.
8.0 CONCRETING OF ALL THE PILES SHALL BE CARRIED OUT USING TERMITE METHOD WITH BENTONITE SLURRY. NO CONSTRUCTION JOINTS ARE PERMITTED IN THE PILE SHAFT.
9.0 PILE CONCRETING SHALL BE CARRIED OUT FOR 900mm. ABOVE THE CUT-OFF ELEVATION AS SHOWN IN THE CONSTRUCTION DRAWN.
10.0 BEFORE CASTING SUPER STRUCTURE ELEMENTS, THE EXCESS CONCRETE SHALL BE CHIPPED OFF AND REMOVED TO THE CORRECT ELEVATION.
11.0 THE MINIMUM PILE PENETRATION SHALL BE AS SHOWN IN THE CONTRACTION DRAWINGS. IN CASE OF HARD LAYER EXPECTED EARLIER THAN THE TARGET PENETRATION. TOE LEVEL SHALL BE DETERMINED AT SITE DEPENDING ON THE ACTUAL SOIL PROFILE AFTER CONSULTING WITH DESIGNER.
12.0 THE DEVIATION IN THE LOCATION OF EACH PILE HEAD SHALL NOT EXCEED 5% OF THE PILE DIAMETER OR 75mm WHICHEVER IS SMALLER. THE INCLINATION OF EACH PILE SHALL NOT EXCEED 1% OVER THE TOTAL LENGTH OF PILE.
13.0 WELDING OF BARS SHALL BE AS PER MANUFACTURE'S SPECIFICATIONS.

STRUCTURAL STEEL MATERIAL:

1.0 STRUCTURAL STEEL MATERIAL SHALL CONFIRM TO THE FOLLOWING SPECIFICATIONS
a) ANGLES, NOSING & BASE PLATE .
TYPE I - IS2062 GRADE 'C250' - Fy = 250MPa.
b) BASE PLATE FOR ANCHORS.
TYPE II - IS2062 GRADE 'E350' -Fy = 350MPa.
2.0 ALL ANCHOR BOLTS SHALL CONFIRM TO IS5624 GRADE 8.8.
3.0 ALL ANCHOR BOLTS AND STRUCTURAL BOLTS SHALL BE HOT DIP GALVANISED.

ABBREVIATIONS :

C/C	CENTER TO CENTER
DWG.	DRAWING
HWL	HIGH WATER LEVEL
LWL	LOW WATER LEVEL
M	METER
MM	MILLIMETER
NO	NUMBER
NOS	NUMBERS
PCL.	PILE CUTOFF LEVEL
THK.	THICK
TL.	TOP LEVEL
(TYP)	TYPICAL
PL	PLATE
MAX.	MAXIMUM
MIN.	MINIMUM

REINFORCEMENT :

1.0 REINFORCING BARS ARE REFERENCED ON THE REINFORCEMENT DETAILS AS FOLLOW:

a) MAIN BARS

15 — NUMBER OF BARS
T — HIGH YIELD -T / TYPES OF STEEL / MILD STEEL-R
32 — BAR DIAMETER
121 — BAR SPACING
① — BAR MARK

b) STIRRUPS

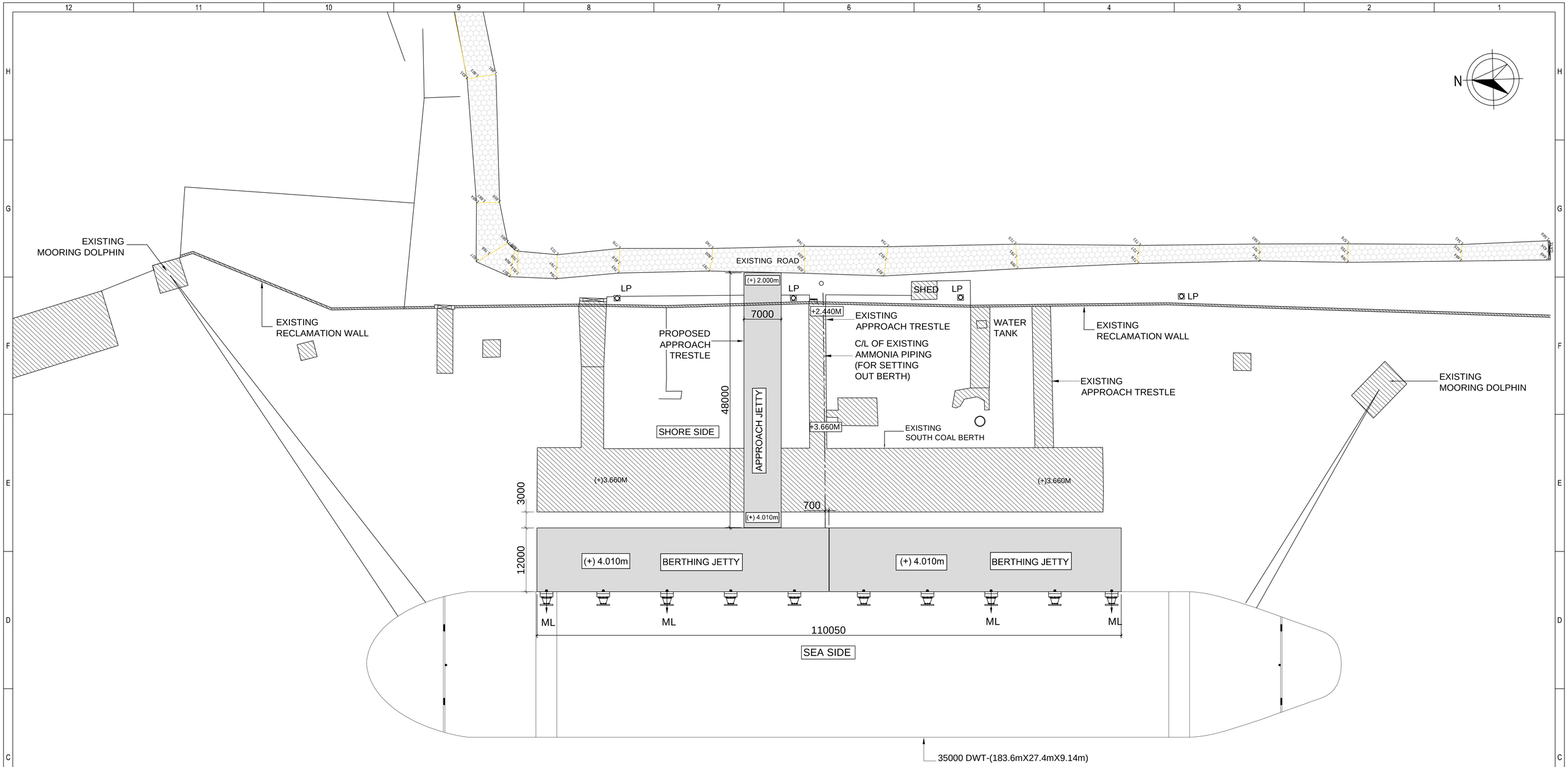
15 — NUMBER OF SETS
2L — NUMBER OF LEGS
T — HIGH YIELD -T / TYPES OF STEEL / MILD STEEL-R
32 — BAR DIAMETER
121 — BAR SPACING
① — BAR MARK

REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
							DRAWN	
							CHECKED	
							APPROVED	
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE-A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE DRAWING LIST & GENERAL NOTES (SHEET 2 OF 2)
DRAWING NO:	IITM - CPT - SCB - 001-02
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020
Scale as shown
REV 0



GENERAL LAYOUT OF SOUTH COAL BERTH
Scale 1:350

NOTES :-

EXISTING AMMONIA PIPE ROUTING LOCATIONS AND LEVELS SHOWN THE EXACT DETAILS SHALL BE REFER DRAWINGS NO. 0716-6993-5180-0007 AND MIGHT BE CHANGE WITH PRESENT CONDITIONS.

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. THE PROPOSED DEMOLITION UNDER THE CONTRACTOR'S SCOPE.

LEGEND :-

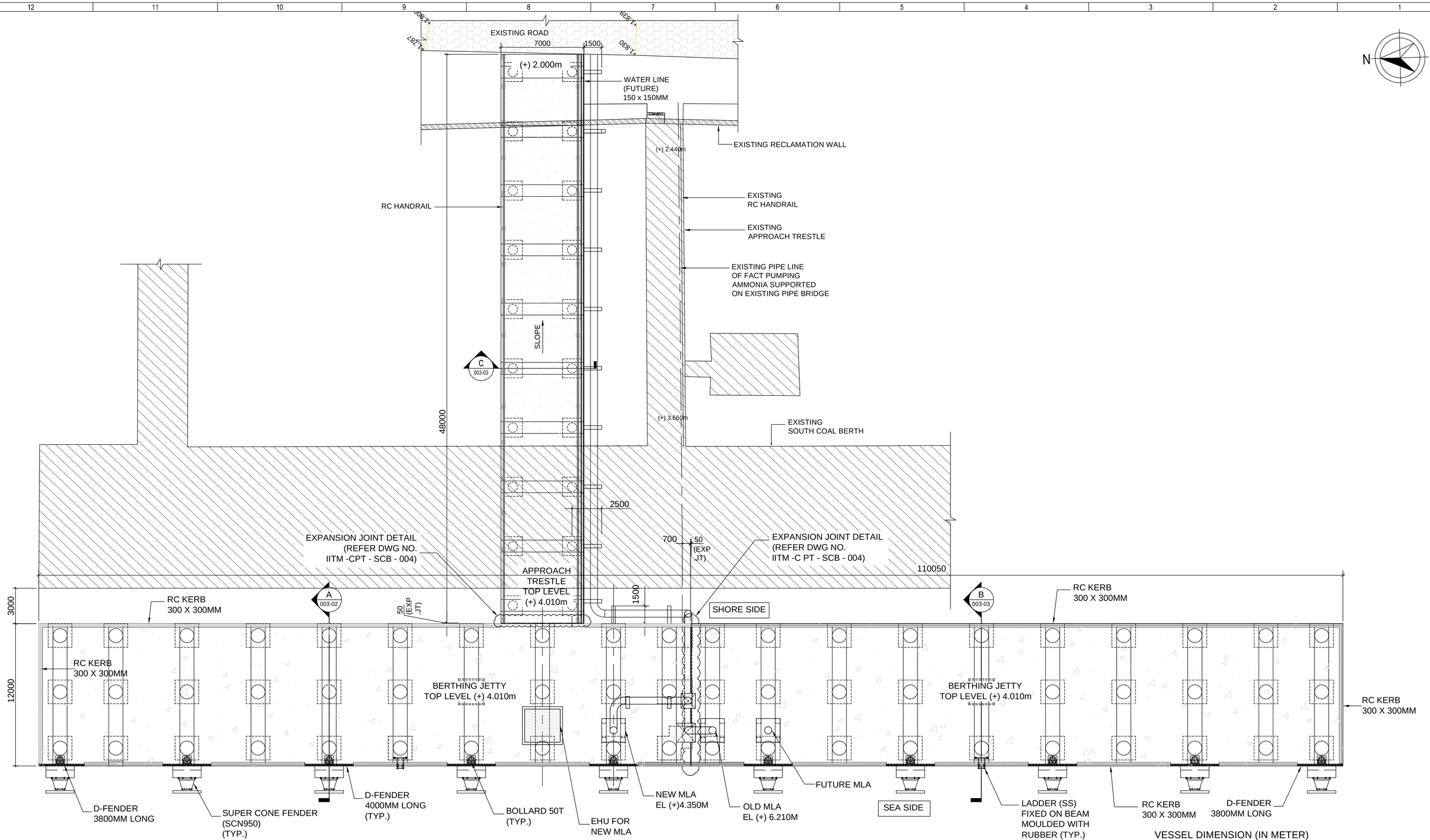
- PROPOSED STRUCTURE
- EXISTING
- ROAD
- RECLAMATION WALL
- ML - MOORING LINE
- LP - LIGHT POLE

REV.	DATE (DDMMYY)	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSED FOR TENDER						

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE GENERAL LAYOUT
DRAWING NO:	IITM - CPT - SCB - 002
DATE:	27.03.2020
	Scale as shown REV 0

ENGINEERING FIRM:
Prof.S.A.SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36



N

OVERALL LAYOUT FOR SOUTH COAL BERTH
Scale 1:150

DREDGE DEPTH (-) 9.70M

MLA & EHU IS NOT UNDER COPT CONTRACT.
IT WILL BE DONE BY OTHER AGENCIES

NOTES :-

EXISTING AMMONIA PIPE ROUTING LOCATIONS AND LEVELS SHOWN THE EXACT DETAILS SHALL BE REFER DRAWINGS NO. 0716-6993-5180-0007 AND MIGHT BE CHANGE WITH PRESENT CONDITIONS.

VESSEL DIMENSION (IN METER)

VESSEL SIZE (DWT)	LENGTH (L)	BREADTH (B)	DEPTH (D)	DRAFT
35000	183.6	27.4	14.3	9.14

LEGEND :-

- BERTHING JETTY
- APPROACH TRESTLE
- PILE
- MAIN BEAM
- CUTOUT
- PILE MUFF 400MM THK.
- TYP. - TYPICAL
- MLA. - MARINE LOADING ARM
- KERB WALL
- ROAD
- EXISTING
- RECLAMATION WALL
- SS - STAINLESS STEEL.

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.

4.FENDER SPECIFICATION

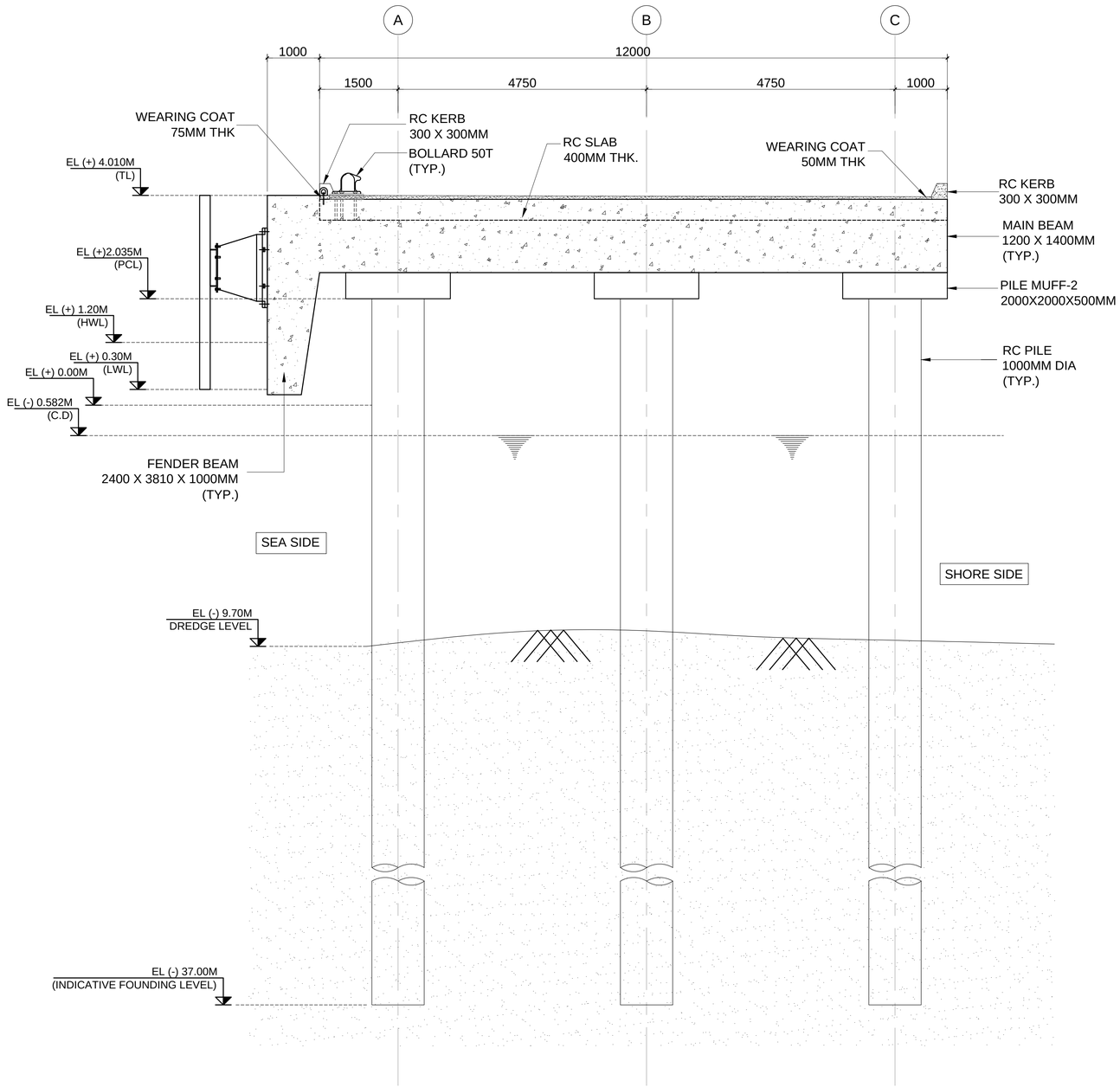
MAIN BERTH
TYPE - SUPER CONE FENDER
MAXIMUM REACTION - 1238.20 KNm
FENDER FRAME - HULL PRESSURE LIMITED TO 20T/M2

REV.	DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
	DDMMYY		DRAWN		CHECKED		APPROVED	

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE LAYOUT & CROSS SECTION (SHEET 1 OF 3)
DRAWING NO:	IITM - CPT - SCB - 003-01
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020
Scale as shown
REV 0



CROSS SECTION-AA
(FENDER LOCATION)
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. THE DEPTH OF STEEL LINER SHOWN IS INDICATIVE ONLY. THE TERMINATION LEVEL SHALL BE DETERMINED DEPENDING ON THE SOIL PROFILE.
4. PILE TOE LEVEL SHOWN IN THIS DRAWING IS MINIMUM AND SHALL BE DETERMINED AT THE SITE DEPENDING ON THE ACTUAL GROUND CONDITIONS.

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION

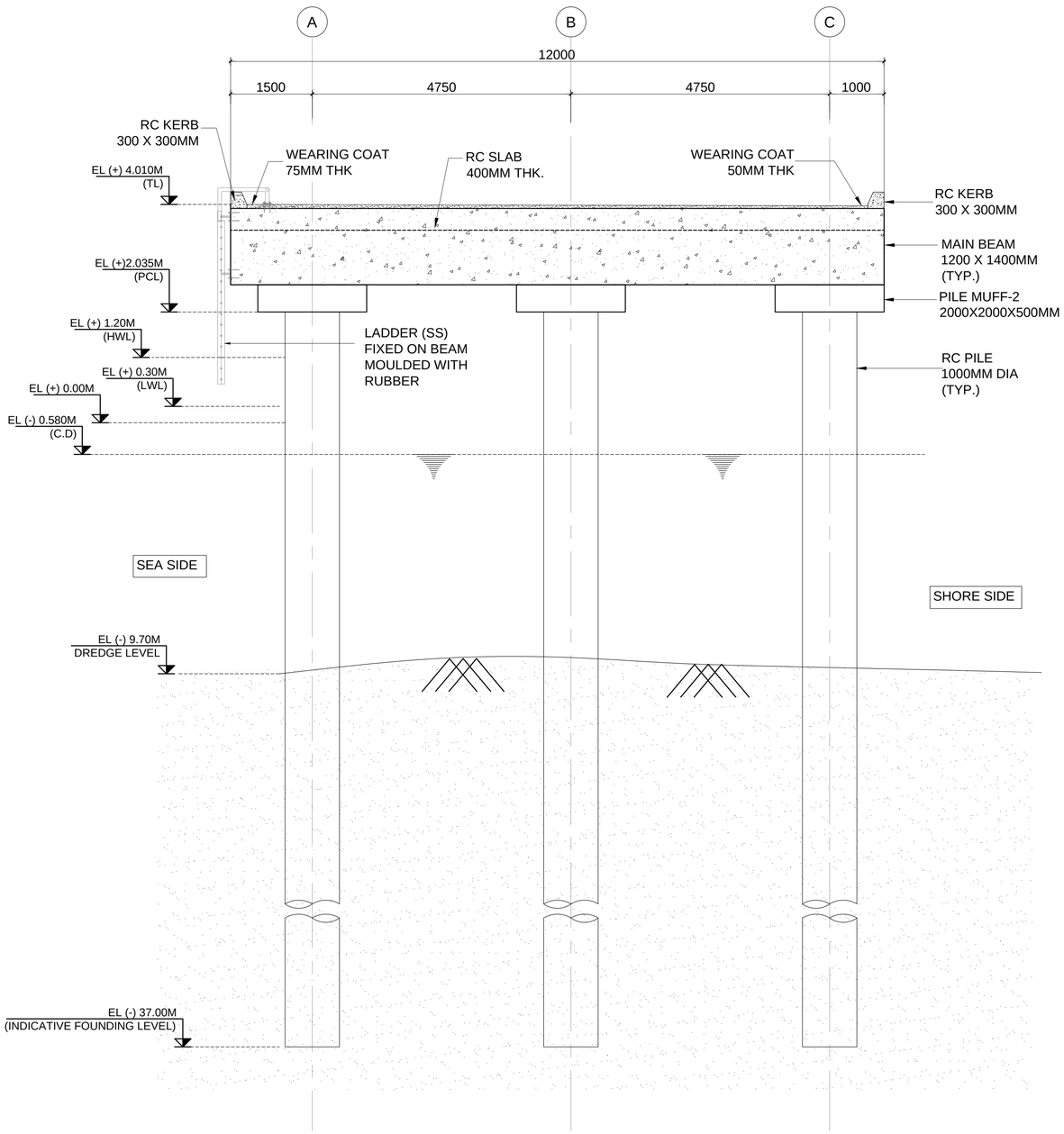
THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-003-01

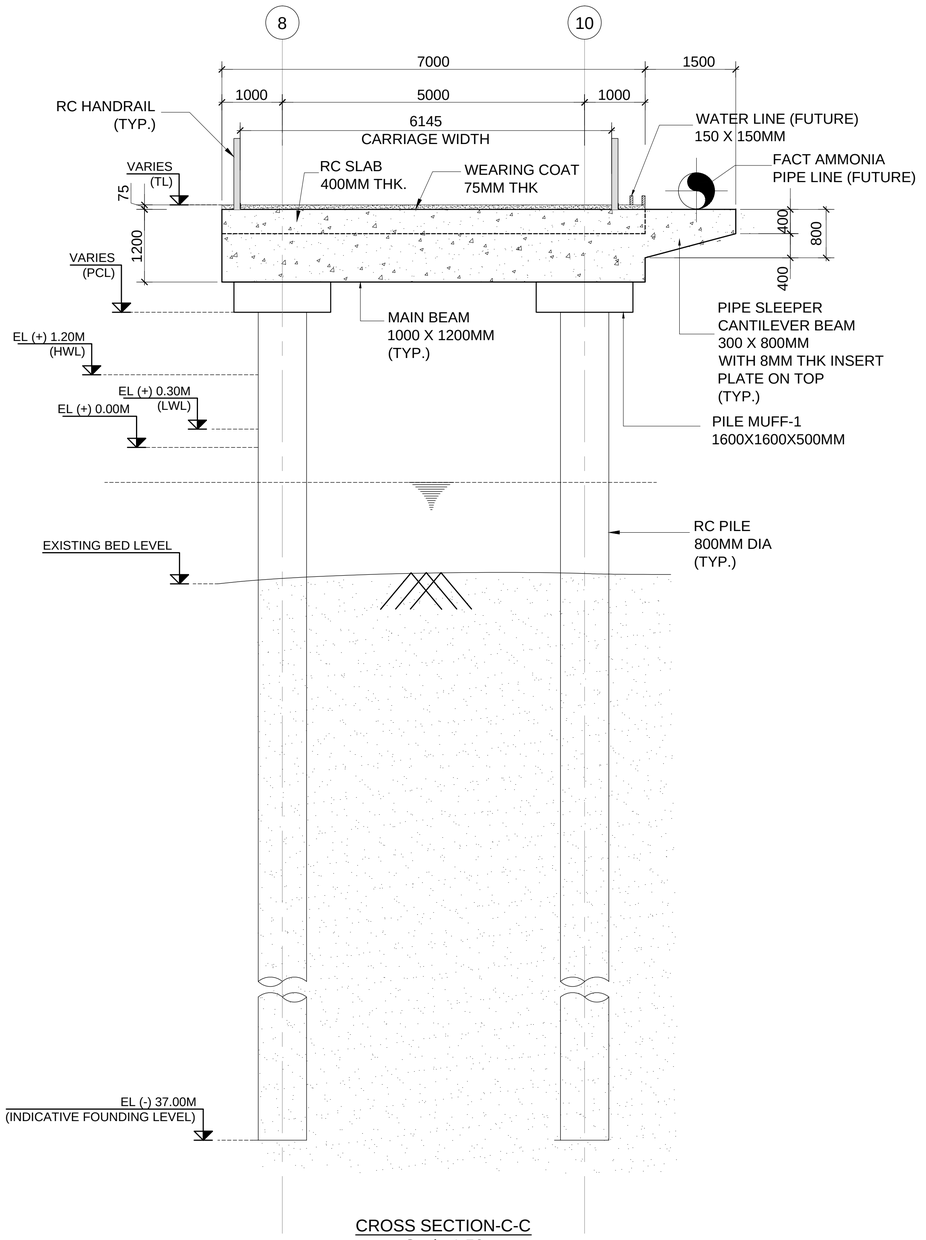
REV.	DDMMYY / DATE	DESCRIPTION	INIT. / DRAWN	SIGN.	INIT. / CHECKED	SIGN.	INIT. / APPROVED	SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE LAYOUT & CROSS SECTION (SHEET 2 OF 3)	
DRAWING NO:	IITM - CPT - SCB - 003-02	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



CROSS SECTION-B-B
(WITHOUT FENDER LOCATION)
Scale 1:50



CROSS SECTION-C-C
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. THE DEPTH OF STEEL LINER SHOWN IS INDICATIVE ONLY. THE TERMINATION LEVEL SHALL BE DETERMINED DEPENDING ON THE SOIL PROFILE.
4. PILE TOE LEVEL SHOWN IN THIS DRAWING IS MINIMUM AND SHALL BE DETERMINED AT THE SITE DEPENDING ON THE ACTUAL GROUND CONDITIONS.

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION

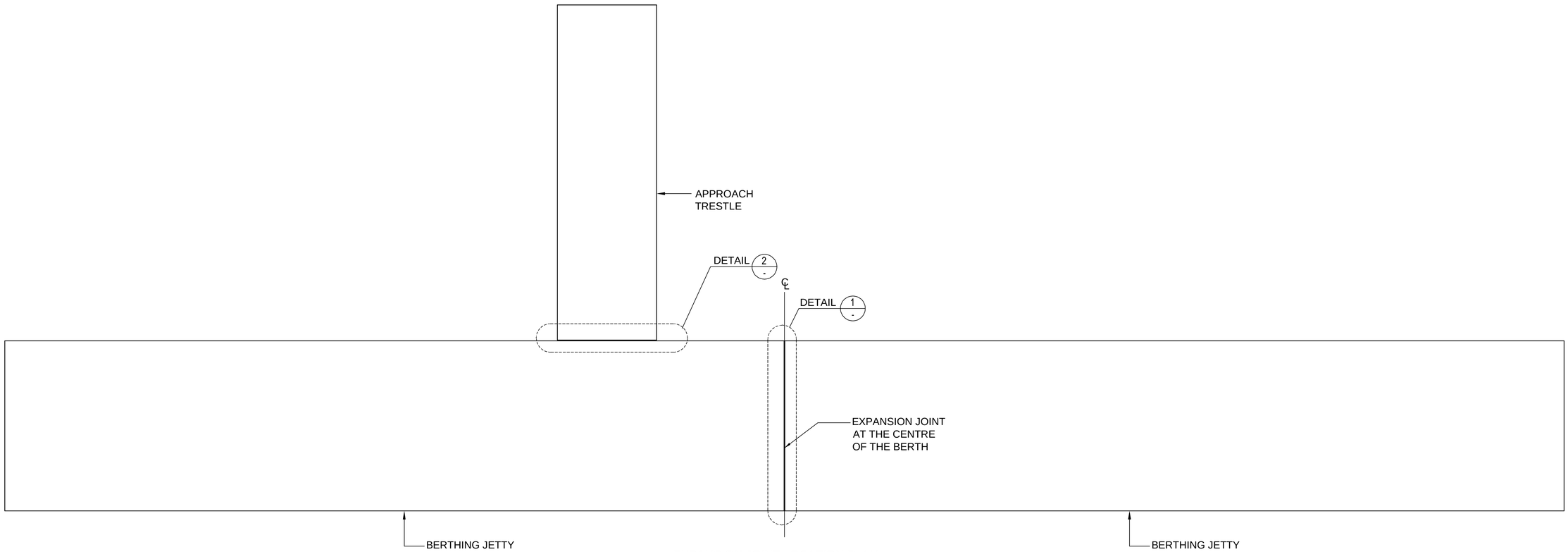
THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-003-01

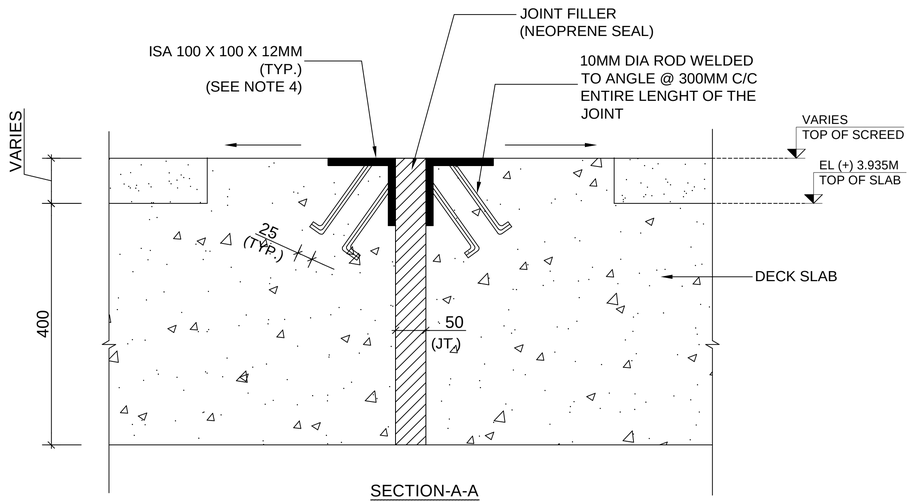
REV.	DDMMYY / DATE	DESCRIPTION	INIT. / DRAWN	SIGN.	INIT. / CHECKED	SIGN.	INIT. / APPROVED	SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE A1

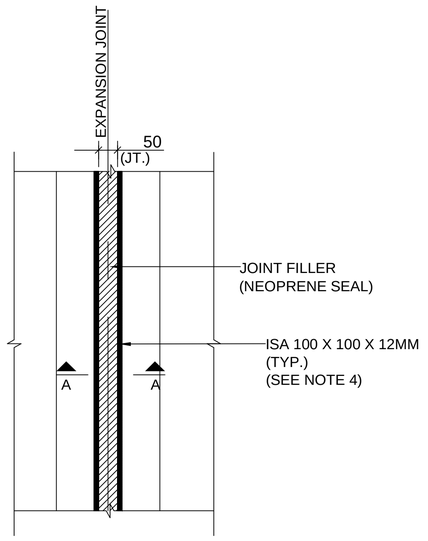
CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE LAYOUT & CROSS SECTION (SHEET 3 OF 3)	
DRAWING NO:	IITM - CPT - SCB - 003-03	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



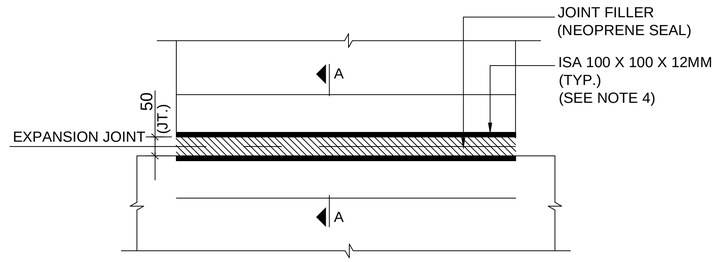
EXPANSION JOINT LOCATION PLAN
Scale 1:150



SECTION-A-A
Scale 1:5



DETAIL-1
Scale 1:8



DETAIL-2
Scale 1:8

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. ALL STEEL SECTION SHALL BE PROTECTED AGAINST CORROSION BY ANTICORROSIVE COATING OF THICKNESS 100 MICRONS.
4. THE ANGLE OF COMPRESSION SEAL SUPPLIED IN A PREFABRICATED FORM IN SEGMENT SHALL BE WELDED TO ACHIEVE THE CONTINUITY AT SITE.
5. THE GAP BETWEEN THE ANGLES SHALL BE ADJUSTED DEPENDING ON THE TEMPERATURE PREVENT AT THE TIME OF INSTALLATION.

LEGEND :-

EL - ELEVATION
TYP. - TYPICAL

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

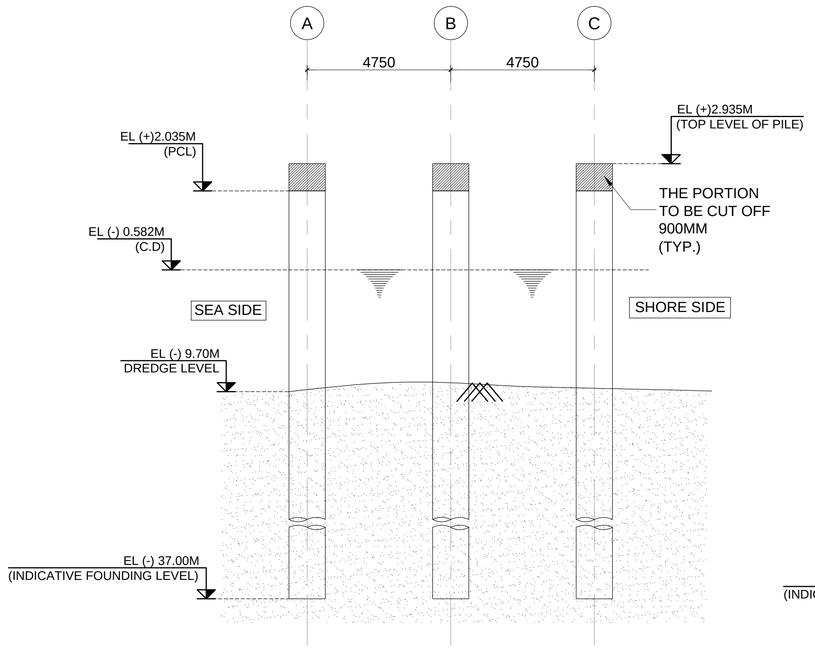
a) IITM-CPT-SCB-003-01

REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
			DRAWN		CHECKED		APPROVED	

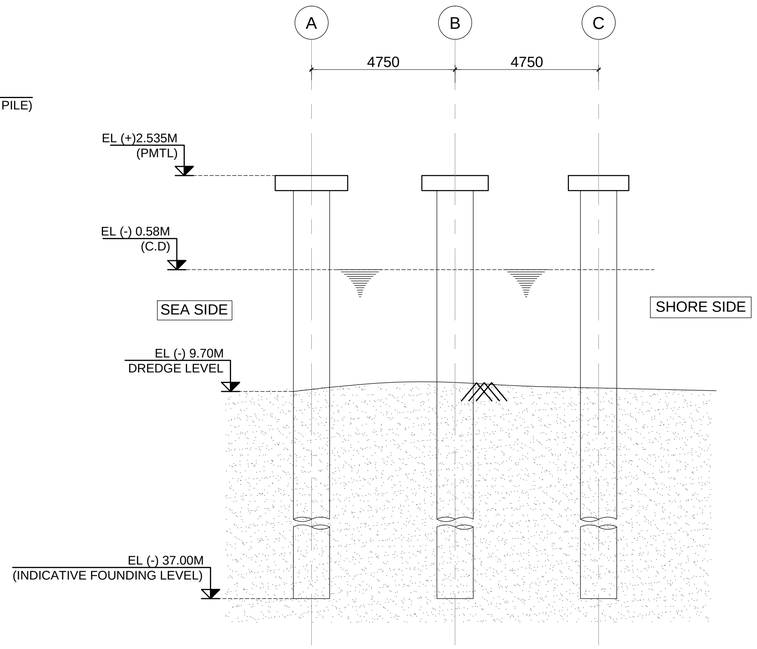
ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE TYPICAL EXPANSION JOINT DETAILS
DRAWING NO:	IITM - CPT - SCB - 004
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

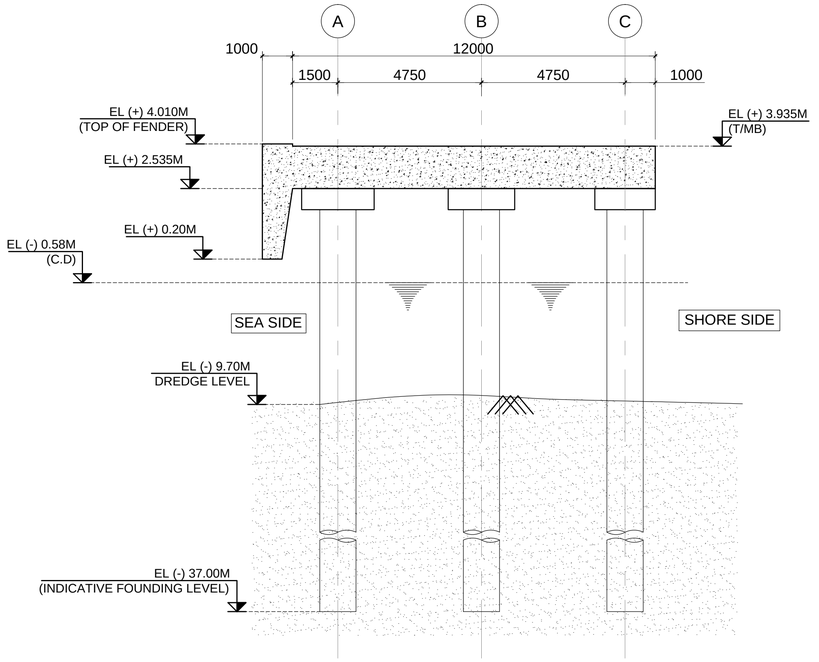
DATE: 27.03.2020
Scale as shown
REV 0



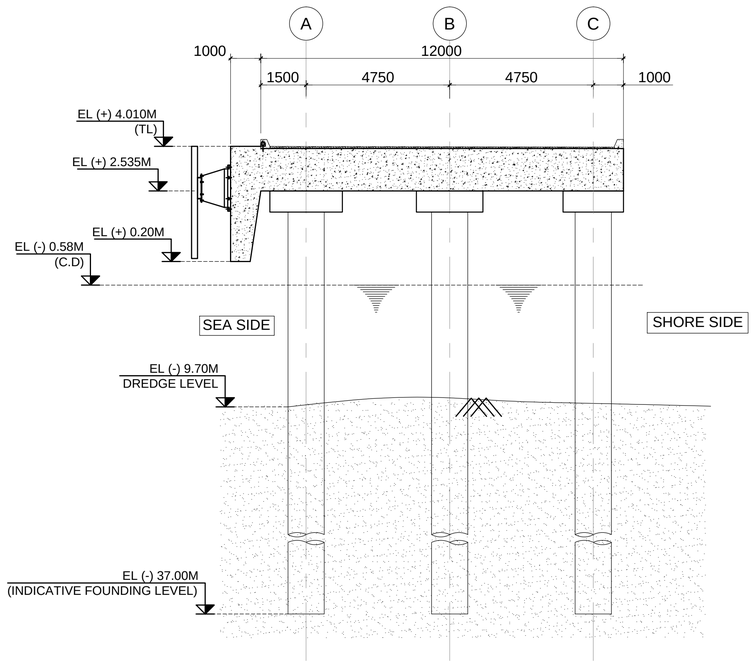
STAGE-1
PILE CONSTRUCTION
Scale 1:100



STAGE-2
PILE MUFF CONSTRUCTION
Scale 1:100



STAGE-3
BEAM AND SLAB CONSTRUCTION
Scale 1:100



STAGE-4
FINAL STAGE
Scale 1:100

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM.
3. THE CONSTRUCTION SEQUENCE SHALL BE STRICTLY FOLLOWED.
4. NO DREDGING IS ALLOWED BEFORE DECK BEAM / SLAB CONSTRUCTION IS OVER.

LEGEND :-

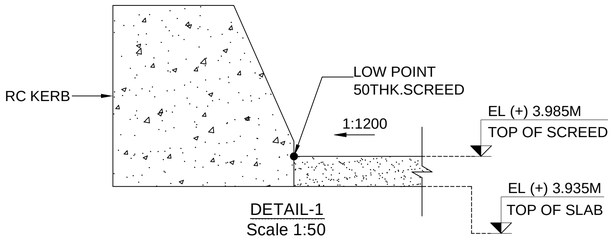
C.D	-	CHART DATUM
PCL	-	PILE CUTOFF LEVEL
PMTL	-	PILE MUFF TOP LEVEL
T/MB	-	TOP OF MAIN BEAM
EL	-	ELEVATION

SAME CONSTRUCTION SEQUENCE TO BE FOLLOW APPROACH TRESTLE.

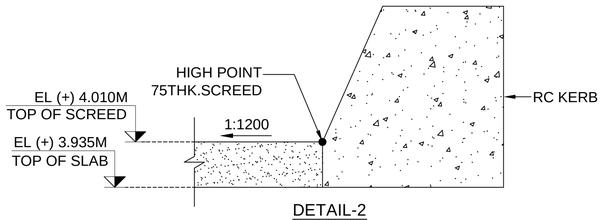
REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN. (DRAWN)	INIT.	SIGN. (CHECKED)	INIT.	SIGN. (APPROVED)
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

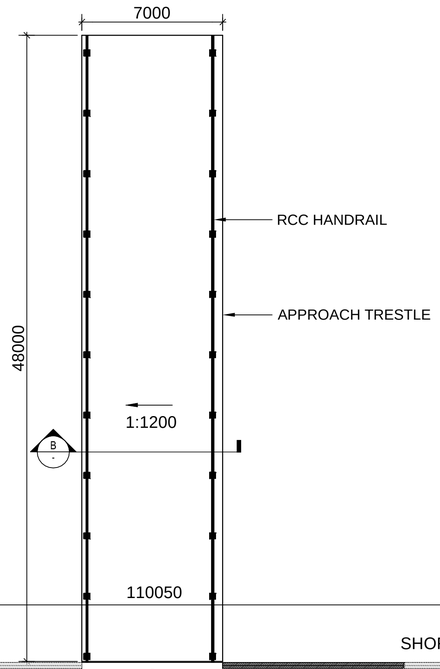
CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY & APPRAOCH TRESTLE CONSTRUCTION SEQUENCE OF STRUCTURE	
DRAWING NO:	IITM - CPT - SCB - 005	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	

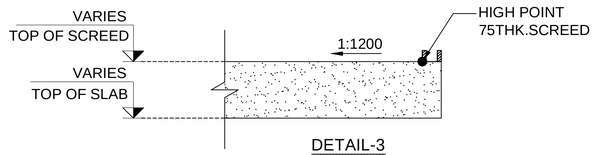


DETAIL-1
Scale 1:50

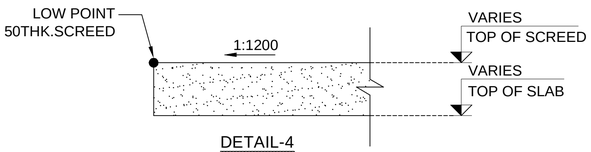


DETAIL-2
Scale 1:50

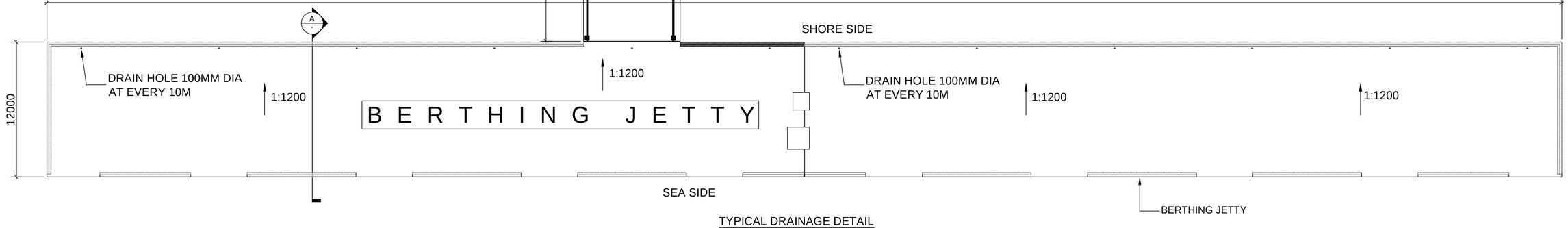




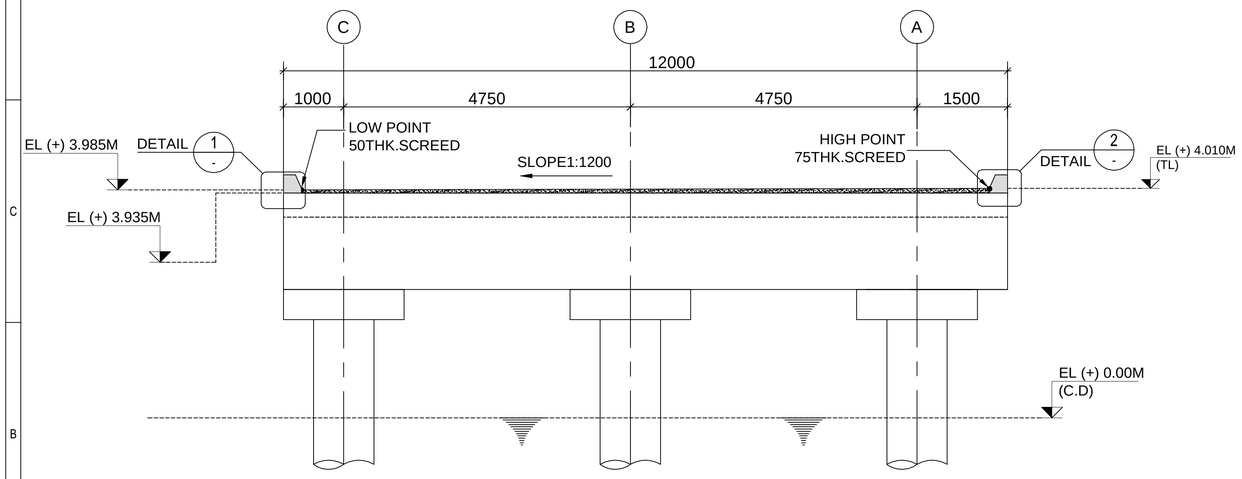
DETAIL-3
Scale 1:40



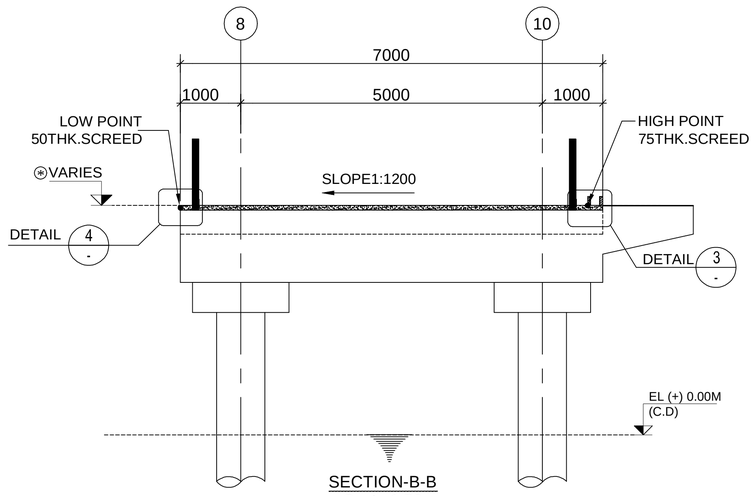
DETAIL-4
Scale 1:40



TYPICAL DRAINAGE DETAIL
Scale 1:150



SECTION-A-A
Scale 1:50



SECTION-B-B
Scale 1:50

TOP OF SLAB LEVELS VARIES DUE TO GRADIENT SLOPE.

NOTES :-

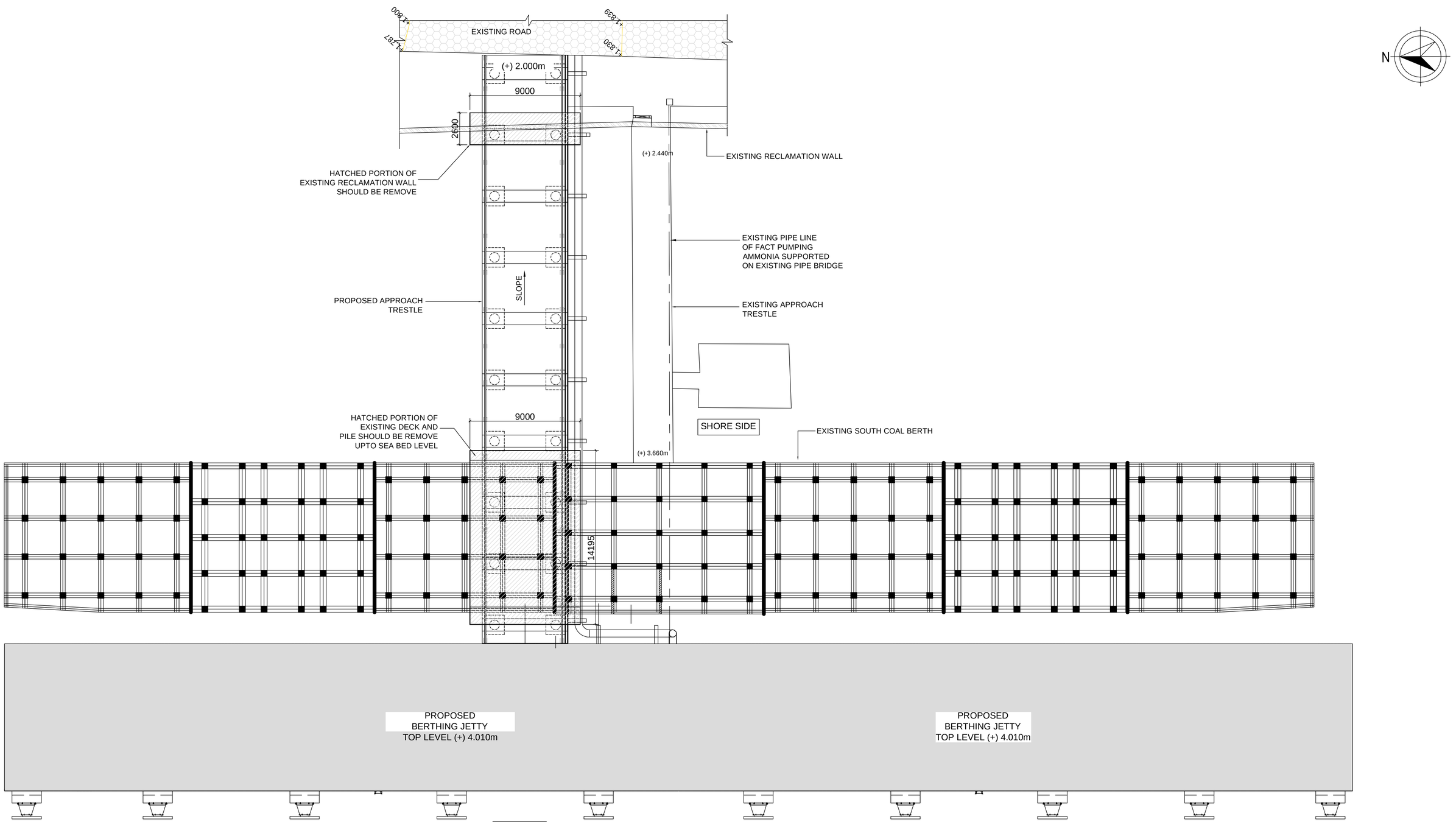
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE FE550/FE500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE FE415. THE MINIMUM YIELD STRENGTH SHALL BE 500 MPA & 415MPA (FE500 & FE415).
6. GRADE OF SCREED CONCRETE M30.
7. THICKNESS OF SCREED SHOWN IS MINIMUM TO ACHIEVE THE REQUIRED SLOPE
8. THE SCREED TOP SURFACE SHALL BE WIRE-MESH FINISH

REV.	DDMMYY / DATE	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE TYPICAL DRAINAGE DETAILS
DRAWING NO:	IITM - CPT - SCB - 006
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020
Scale as shown
REV 0



EXISTING BERTH DEMOLITION PLAN
Scale 1:150

NOTES :-

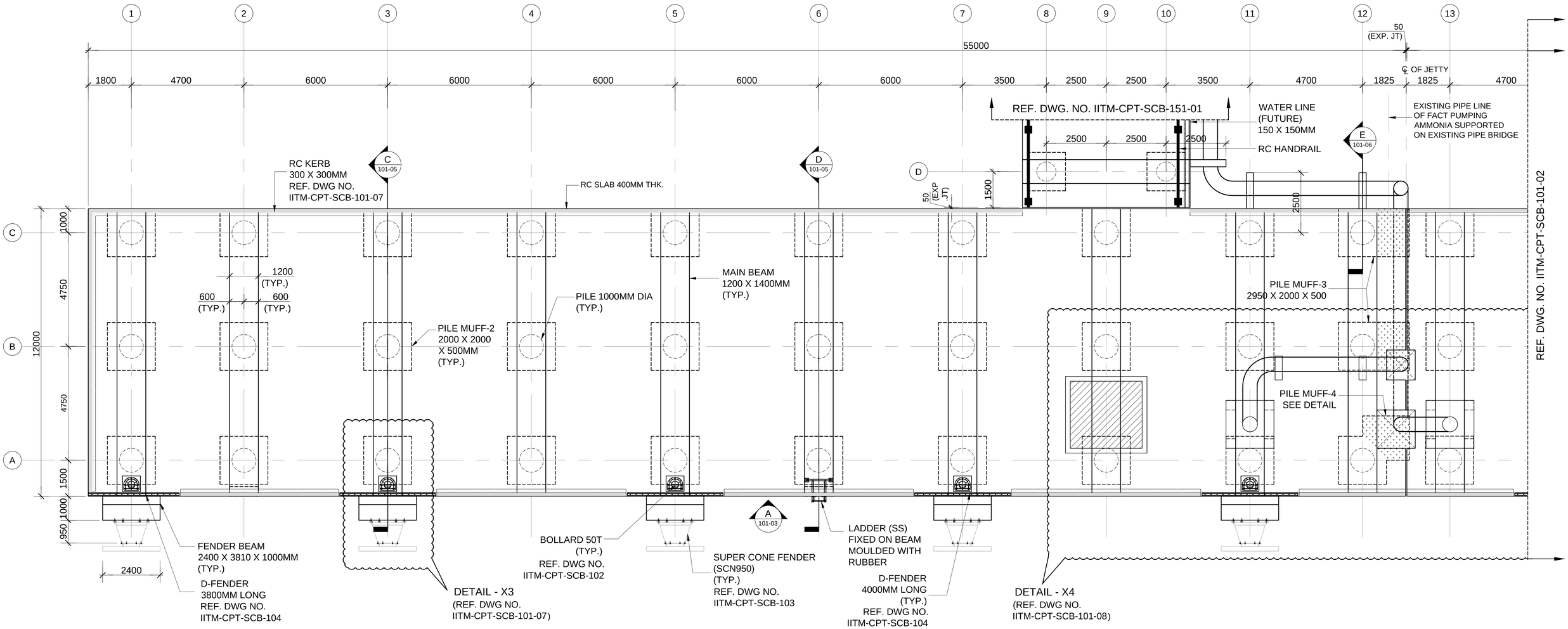
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.

REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN. (DRAWN)	INIT.	SIGN. (CHECKED)	INIT.	SIGN. (APPROVED)
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY & APPROACH TRESTLE EXISTING BERTH DEMOLITION PLAN
DRAWING NO:	IITM - CPT - SCB - 007
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020
Scale as shown
REV 0



GENERAL ARRANGEMENT LAYOUT-PARTIAL

Scale 1:80

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

- PILE
- MAIN BEAM
- CUTOUT
- PILE MUFF 500MM THK.
- PILE MUFF 400MM THK.
- KERB WALL
- TYP. · TYPICAL
- SS. · STAINLESS STEEL

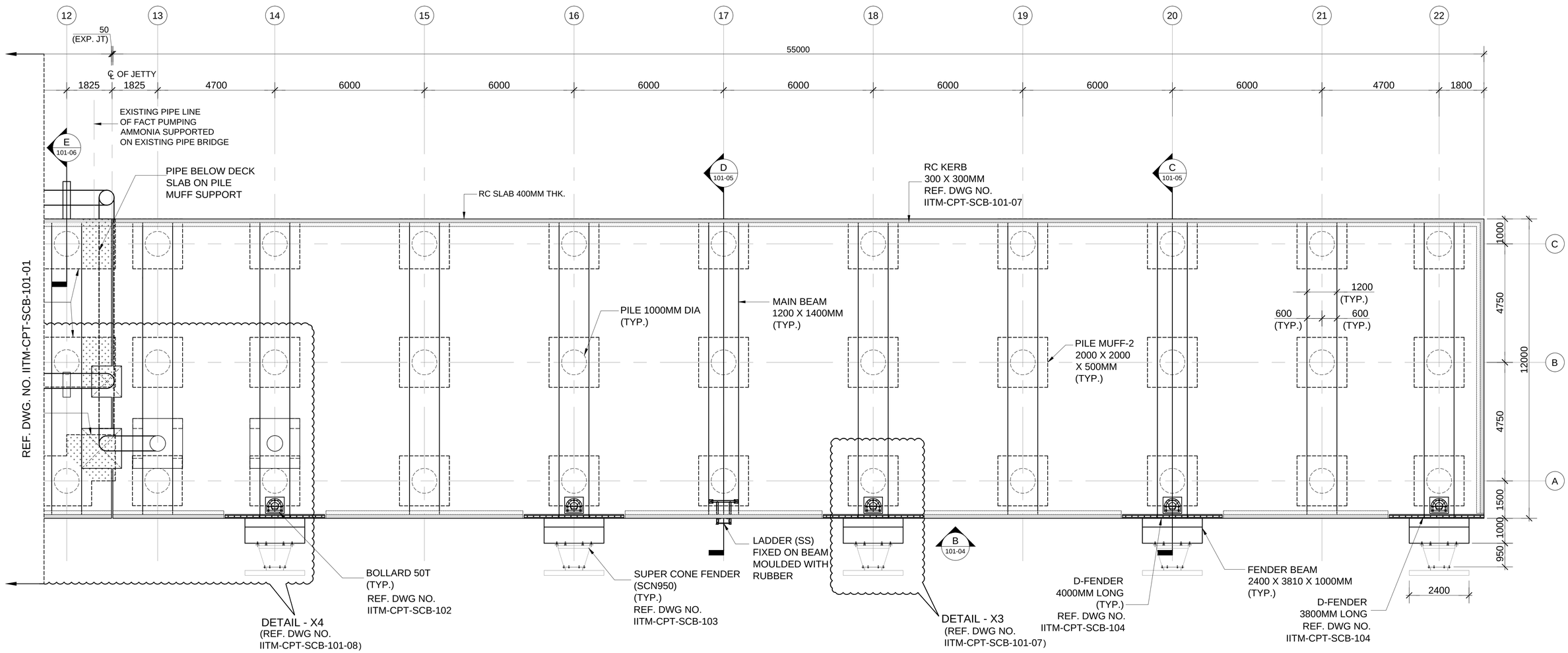
THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-101-03
b) IITM-CPT-SCB-101-04
c) IITM-CPT-SCB-101-05
d) IITM-CPT-SCB-101-06
e) IITM-CPT-SCB-101-07
f) IITM-CPT-SCB-101-08

REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
			DRAWN		CHECKED		APPROVED	

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 1 OF 8)	
DRAWING NO:	IITM - CPT - SCB - 101-01	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



GENERAL ARRANGEMENT LAYOUT-PARTIAL
Scale 1:80

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

- PILE
- MAIN BEAM
- CUTOUT
- PILE MUFF 500MM THK.
- PILE MUFF 400MM THK.
- KERB WALL
- TYP. · TYPICAL
- SS. · STAINLESS STEEL

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

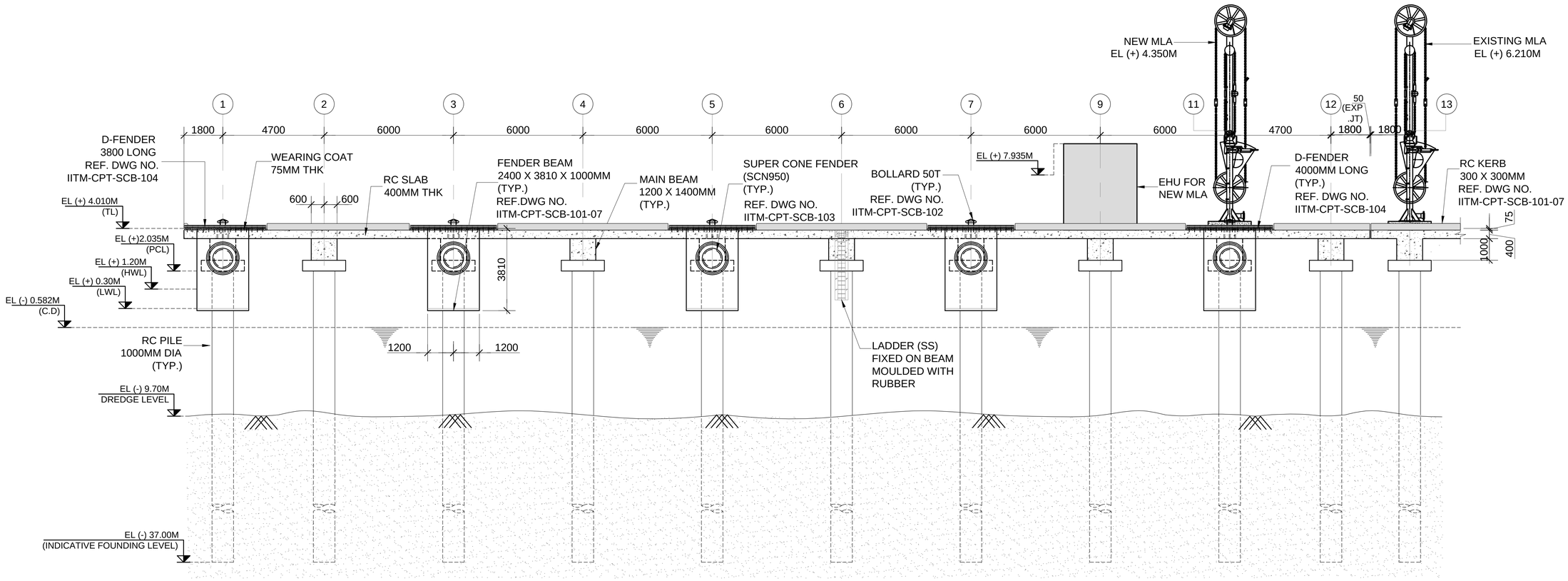
a) IITM-CPT-SCB-101-03
b) IITM-CPT-SCB-101-04
c) IITM-CPT-SCB-101-05
d) IITM-CPT-SCB-101-06
e) IITM-CPT-SCB-101-07
f) IITM-CPT-SCB-101-08

REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN. (DRAWN)	INIT.	SIGN. (CHECKED)	INIT.	SIGN. (APPROVED)
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 2 OF 8)
DRAWING NO:	IITM - CPT - SCB - 101-02
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020
Scale as shown
REV 0



VIEW -A
Scale 1:100

NOTES :-

MLA & EHU IS NOT UNDER COPT CONTRACT.
IT WILL BE DONE BY OTHER AGENCIES

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION
MLA	-	MARINE LOADING ARM

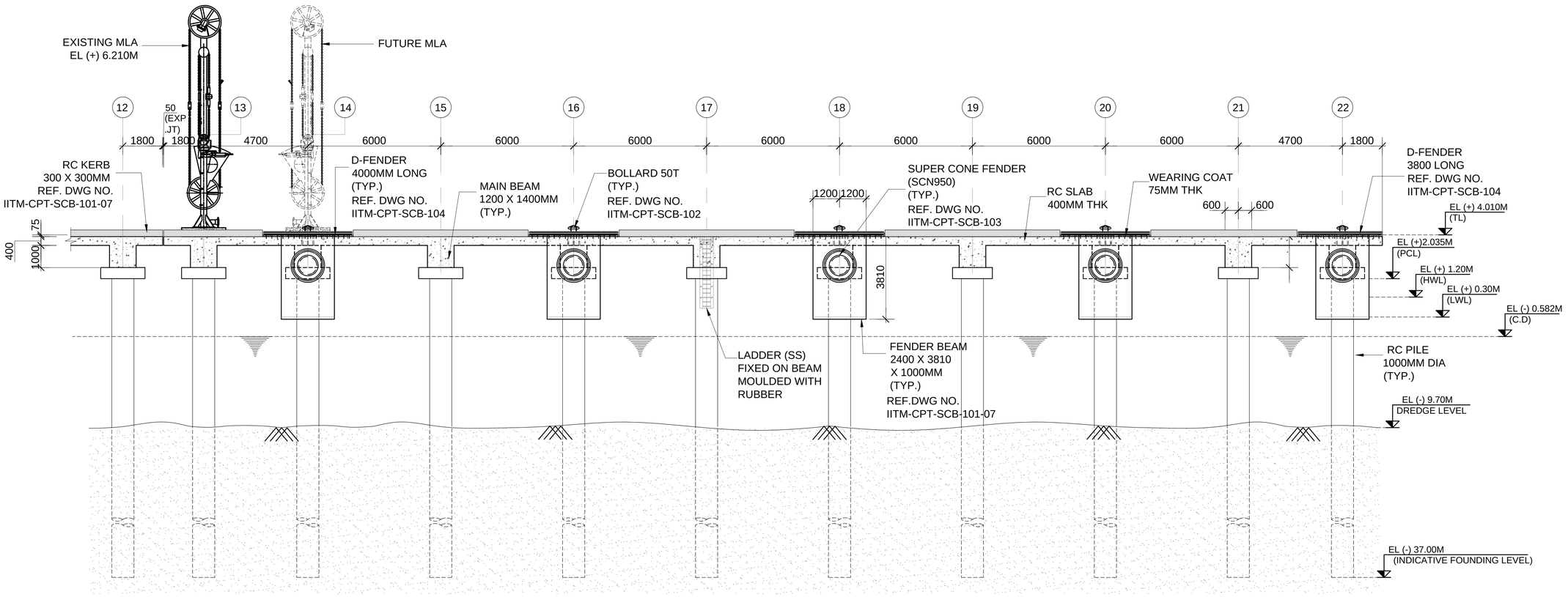
THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-101-01

REV.	DDMMYY / DATE	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE: A1

CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 3 OF 8)	
DRAWING NO:	IITM - CPT - SCB - 101-03	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



VIEW -B
Scale 1:100

NOTES :-

MLA & EHU IS NOT UNDER COPT CONTRACT.
IT WILL BE DONE BY OTHER AGENCIES

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION
MLA	-	MARINE LOADING ARM

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-101-02

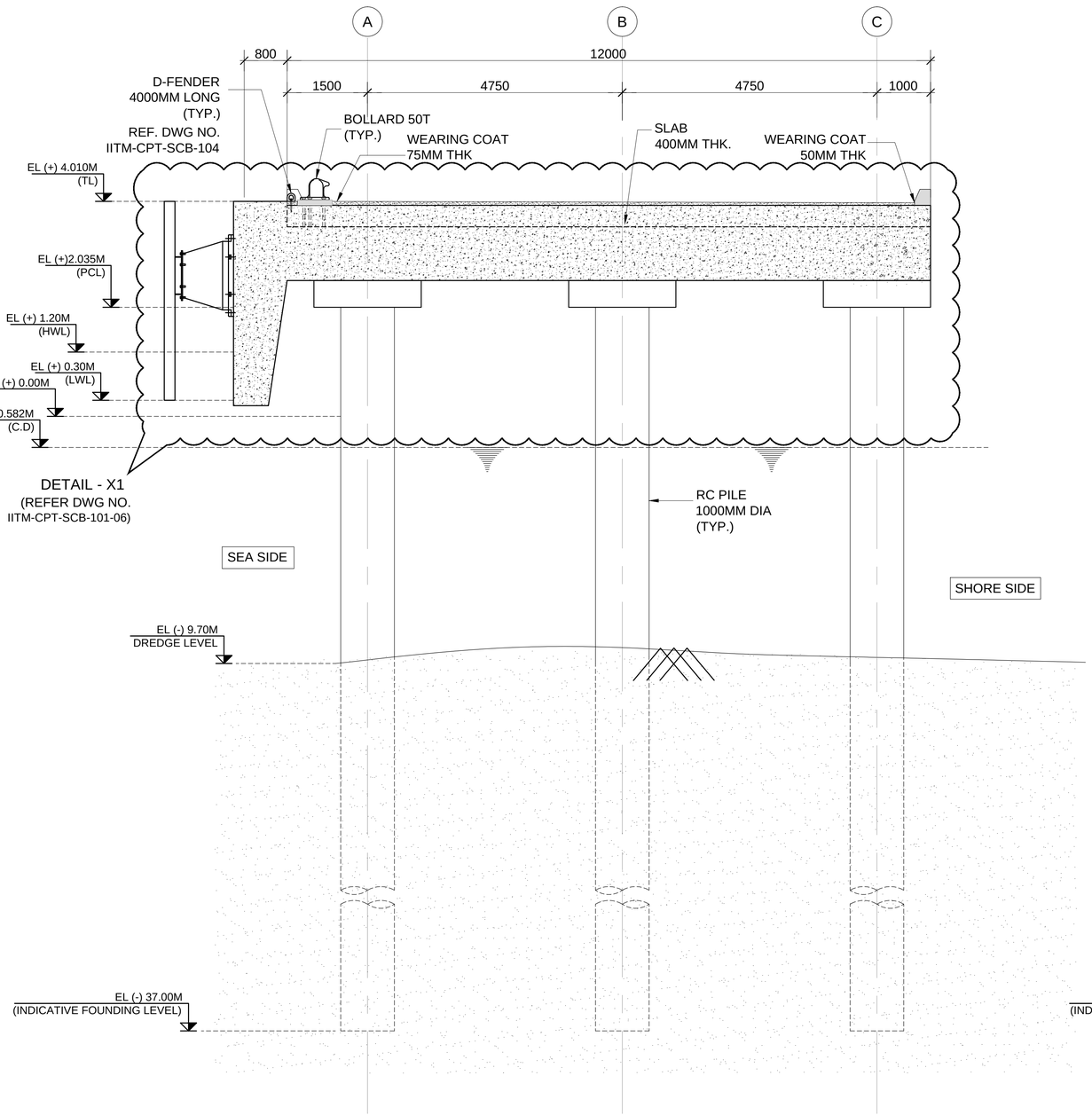
REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
			DRAWN		CHECKED		APPROVED	

ORIGINAL SIZE-A1

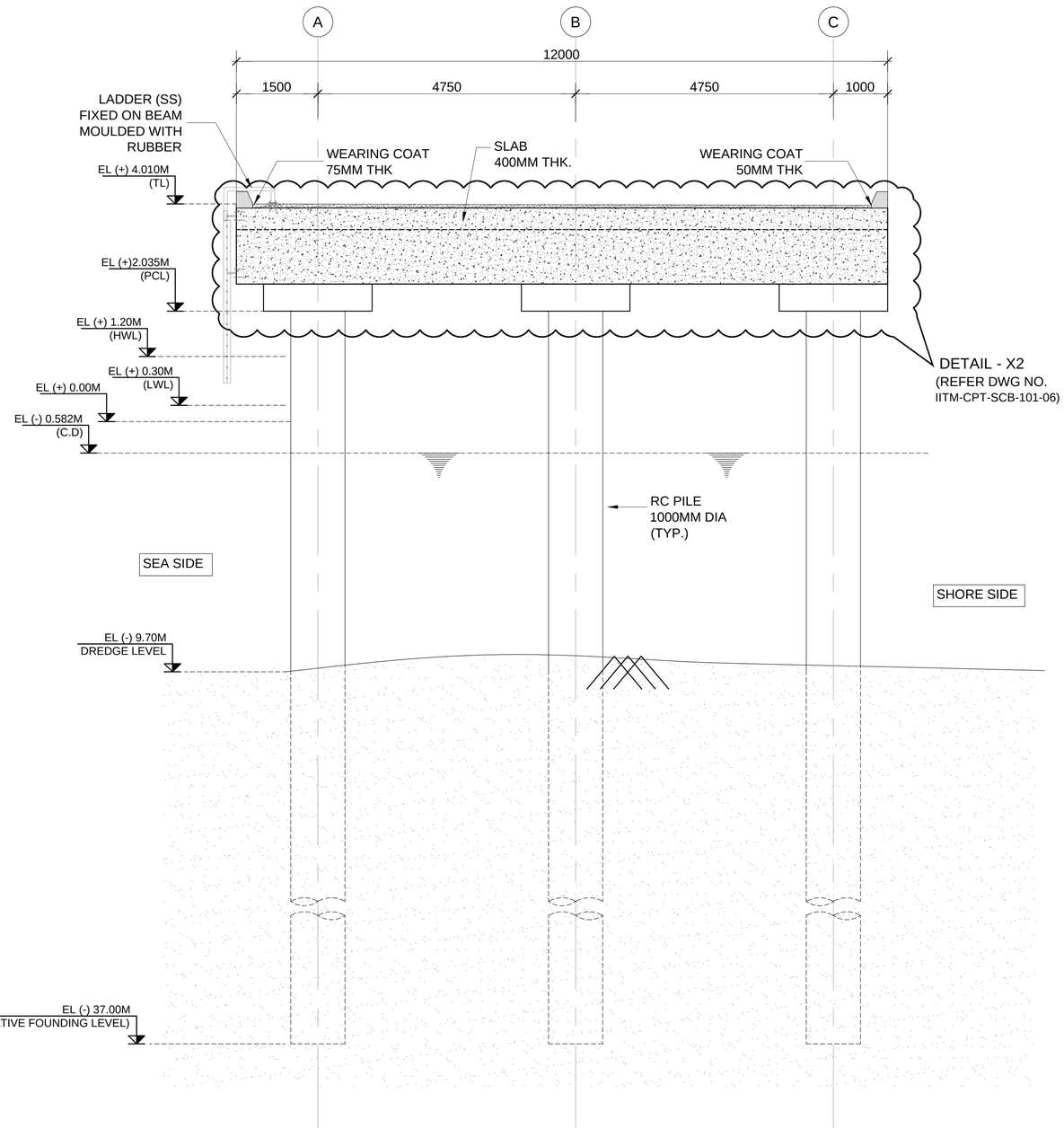
CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 4 OF 8)
DRAWING NO:	IITM - CPT - SCB - 101-04
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020

Scale as shown
REV 0



CROSS SECTION-CC
(FENDER LOCATION)
Scale 1:50



CROSS SECTION-DD
(WITHOUT FENDER LOCATION)
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

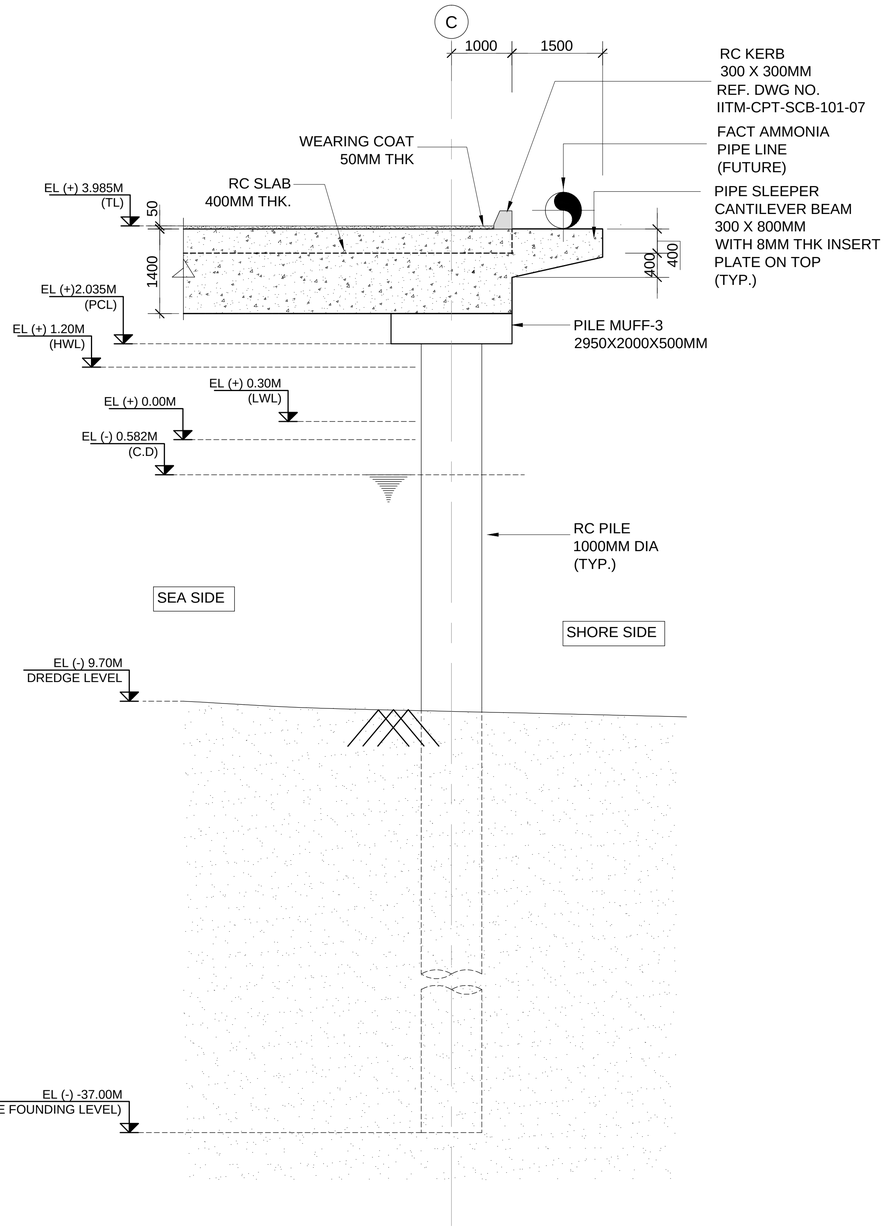
a) IITM-CPT-SCB-101-01

b) IITM-CPT-SCB-101-02

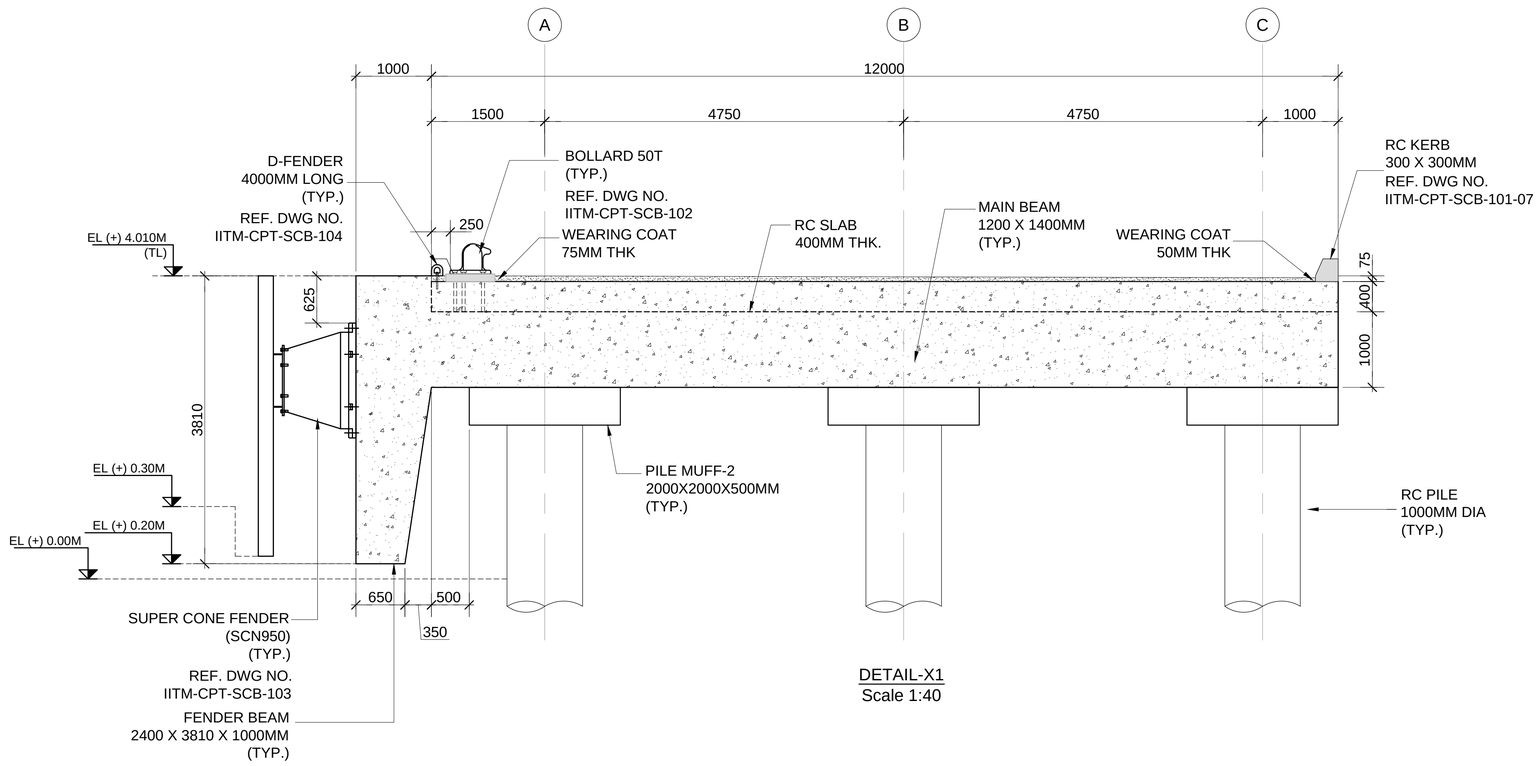
REV.	DDMMYY / DATE	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

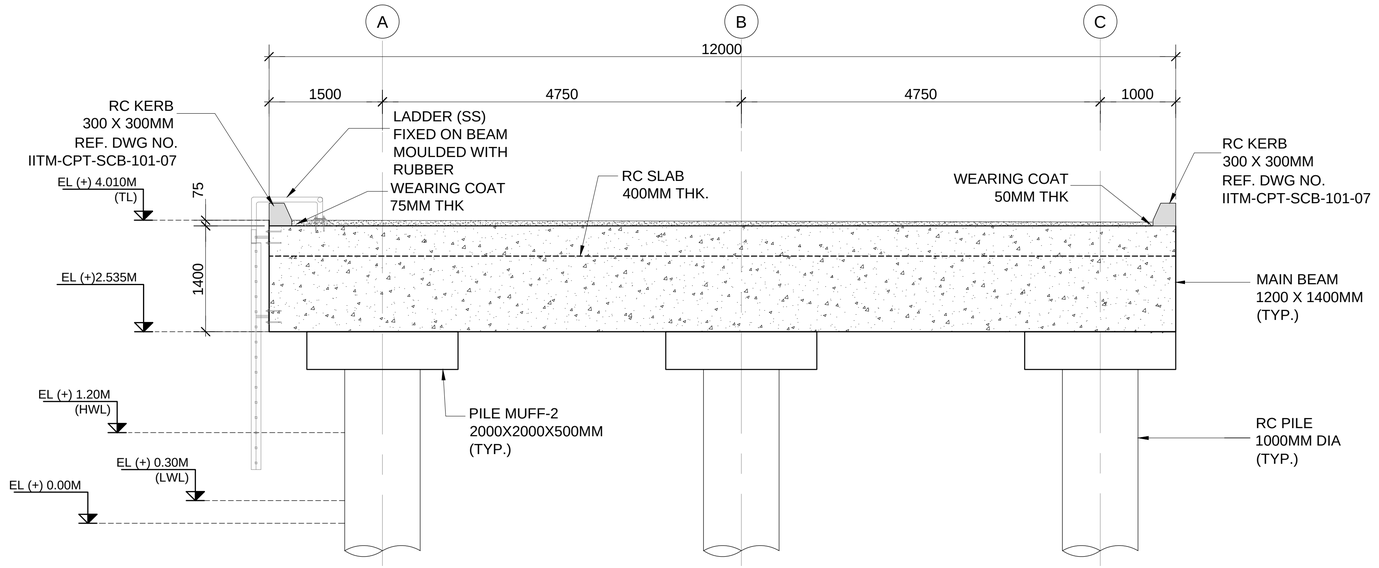
CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 5 OF 8)	
DRAWING NO:	IITM - CPT - SCB - 101-05	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



CROSS SECTION-EE
Scale 1:50



DETAIL-X1
Scale 1:40



DETAIL-X2
Scale 1:40

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION
MLA	-	STAINLESS STEEL

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

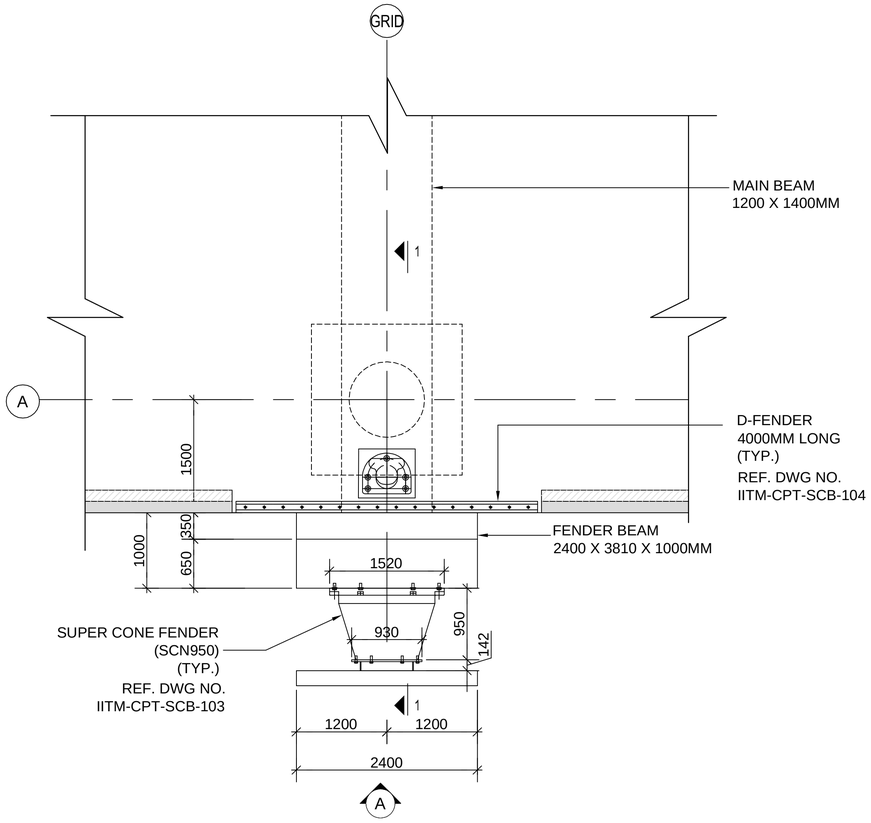
a) IITM-CPT-SCB-101-01

b) IITM-CPT-SCB-101-05

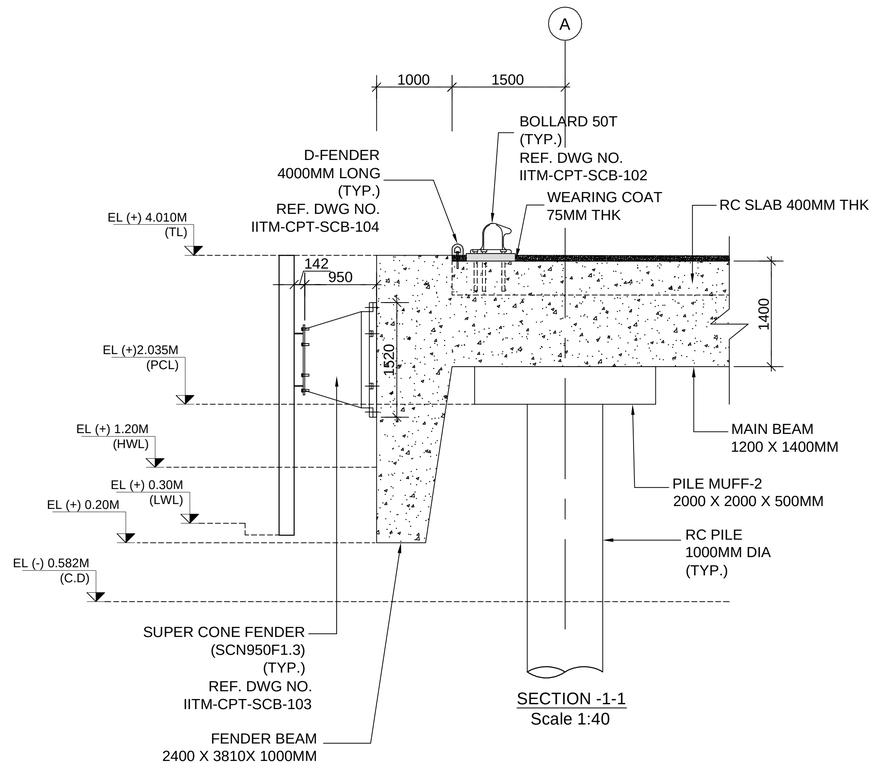
REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN. (DRAWN)	INIT.	SIGN. (CHECKED)	INIT.	SIGN. (APPROVED)
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

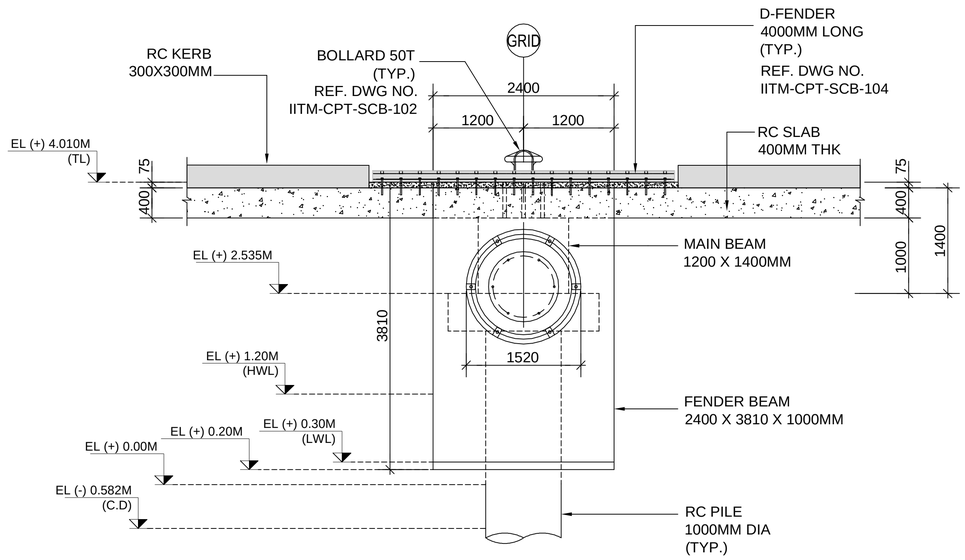
CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 6 OF 8)	
DRAWING NO:	IITM - CPT - SCB - 101-06	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



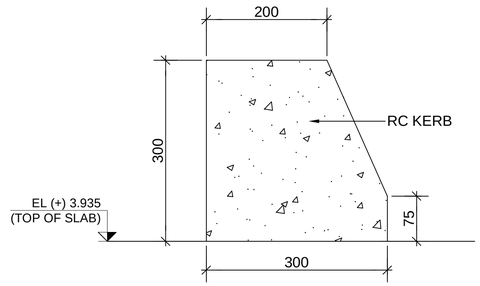
DETAIL-X3
Scale 1:40



SECTION -1-1
Scale 1:40



VIEW - A
Scale 1:40



TYPICAL DETAIL FOR KERB
Scale 1:5

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION
MLA	-	MARINE LOADING ARM

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-101-01

b) IITM-CPT-SCB-101-02

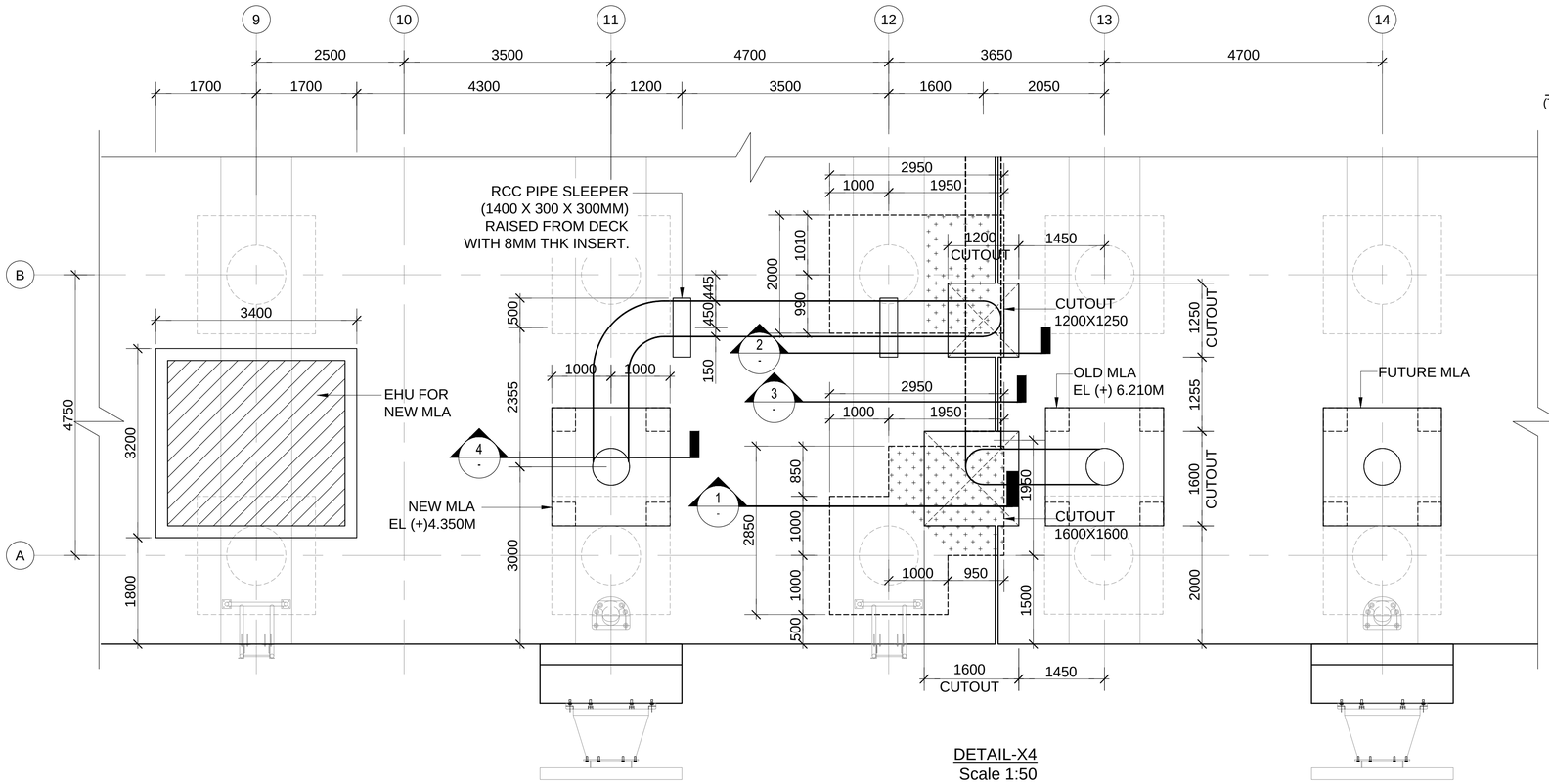
REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN. (DRAWN)	INIT.	SIGN. (CHECKED)	INIT.	SIGN. (APPROVED)
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

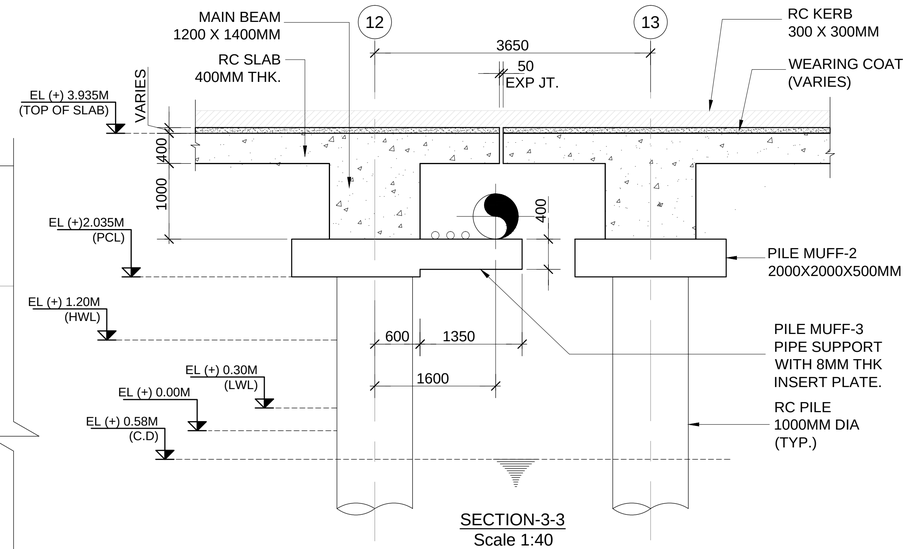
CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 7 OF 8)
DRAWING NO:	IITM - CPT - SCB - 101-07
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020

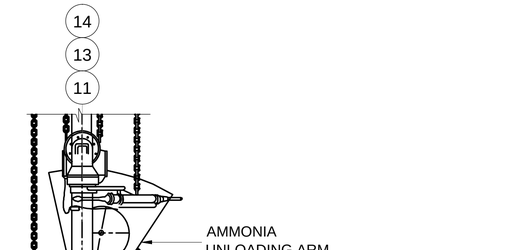
Scale as shown
REV 0

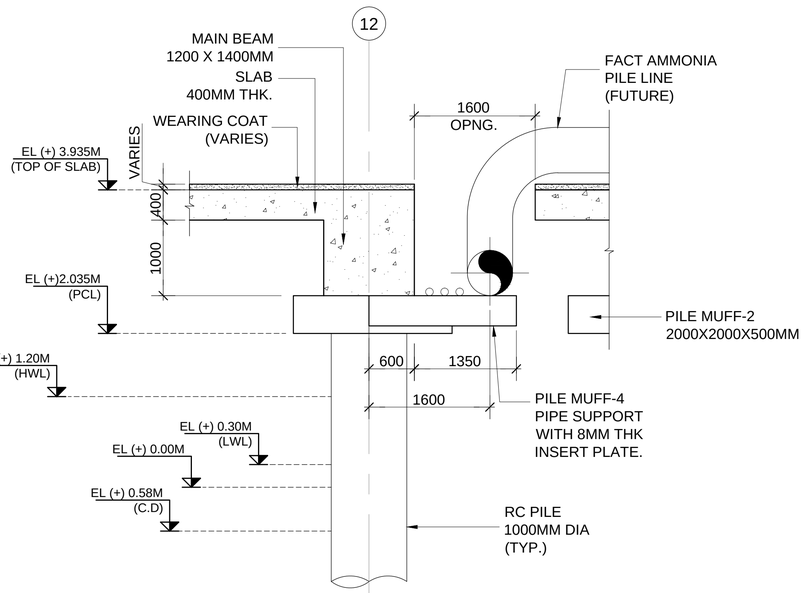


DETAIL-X4
Scale 1:50

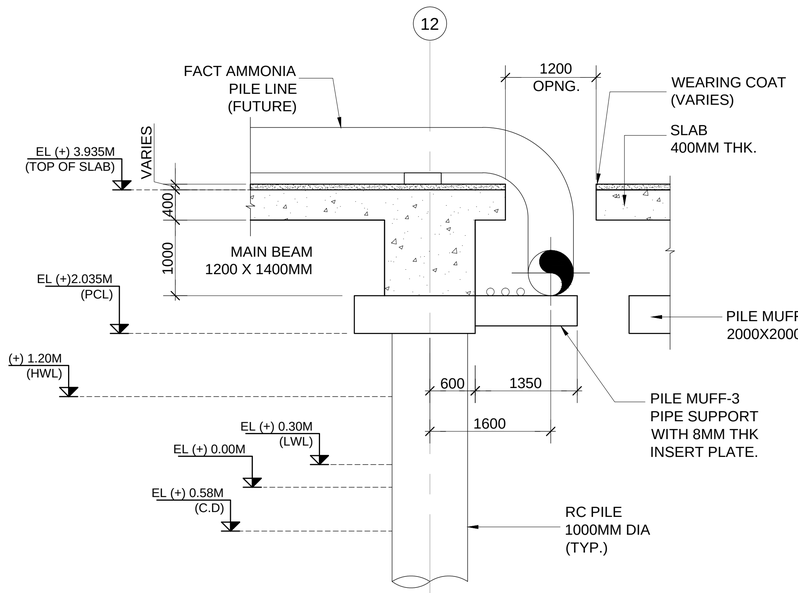


SECTION-3-3
Scale 1:40

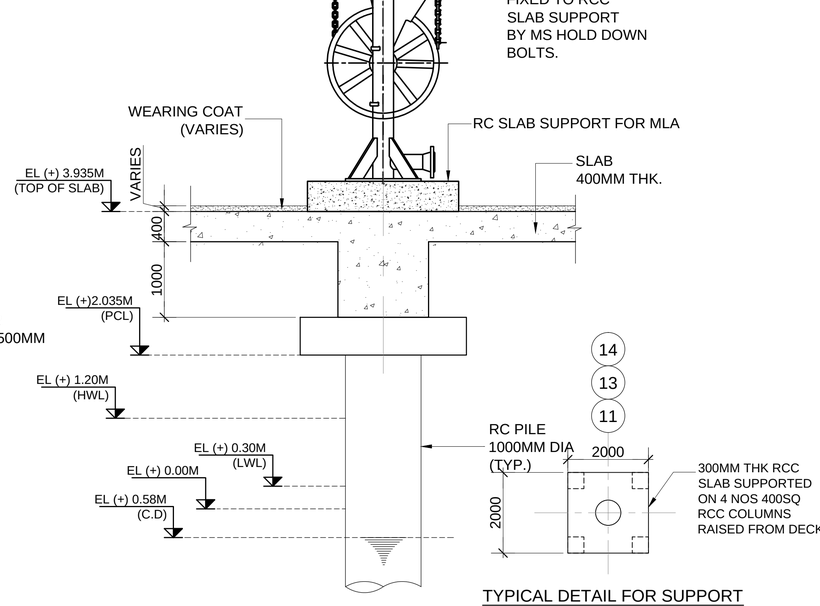




SECTION-1-1
Scale 1:40



SECTION-2-2
Scale 1:40



SECTION-4-4
Scale 1:40

TYPICAL DETAIL FOR SUPPORT
OF MARINE LOADING ARM
Scale 1:75

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION
MLA	-	MARINE LOADING ARM
	-	PILE CAP 400MM THK.
☒	-	CUTOUT

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

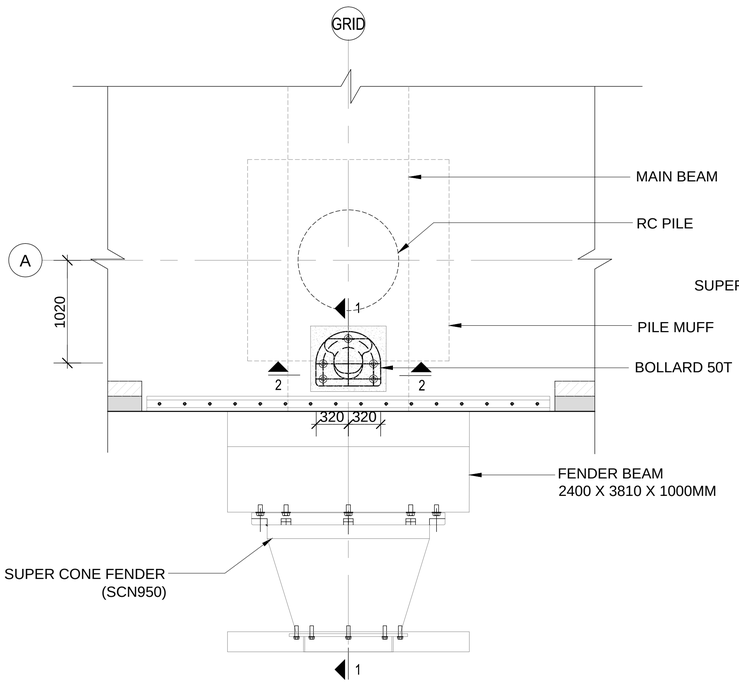
a) IITM-CPT-SCB-101-01

b) IITM-CPT-SCB-101-02

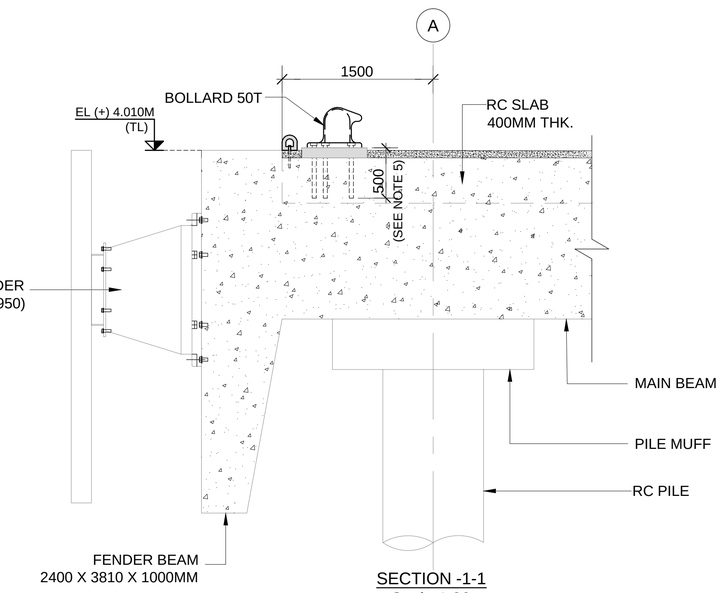
REV.	DDMMYY / DATE	DESCRIPTION	INIT. / DRAWN	SIGN.	INIT. / CHECKED	SIGN.	INIT. / APPROVED	SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE A1

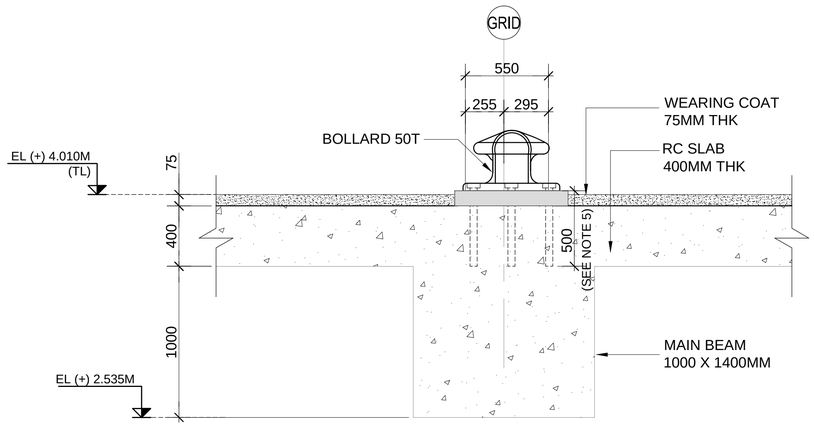
CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY GENERAL ARRANGEMENT (SHEET 8 OF 8)	
DRAWING NO:	IITM - CPT - SCB - 101-08	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



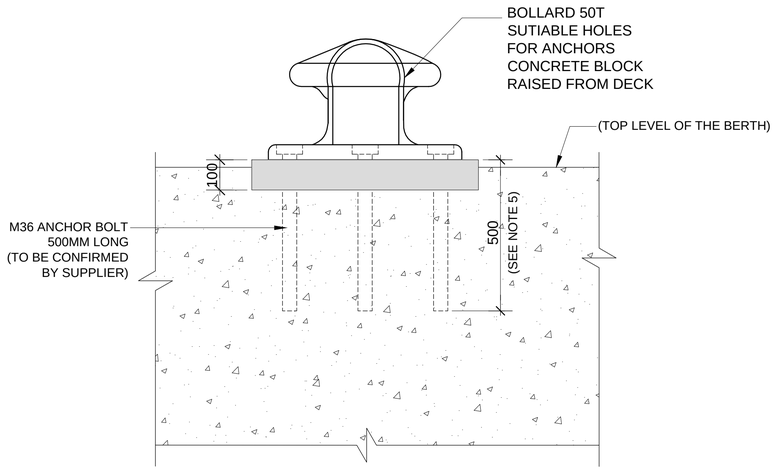
PLAN
Scale 1:30



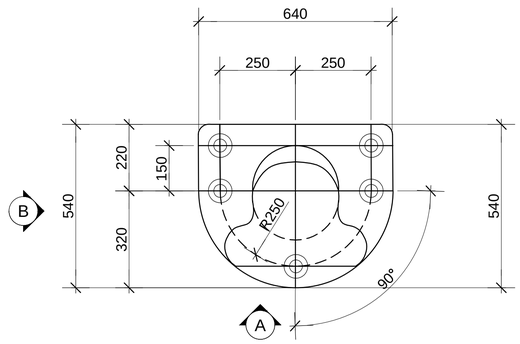
SECTION -1-1
Scale 1:30



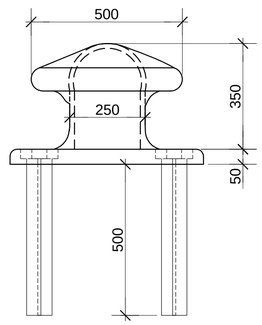
SECTION-2-2
Scale 1:20



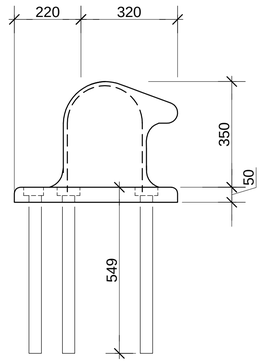
DETAILS OF FIXING OF BOLLARD 50T
Scale 1:10



PLAN VIEW FOR BOLLARD 50T
Scale 1:10



VIEW -A
Scale 1:10



VIEW -B
Scale 1:10

SCHEDULE FOR BOLLARD

BOLLARD AT GRID LOCATION	NOS.
A1,A3,A5,A7,A9,A11 A13,A15,A17,A19,A21	10

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. GRADE OF SCREED CONCRETE M30.
3. ALL BOLTS, NUTS AND OTHER FASTENERS SHALL BE ADEQUATE CROSS - SECTIONAL AREA TO SAFELY WITHSTAND THE SPECIFIED WORKING FORCE.
4. BOLLARDS SHALL BE OF CAST IRON AS PER IS-210-2009.
5. THE BOLLARD FIXING DETAILS INCLUDING BASE PLATE, ANCHOR LENGTH & DIAMETER TO BE SPECIFIED BY SUPPLIER.
6. ALL ANCHOR BOLTS SHALL BE EMBEDDED INTO CONCRETE BEFORE CASTING.

LEGEND :-

TL	-	TOP LEVEL
EL	-	ELEVATION
TYP.	-	TYPICAL

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-101-01

b) IITM-CPT-SCB-101-02

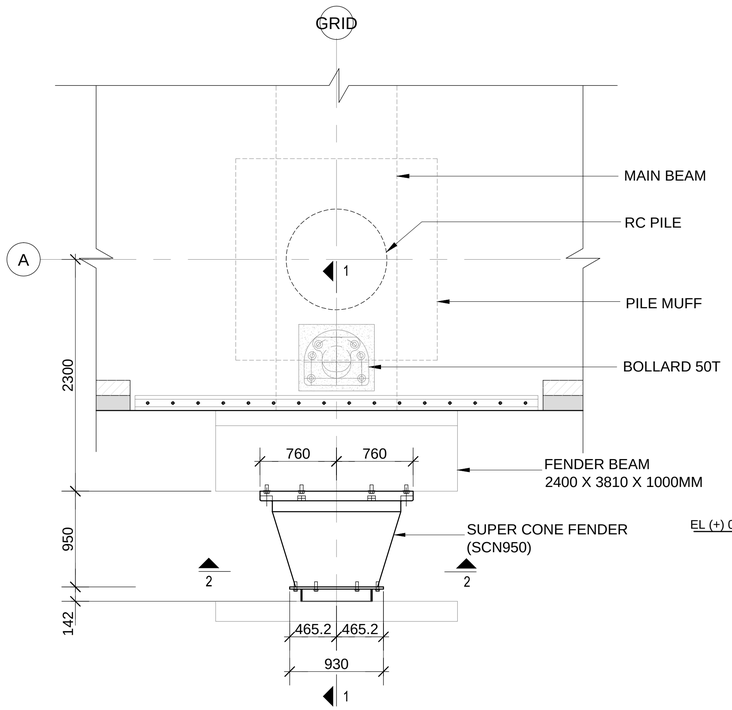
REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
			DRAWN		CHECKED		APPROVED	

ORIGINAL SIZE:A1

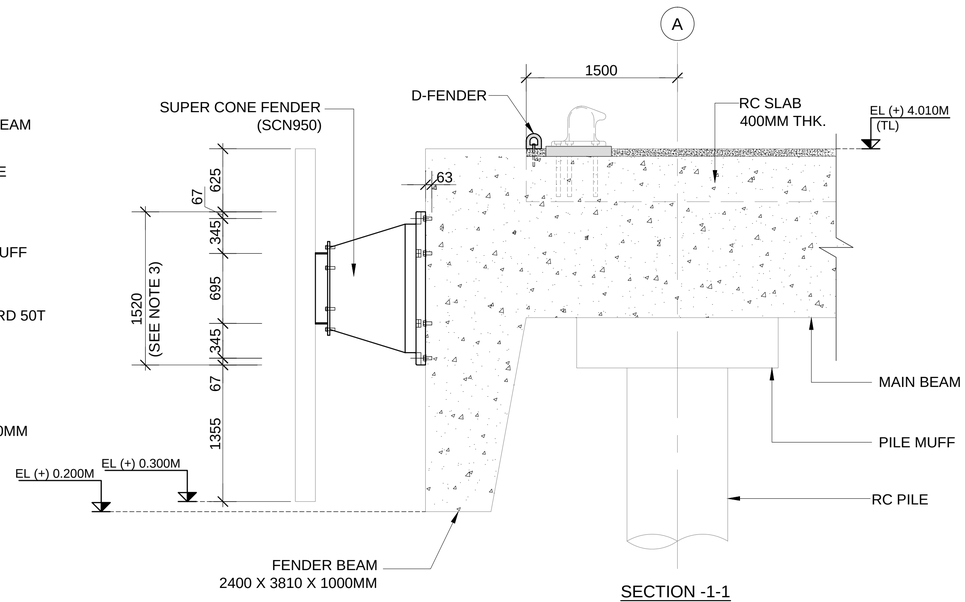
CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY FIXING DETAILS OF BOLLARD
DRAWING NO:	IITM - CPT - SCB - 102
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020

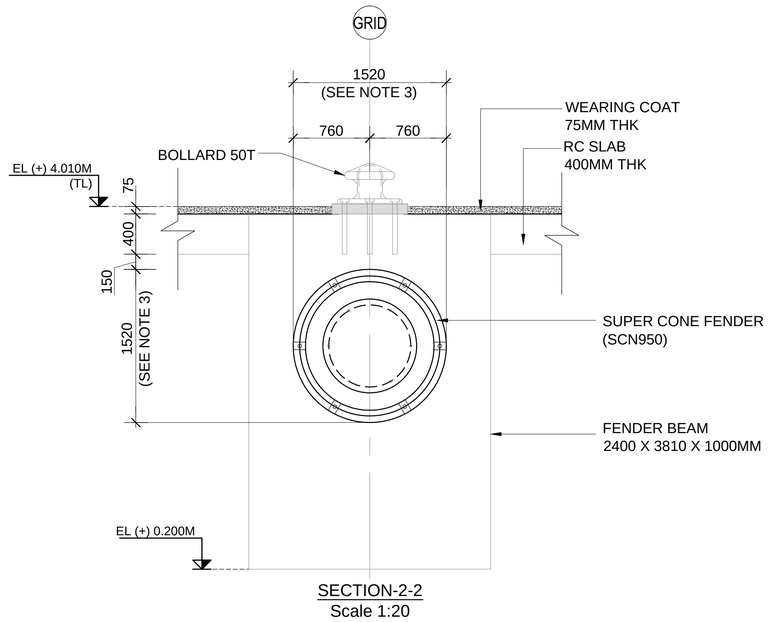
Scale as shown REV 0



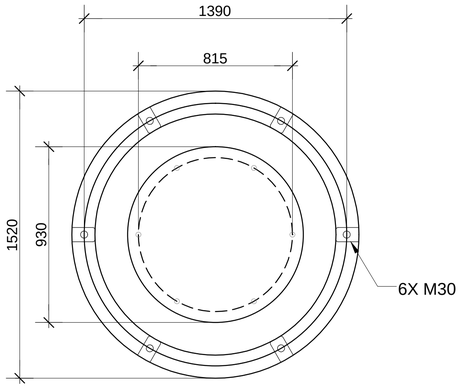
PLAN
Scale 1:30



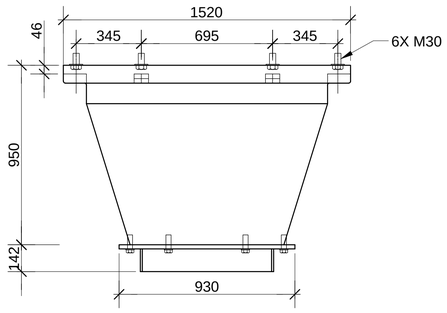
SECTION -1-1
Scale 1:30



SECTION-2-2
Scale 1:20



VIEW - A
Scale 1:16



PLAN OF SCN950
Scale 1:16

SCHEDULE FOR FENDER

FENDER AT GRID LOCATION	NOS.
A1,A3,A5,A7,A9,A11 A13,A15,A17,A19,A21	10

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. FENDER WITH 131KN ENERGY CAPACITY SHALL BE SELECTED WITH NOT TO EXCEED REACTION OF 313.6KN. SELECTED FENDER SHALL BE INSTALLED WITH ALL NECESSARY ANCHORS ON TO THE CONCRETE. THE ANCHORS SHALL BE DESIGNED FOR ALL DESIGN FORCES DURING BERTHING.
4. ALL ANCHOR BOLTS SHALL BE EMBEDDED INTO CONCRETE BEFORE CASTING.

LEGEND :-

TL - TOP LEVEL
EL - ELEVATION
TYP. - TYPICAL

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

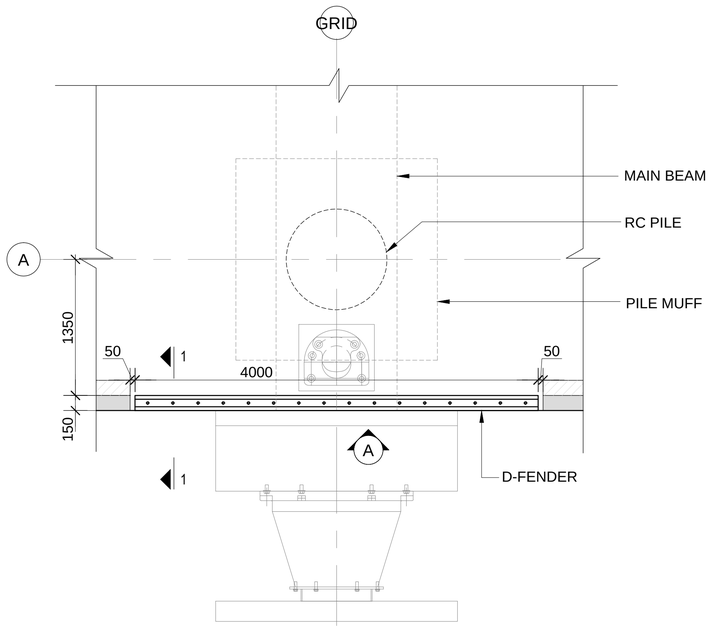
a) IITM-PT-BJ-101-01

b) IITM-PT-BJ-101-02

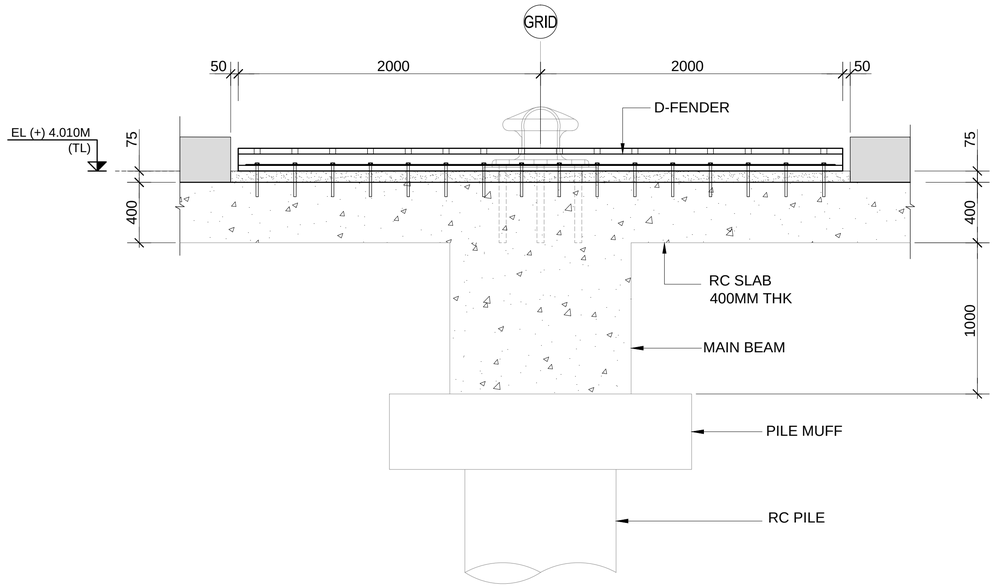
REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
			DRAWN		CHECKED		APPROVED	

ORIGINAL SIZE:A1

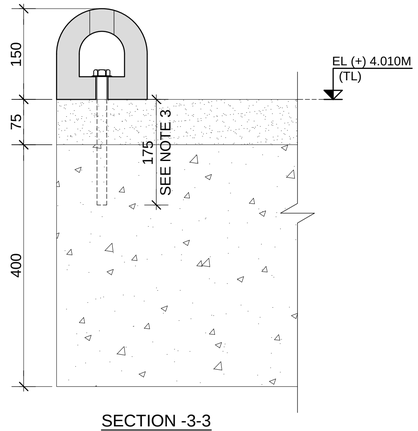
CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	BERTHING JETTY FIXING DETAILS OF FENDER	
DRAWING NO:	IITM - CPT - SCB - 103	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	



PLAN
Scale 1:30



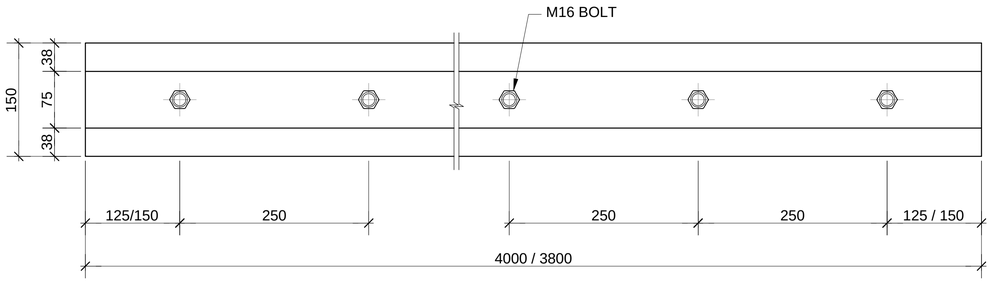
VIEW - A
Scale 1:20



SECTION -3-3
Scale 1:5

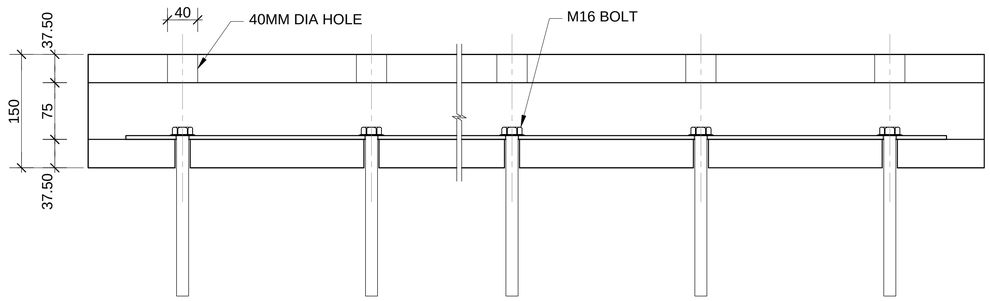
SCHEDULE FOR D-FENDERS

D-FENDER AT GRID LOCATION	NOS.
A1,A3,A5,A7,A9,A11 A13,A15,A17,A19,A21	10



PLAN
Scale 1:4

SIDE VIEW
Scale 1:4



FRONT VIEW
Scale 1:4

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. FENDER WITH 131KN ENERGY CAPACITY SHALL BE SELECTED WITH NOT TO EXCEED REACTION OF 313.6KN. SELECTED FENDER SHALL BE INSTALLED WITH ALL NECESSARY ANCHORS ON TO THE CONCRETE. THE ANCHORS SHALL BE DESIGNED FOR ALL DESIGN FORCES DURING BERTHING.
4. ALL ANCHOR BOLTS SHALL BE EMBEDDED INTO CONCRETE BEFORE CASTING.

LEGEND :-

TL - TOP LEVEL
EL - ELEVATION
TYP. - TYPICAL

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-PT-BJ-101-01

b) IITM-PT-BJ-101-02

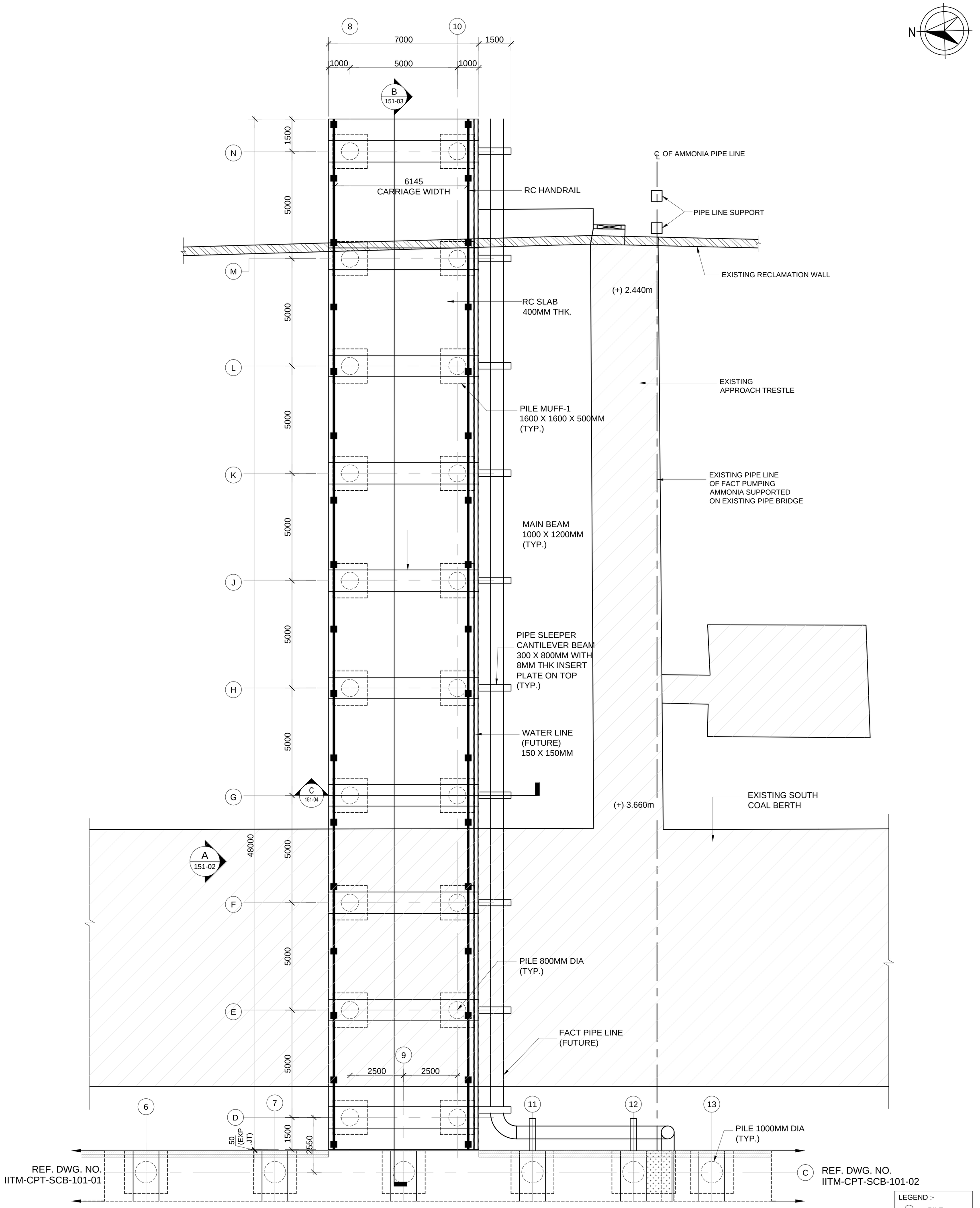
REV.	DDMMYY / DATE	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE: A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	BERTHING JETTY FIXING DETAILS OF D-FENDER
DRAWING NO:	IITM - CPT - SCB - 104
DATE:	27.03.2020
Scale as shown	REV 0

ENGINEERING FIRM:

Prof.S.A.SANNASIRAJ
DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36



GENERAL ARRANGEMENT LAYOUT
Scale 1:80

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :
a) IITM-CPT-SCB-151-02 c) IITM-CPT-SCB-151-04
b) IITM-CPT-SCB-151-03

NOTES :-

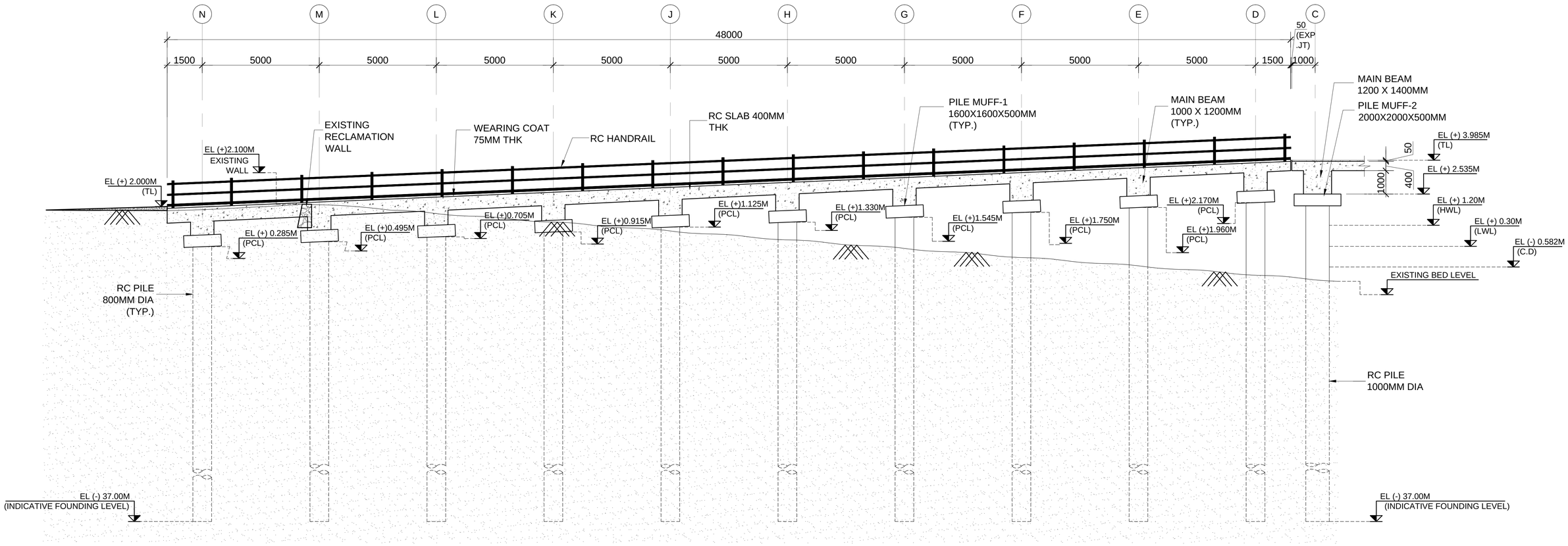
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
4. ALL MAIN REINFORCEMENT SHALL BE OF HIGH YIELD STRENGTH DEFORMED BARS WITH GRADE Fe550/Fe500.
5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

REV.	DDMMYY / DATE	DESCRIPTION	INIT.	SIGN.	INIT.	SIGN.	INIT.	SIGN.
0	27.03.2020	ISSUED FOR TENDER						
			DRAWN		CHECKED		APPROVED	

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	APPROACH TRESTLE GENERAL ARRANGEMENT (SHEET 1 OF 4)	
DRAWING NO:	IITM - CPT - SCB - 151-01	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	

REV 0



VIEW-A
Scale 1:85

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
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5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-151-01

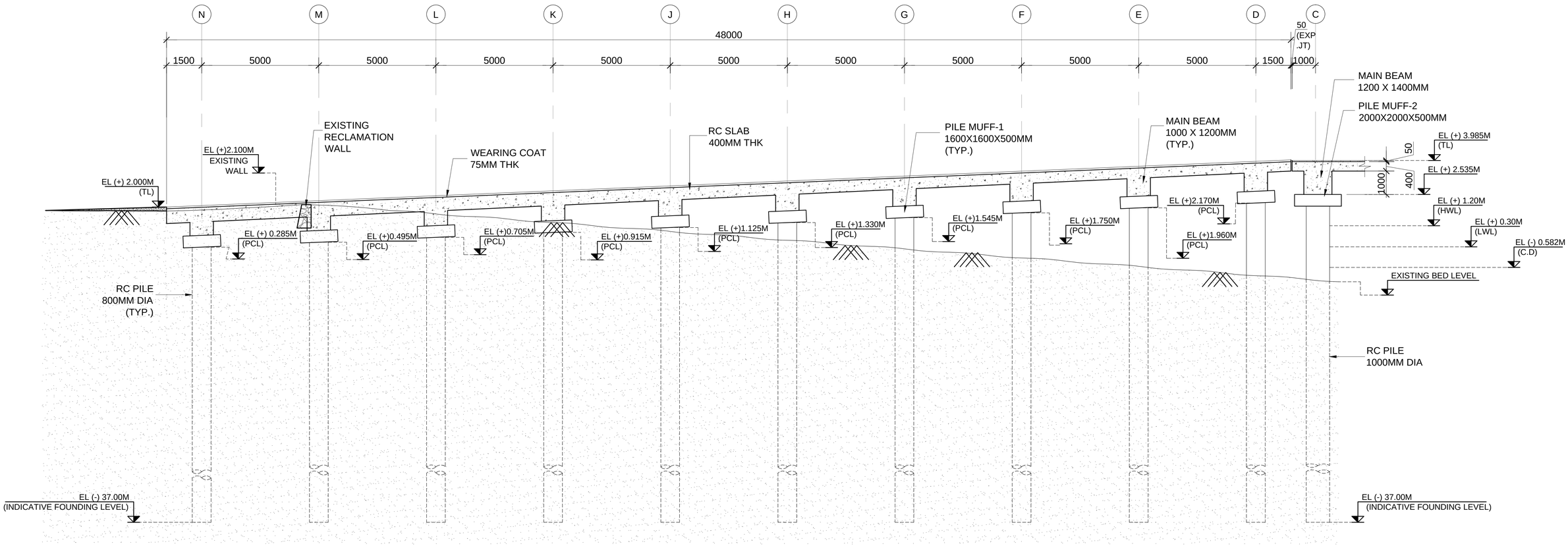
REV.	DDMMYY / DATE	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	APPROACH TRESTLE GENERAL ARRANGEMENT (SHEET 2 OF 4)
DRAWING NO:	IITM - CPT - SCB - 151-02
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020

Scale as shown
REV 0



CROSS SECTION-BB
Scale 1:85

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS INDICATED ARE IN METERS WITH REFERENCE TO PORT'S CHART DATUM,WHICH IS 0.582M BELOW AMSL.
3. CONCRETE GRADE FOR ALL RC STRUCTURE SHALL BE M40 WITH MINIMUM 28 DAYS CHARACTERISTIC STRENGTH OF 40 MPa.
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5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION
MLA	-	MARINE LOADING ARM

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-151-01

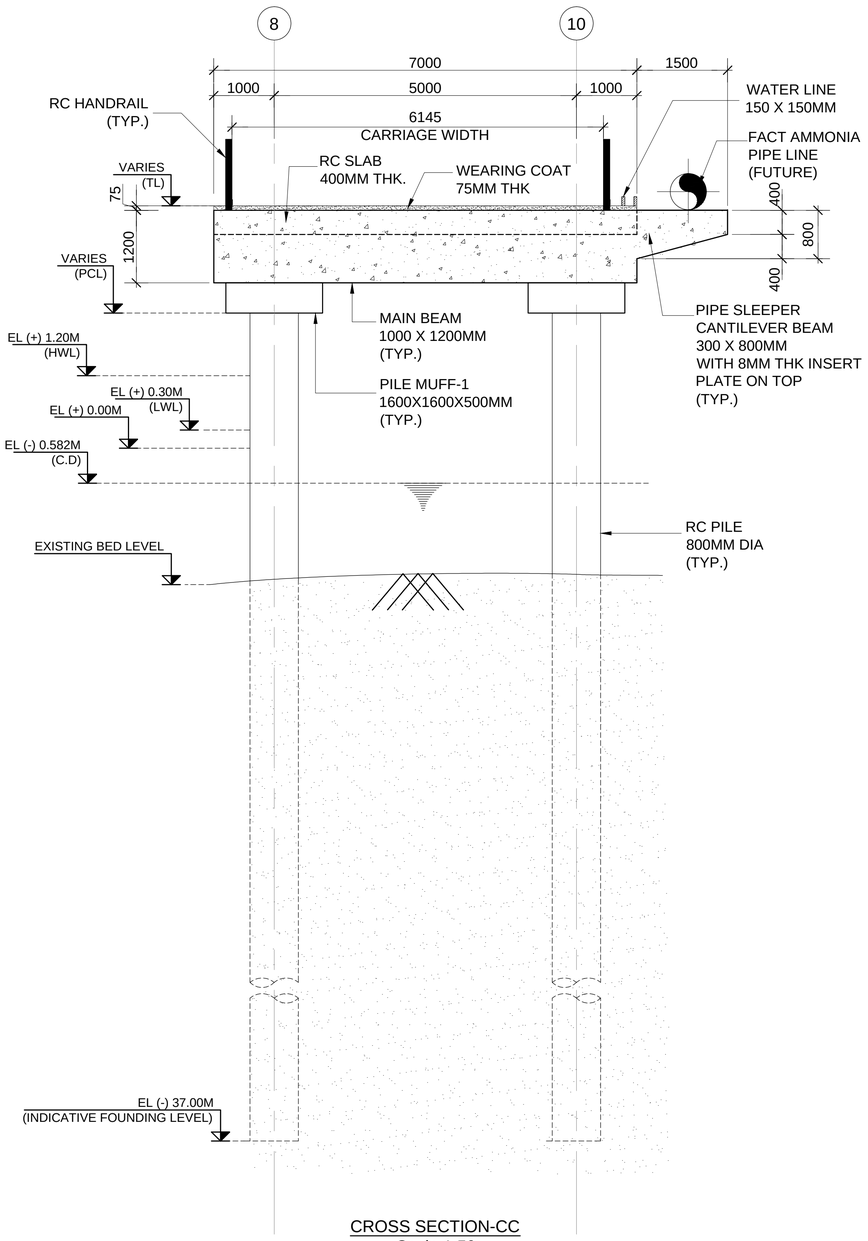
REV.	DDMMYY / DATE	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE:A1

CLIENT:	COCHIN PORT
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN
DRAWING TITLE:	APPROACH TRESTLE GENERAL ARRANGEMENT (SHEET 3 OF 4)
DRAWING NO:	IITM - CPT - SCB - 151-03
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ, DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36

DATE: 27.03.2020

Scale as shown
REV 0



CROSS SECTION-CC
Scale 1:50

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
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5. THE SECONDARY REINFORCEMENT SHALL BE OF GRADE Fe415. THE MINIMUM YIELD STRENGTH SHALL BE 500 Mpa & 415Mpa (Fe500 & Fe415).

LEGEND :-

C.D	-	CHART DATUM
TL	-	TOP LEVEL
HWL	-	HIGH WATER LEVEL
LWL	-	LOW WATER LEVEL
PCL	-	PILE CUTOFF LEVEL
EL	-	ELEVATION

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH LATEST DRAWING NO :

a) IITM-CPT-SCB-151-01

REV.	DDMMYY / DATE	DESCRIPTION	DRAWN INIT.	DRAWN SIGN.	CHECKED INIT.	CHECKED SIGN.	APPROVED INIT.	APPROVED SIGN.
0	27.03.2020	ISSUED FOR TENDER						

ORIGINAL SIZE: A1

CLIENT:	COCHIN PORT	DATE: 27.03.2020
PROJECT:	RECONSTRUCTION OF SOUTH COAL BERTH AT COCHIN	
DRAWING TITLE:	APPROACH TRESTLE GENERAL ARRANGEMENT (SHEET 4 OF 4)	
DRAWING NO:	IITM - CPT - SCB - 151-04	Scale as shown REV 0
ENGINEERING FIRM:	Prof.S.A.SANNASIRAJ DEPARTMENT OF OCEAN ENGINEERING,IIT MADRAS, CHENNAI - 36	

SCB layout

An Electrical Layout Drawing