

VOLUME-II of II

TECHNICAL SECTION

Tender No.: 3300009937

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LIST OF ATTACHMENTS

Bidder to refer to the following attachments for the preparation of the bid:

No.	Description
Attachment-C1	Structural Details for Outdoor Cable Trench Between 110/33 kV SS-10 & SS-01A of Aromatic Complex Power System Upgradation Work Tractebel Dwg. No. P.020678-M-46057-C001

1. INTRODUCTION

This part describes the brief scope, technical specification and acceptance criteria for the execution, construction, materials and workmanship for all Civil work related to this Package (as specified in scope clause) for the construction of new Electrical Cable Trench between 110/33 kV new substation SS-10 beside MSEZ 110/33 kV substation GSS-03 and existing substation SS-01A in the premises of MRPL Aromatic Complex for the Power System Upgradation Work at MRPL Aromatic Complex, Mangalore, Karnataka (India). The new Electrical Cable Trench shall be approximately 1.7 km long.

The Bidder shall inspect and examine the site and its surrounding and shall satisfy himself before submitting his bid as to the nature of the ground and subsoil, the form and nature of the site, the quantum and the nature of work and material necessary for successful completion of the work and the means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his bid. Under no circumstances, extra payment consequent on any misunderstanding or otherwise on the part of the Contractor shall be allowed.

Latest CPWD (Center Public Works Department) Technical Specification (Vol. 1 & 2), item description mentioned in Schedule of Rates (SOR) and details provided in IFC drawings shall be followed by the Contractor for the technical details not specified in this Technical specification for Civil Work. In case of any discrepancy between this tender specification & above stated documents, the description of items mentioned in SOR and details shown in approved IFC drawings shall be followed.

2. SCOPE, TERMINAL POINTS AND EXCLUSIONS

2.1 SCOPE

The followings are the main work involved in this package, but not limited to:

- a. Site cleaning & preparatory work including excavation required for the Construction of RCC Cable Trenches/Ductbanks.
- b. Construction of electrical Cable Trench with precast cover, as per detail drawing attached with this tender document.
- c. Construction of electrical Ductbanks at road/drain crossings, as per detail drawing attached with this tender document.
- d. Backfilling work with proper compaction after the const of Cable Trench/Ductbanks.
- e. Reconstruction of portion of boundary wall, bituminous road, drain, fencing etc. whatever dismantled by the Contractor for construction of cable trench/ductbank at crossing locations as per site conditions.
- f. Miscellaneous work such as dismantling and making good the existing (if any) roads, brick / stone masonry work, RCC work, etc. wherever electrical cable trench crossings are envisaged through existing areas. Dismantling of existing (if any) brick / stone masonry structures, concrete and

steel structures, road, fence & other related civil structures shall be kept minimum in such a fashion that site becomes suitable for construction activity.

- 2.1.1 The scope will cover construction, fabrication and erection work including material procurement / supply and transportation to site, dismantling of existing structure (if required), site formation and development etc. including all associated work that are necessary for the construction of the cable trench.
- 2.1.2 The item wise quantities are provided in the SOR along with item description for the work to be done under Scope of this tender. However, these quantities may slightly vary during actual site work based on detail design drawings and the Contractor shall be liable to do the additional work in the same unit rate of this Contract. Site and Lab tests of all the Materials are in the Contractor's scope, the Contractor shall not charge any extra amount for the quality tests of materials.
- 2.1.3 The Contractor shall be responsible for providing all material, equipment and services, specified or otherwise which are required to complete the scope and fulfil the intent of ensuring operability, maintainability and the reliability of the complete work covered under this specification. It is not the intent to specify completely herein, all aspects of construction. Nevertheless, the construction shall conform in all respects to high standards of engineering and workmanship, in a manner acceptable to OWNER, who will interpret the meaning of the specification, drawings, on site construction etc. and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification, quality standards specified in relevant IS codes and/or applicable National and International standards mentioned elsewhere in the specification and drawings.
- 2.1.4 The scope of the proposal for this Package shall be on the basis of the single point responsibility completely covering the supplies and services in respect of all work specified and covered under the specification. This specification shall be read in conjunction with the drawings, SOR, technical requirements, CPWD specifications and provisions of NBC-2016, wherever specified in this document.
- 2.1.5 Contractor shall prepare a very clear and legible Site Red Markups for giving inputs for preparing As-built drawings of all the Civil work done at site in line with the IFC (issue for Construction/erection) drawings.
- 2.1.6 Contractor, at their own cost, shall provide for all royalty, statutory requirements, etc. for all construction materials at all stages like purchase, supply, transport, disposal, etc.
- 2.1.7 All the statutory permissions required for carrying out blasting work, if required for excavation and other purposes, shall be in the scope of Contractor at their own cost.
- 2.1.8 The scope of work is defined in general and is not limited to above, Contractor has also to carry out all jobs which are not listed here but required for Completion of Work.
- 2.1.9 Site Cleaning

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During construction and on completion of construction (inclusive of all internal and external finish) clearing all the debris and waste materials scattered around the site and disposal of the same as per direction of the Engineer-in-Charge, shall be in the scope of the Contractor.

2.2 TERMINAL POINTS

The terminal point of the electrical cable trench/ductbank shall be the electrical building in the new 110/33 kV substation SS-10 at one end and the point after the road crossing within MRPL Aromatic Complex as shown in the detail drawing attached with this tender specification, at the other end.

2.3 EXCLUSIONS

- a. Engineering, as OWNER/PMC will provide IFC/AFC drawings.
- b. Sand filling in electrical RCC cable trenches.
- c. Any area / equipment foundation / structure, etc. mentioned and designated for future.

2.4 SCOPE MATRIX

S. No.	DESCRIPTION	CONTRACTOR	OTHERS
#AA	SCOPE OF SUPPLY		
1	Supply of TMT re-bars after Owner's approval	√	
2	Supply of Cement-PPC grade 43 or 53 "OR" OPC grade 43 or 53 after Owner's approval	√	
3	Supply of ready mix WMM after Owner's approval	√	
4	Supply of Ready-Mix-Concrete (RMC) after Owner's approval	√	
5	Supply of fabricated structural steel, if required	√	
6	All raw materials required for permanent work as per SOR items and approval of OWNER	√	
7	Inspection of Raw materials and other materials and Inspection clearance	√	
8	Material Test certificate, invoice/challan, and other documents	√	
9	All temporary materials as required for Construction work	√	
#BB	CONSTRUCTION		
1	All materials and labours for execution of SOR items of the contract	√	
2	Procurement of Raw materials for construction	√	
3	Loading and unloading, storing of materials	√	
4	Guarding and security of the materials	√	
5	Third Party Inspection	√	
6	Design Mix as per Drawing / Site requirement approved by OWNER	√	
7	Field Lab testing	√	
8	Inspection as per QAP and QA/ QC activity	√	√
9	All documentation for work executed and QA/QC related activity	√	

S. No.	DESCRIPTION	CONTRACTOR	OTHERS
10	Statutory Clearance if required	√	
11	All consumables	√	
#CC	EXECUTION DRAWING		
1	Issue of IFC/AFC drawing		√
2	Necessary revision of IFC/AFC Drawing as per requirement		√
3	Generating Site Red Markups for preparing As Built Drawing	√	
4	Preparing As-Built Drawing		√
5	Any temporary structure required for execution works	√	
#DD	MACHINERY TOOLS & CONSUMABLES		
1	All machinery required for Concreting works	√	
2	All machinery required for Wet Mix Macadam	√	
3	All machinery required for other work as per SOR items	√	
4	Temporary Construction materials	√	
5	Spares and consumables	√	
#EE	SITE FACILITY		
1	Land for Site office and store inside plant premises		√
2	Site Offices & Store	√	
3	Construction Power	√	
4	Construction water	√	
5	Further distribution of Construction Power with materials	√	
6	Further Distribution of Constriction Water as per requirement with materials	√	
7	Local issues	√	
#FF	OTHERS		
1	Royalty wherever applicable for construction material at all stages (purchase, supply, transport, disposal, etc.)	√	
2	Labour Licence and maintaining proper records as per LEO requirement	√	
3	Insurance - EAR	√	
4	Workman Compensation Insurance	√	
5	(i) HSSE Equipment	√	
6	(ii) Implementation and monitoring	√	
7	Gate pass	√	
#GG	MANPOWER		
1	RCM	√	
2	Engineer - Experienced for all sections i.e. civil, Mechanical, Electrical, I&C as applicable	√	
3	Supervisors - Experienced for all sections i.e. civil, Mechanical, Electrical, I&C as applicable	√	
4	HSSE inspection	√	
5	QA/QC inspection - Experienced for all sections i.e. civil, Mechanical, Electrical, I&C as applicable	√	
6	Skilled worker	√	
7	Semi-skilled workers	√	

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S. No.	DESCRIPTION	CONTRACTOR	OTHERS
8	Unskilled workers	√	
9	All other requirement not specified but required to complete the job	√	
10	Transportation of manpower	√	
11	Accommodation of manpower	√	
12	Medical expenses of manpower	√	
13	Food expenses of manpower	√	
14	Termination benefits as per Labour Rules and regulations	√	
No escalation or idle manpower, machines and equipment shall be provided. It shall be as per Contract conditions. No claim for damage of any machinery, equipment, T&P and other resources shall be accepted.			

3. CODES AND STANDARDS

All materials, design, workmanship, test and acceptance criteria etc., must conform to the latest edition of the following standards.

- a. Indian Standard Codes (IS)
- b. Special Publications (SP)
- c. Indian Road Congress Standards (IRC)
- d. National Building Codes (NBC)
- e. CPWD Specifications
- f. MORTH Specifications

Other International standards are also acceptable provided those ensure a quality equal or higher than Indian Standards. If any, standard/clauses of the standard contains a provision which is inconsistent with a provision in Indian Standard, the more stringent requirement as per the interpretation of the OWNER shall prevail. All work shall be carried out on the basis of latest edition of applicable codes & standards mentioned. A list of specific codes is given below:

Indian Standard codes (IS)	
IS: 456	Code of practice for plain and reinforced concrete (third revision)
IS: 516	Methods of test for strength of concrete
IS: 1566	Specification for hand drawn steel wire fabric for concrete reinforcement
IS: 1597	Code of practice for construction of stone masonry
IS: 1838	Preformed filler for expansion joint in concrete pavement and structures (non-extruding and resilient type)
IS: 1838 Part 1	Specification for preformed fillers for expansion joints in pavements and structures: Part 1 Bitumen impregnated fibre
IS: 1838 Part 2	Specification for preformed fillers for expansion joints pavements and structures: Part 2 CNSL Aldehyde resin and coconut pith
IS: 1905	Code of practice for structural use of unreinforced masonry
IS 2386-Part 5	Method of test for aggregate for concrete
IS: 2720	Methods of test for soils

IS: 4701	Code of practice for earthworks on canals
IS: 5317	Specification for bitumen mastic for bridge decking and roads
IS: 5640	Method for determining the aggregate impact value of soft coarse aggregate
IS: 5758	Specification for precast concrete kerbs, channels, edgings, quadrants and gutter aprons
IS: 6241	Method of test for determination of stripping value of road aggregates
IS: 6509	Code of practice for installation of joints in concrete pavements.
IS: 6579	Specification for coarse aggregate for water bound macadam
IS: 8089	Code of safe practice for layout of outside facilities in an industrial plant
IS: 10379	Code of practice for field control of moisture and compaction of soils of embankment and subgrade.
IS: 15658	Precast concrete blocks for paving-Specification
Indian Road Congress Codes (IRC)	
IRC 3	Dimensions and weights of Road Design vehicles
IRC 6	Standard specification and code of practice for road bridges, section II – loads and stresses
IRC 15	Standard specification and code of practice for construction of concrete roads
IRC 16	Specification for priming of base course with bituminous binders
IRC 19	Standard Specifications and Code of Practice for Water Bound Macadam (Second Revision)
IRC 20	Recommended Practice for Bituminous Penetration Macadam (Full Grout)
IRC 27	Tentative specification for bituminous macadam (base and binder course)
IRC 29	Specification for bituminous concrete (Asphaltic concrete) for road pavements
IRC 32	Standard for vertical and horizontal clearances of overhead electric power and telecommunication lines as related to roads
IRC 34	Recommendations for road construction in waterlogged area
IRC 37	Guidelines for the Design of Flexible Pavements (First Revision)
IRC 49	Recommended Practice for the Pulverization of Black Cotton Soils for Lime Stabilization
IRC 50	Recommended Design Criteria for the Use of Cement Modified Soil in Road Construction
IRC 57	Recommended practice for sealing of joints in concrete pavements
IRC 58	Guidelines for the design of plain jointed rigid pavement for highways
IRC 73	Geometric design of highway roads
IRC 75	Guidelines for the Design of High Embankments
IRC 86	Geometric design standards for urban roads in plains
IRC SP 11	Handbook of quality control for construction of roads and roadways
IS: SP 23	Handbook on concrete mixes (based on Indian standards)
MORTH: Fifth Revision	Specification by Ministry of Road Transport & Highways
Latest CPWD specifications (Vol. 1&2)	Central Public Works Department (GOI): Specifications

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Other Codes/Standards	National Building Code of India
	Bureau of Indian Standard
	State Government Factory Acts
	Local Municipality / Authority's Bye-laws as applicable
	Any other rules/ regulations/ recommendations as applicable for a particular project

In the instances where Other Standards and Codes are to be used, the Contractor shall identify which Standards it proposes to use and present a list to OWNER for review and approval. The Contractor shall prepare a tabulated list of discrepancies between this Specification and the Standards for review by OWNER. Resolution of any such conflicts shall be obtained from OWNER in writing before proceeding. Where conflict exists between OWNER Arrangement drawings, SOR and Standards, the Drawings shall govern. Where conflict exists within Project Specific Standards, OWNER shall be notified. The affected Standards will be revised by OWNER as necessary to clarify requirements.

4. BASIC REQUIREMENTS FOR CIVIL WORK

All materials used in the work shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the OWNER or his representative and shall comply strictly with the tests prescribed hereinafter or, where tests are not laid down in this specification, with the requirements of the latest issue of the relevant Indian or any other International Standards or other Standards approved by the OWNER or his representative.

Material will be strictly follows as described in this specification, item description stated in SOR of this document. Samples of all materials proposed to be used in the works may be called for at any time by the Engineer. The work shall be carried out by competent personnel skilled in their respective trades.

Before commencing the works, the contractor shall ascertain the locations and nature of all existing underground services and shall take every possible precaution against any damage occurring to them or interference therewith, during the execution of the works.

5. EXISTING FACILITIES UNDER AND ABOVE GROUND

Relocation (if required) of existing above ground or underground facilities encountered before or during construction shall be carried out with the approval of the OWNER / PMC.

6. EARTHWORK SPECIFICATION

6.1 DEFINATIONS

Deadmen or Tell Tales: Mounds of earth left undisturbed in pits dug out for borrowing earth

Burjis : Short pillars of brick having top surface finished with cement plaster for markings etc.

Formation or Profile : Final shape of the ground after excavation or filling up.

Lead : All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in

cases of unavoidable circumstances and approved by Engineer-in-charge along with reasons in writing.

Carriage by manual labour shall be reckoned in units of 50 m or part thereof. Carriage by mechanical transport shall be reckoned in one km unit. Distances of 0.5 km or more shall be taken as 1 km and distance of less than 0.5 km shall be ignored. However, when the total lead is less than 0.5 km, it will not be ignored but paid for separately in successive stages of 50 m subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km by mechanical/animal transport.

Lift: The vertical distance for removal with reference to the ground level. The excavation up to 1.5 m depth below the ground level and depositing the excavated materials up to 1.5 m above the ground level are included in the rate of earth work.

Lifts inherent in the lead due to ground slope shall not be paid for.

6.2 SCOPE

This general specification deals with earth work in excavation and filling in all kinds of soil including murrum, hard murrum, soft rock (without blasting), hard rock (with blasting), hard rock (with chiselling) filling excavated earth in plinths, sand filling in plinth & filling for general foundations.

6.3 APPLICABLE STANDARDS/CODES

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

IS: 1200-Part 1: 1992	Methods of Measurement of Building and Civil Engineering Works - Earthwork
IS:2720 Part 2: 1983	Methods of Test for Soils: Determination of Water Content.
IS:2720 Part 7: 1980	Determination of Water Content - Dry Density relation using light compaction.
IS:2720 Part 8: 1983	Determination of Water Content - Dry Density relation using heavy compaction.
IS: 1200 PART 28: 1974	Determination of Dry Density of Soils in place by the Sand Replacement Method.
IS: 1200 PART 29: 1975	Determination of Dry Density of Soils in place by the Core Cutters Method IS:3764 : 1992 Safety Code for Excavation Work.

6.4 GENERAL

Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, anything and everything necessary, whether or not such items are specifically stated herein, for completion of the job in accordance with specification and requirements.

Contractor shall carry out the survey of the site before commencing excavation and set properly all lines and establish levels for various works such as earthwork in excavation for site grading, foundations, plinth filling, roads, drains, cable trenches, pipelines, etc. Such survey shall be carried

out by studying thoroughly the drawings for the existing plant and modus operandi for earthwork shall be discussed with Engineer-in-Charge. Ground levels shall be taken and properly recorded by the Contractor and shall be checked and certified by Engineer-in-Charge.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps to ensure safety at night.

The excavation shall also include for dumping of excavated materials in required heaps, bunds, riprap with regular slope as directed by Engineer-in-Charge, within the lead specified and levelling the same so as to provide stability and natural drainage.

Soil excavated shall be stacked properly as directed by Engineer-in-Charge. As a rule, all softer materials shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top.

6.5 CLEANING

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

6.6 EXCAVATION & DEWATERING

6.1.1 All Types of Soils Including Soft Rocks

All excavation work shall be carried out in all types of soils, manually or by mechanical equipment, as directed by Engineer-in-Charge. Initially, excavation shall be carried out to a depth of 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final excavation and shall be carried out just prior to laying the PCC Contractor may, to facilitate his work or similar other reasons, excavate and also backfill later, if specifically approved by Engineer-in-Charge, at his own cost, outside the lines shown on the approved drawings.

All excavations shall be done to the minimum dimensions as required for safety and working facility. However, prior approval of Engineer-in-charge shall be obtained by Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. Excavation shall be carried out with such tools, tackles and equipment as required.

6.1.2 Dewatering

All excavation shall be kept free of water. Grading in the vicinity of excavation shall be controlled to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer-in-Charge any water, inclusive of rainwater and subsoil water accumulated in excavation, and keeps all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations / trenches required for further work. Method of pumping shall be approved by Engineer-in-Charge, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in thereof due to differential head of water during pumping. Pumping arrangements shall be

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adequate to ensure no delays in construction. The cost of dewatering shall be included in the items for excavation.

6.7 FILL & BACK FILLING

6.1.3 General

All fill material shall be subject to approval of Engineer-in-Charge. If any material is rejected, Contractor shall remove the same forthwith from the site within 24 hours at no extra cost to the Owner. Surplus fill material shall be deposited / disposed of as directed by Engineer-in-Charge after the fill work is complete. No earth fill shall commence until surface drains have been properly intercepted, or otherwise properly dealt with, as directed by Engineer-in-Charge.

6.1.4 Material

Only selected excavated materials shall be used as backfill. Fill material shall be free from clods, silt, salts, and sulphates, organic or other foreign material. All clods of earth shall be removed. If any selected fill material is required to be borrowed, Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of Engineer. The approved borrow pits areas shall be cleared of all bushes, plants, rubbish, etc. Topsoil containing salts / sulphate and other foreign material shall be removed. The materials so removed shall be disposed of, as directed by Engineer.

6.1.5 Filling in Pits & Trenches around Foundations of Structures, Walls. Etc.

As soon as the work in foundation has been accepted and measured, the space around the foundations, structures, pits, trenches, etc. shall be cleared of all debris and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed and properly consolidated, before the succeeding layer is laid. Each layer shall be consolidated to the satisfaction of Engineer-in-Charge.

Earth shall be rammed with approved mechanical compaction machines. Usually, no manual compaction shall be allowed unless Engineer-in-charge is satisfied that in some cases manual compaction by tampers is unavoidable. The final backfilled surface shall be trimmed and levelled to proper profile, as shown on the drawings and as directed by Engineer-in-Charge.

6.1.6 Sand/Murum Filling in Other Places

At places backfilling shall be carried out with local sand/ murum if directed by Engineer-in-Charge. The sand /murum used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to Contractor's account. The surface of the consolidated sand/ murum shall be dressed to required level or slope. Construction of floors or other structures on fill shall not be started until Engineer-in-Charge has inspected and approved the fill.

6.1.7 Compaction of Fill & Backfill

Density requirements as per standard Proctor Test shall be in accordance with relevant parts of IS: 2720 and all tests shall be made by/on under the supervision of OWNER at contractor's own expenses, at optimum moisture content:

- a) Backfilling of foundations and under grade slabs/paving - 98%
- b) Under roadways and parking areas - 95%

Backfill/Fill Earth shall have the following properties:

- a. Natural inorganic soils: salt content not greater than 5%, organic matter less than 3%. For other properties see under 'Select fill'.

The intention is to use ordinary fill for non-built areas.

6.1.8 Select fill

Select fill (if required as per site condition) shall have the following properties:

Well graded (uniformity index not less than 5), non-cohesive and nearly silt free (silt content not greater than 5%; up to 10% tolerated, except below footings of structures), salt free (content less than 3%), soils free of organic matter (limit 2%). Decomposing or compressible materials shall not be used.

All materials shall be of such nature and character that it can be compacted to the specified densities in a reasonable length of time. It shall be free of highly plastic clays, of all materials subject to decay, decomposition, or dissolution, and of cinders or other materials which will corrode piping or other metal.

The intention is to use select fill below plinth, floors, roads areas etc. if applicable.

6.1.9 Safety Precaution

The contractor shall be responsible for all necessary safety measures. Proper strutting, sheeting and bracing, including re-arrangement of the installations when necessary, stabilization and protection of slopes, methods of excavation to reduce risks of slides etc. shall be to the Contractor's debit. The additional moving of soil resulting from such damages will not be for.

6.1.10 Dust Control

The contractor shall use all means necessary to control dust on roads, construction areas and borrow pits. Surfaces shall be regularly watered to prevent dust becoming a nuisance for the public and interfering with the proper execution of the works.

6.1.11 Final Levels

- a. On completion of work, the levels should again be recorded in the measurement sheet.
- b. The formation levels as per final execution of the work should be compared with the drawing formation levels and the work got rectified if required within permissible tolerance.

No deduction shall be made from the rate if in the opinion of the Engineer- in-charge, operations specified in the above is/ are not required to be carried out on any account whatsoever.

7. STONE/RUBBLE MASONRY WORK

7.1 SCOPE

This Specification covers the materials and workmanship requirements for the construction of Un-coursed Rubble Stone Masonry & Pitching Work.

7.2 STONE FOR MASONRY & PITCHING

Rubble stone for Un-coursed masonry and pitching work carried out using approved trap / basalt /granite, shall be hard, tough, sound, durable, dense, clean, of close texture and free from unsound material, cracks, decay and weathering. Water absorption when tested as per IS standards shall not be more than 5%.

The stone shall, in the smallest dimension, be equal to the thickness of the pitching course specified with a tolerance of 25 mm. Stone shall be sufficiently flat bedded. Mortar shall be in the ratio of 1:4.

7.3 CEMENT POINTING

The joints of masonry shall be raked at least 12 mm deep. The dust shall then be brushed out of the joints and the wall washed with water.

The mortar shall consist of cement mortar in proportion of 1:2 (1 cement: 2 coarse sand). This mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be touched again after it has once begun to set.

The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be flat as directed. No false joints shall be allowed.

The work shall be kept wet for seven days after the pointing is complete.

7.4 MATERIAL

7.4.1 Boulder / Stone

Rubble stone for Un-coursed masonry and pitching work carried out using approved trap / basalt / granite, shall be hard, tough, sound, durable, dense, clean, of close texture and free from unsound material, cracks, decay and weathering. Water absorption when tested as per IS standards shall not be more than 5%.

The stone shall, in the smallest dimension, be equal to the thickness of the pitching course specified with a tolerance of 25 mm. Stone shall be sufficiently flat bedded.

7.4.2 Cement

Cement shall be 43 grade and 53 Grade Pozzolana Portland cement conforming to IS: 1489 or 43 grade OPC conforming to IS: 8112 and 53 grade ordinary port land cement conforming to IS: 12269-1987 with prior approval of the Engineer-in-Charge.

7.4.3 Sand

The sand used shall be natural sand from one approved source. The sand shall be hard, durable, clean and free from adherent coatings, mica, shale, organic matter and appreciable amount of clay.

The sand shall not contain impurities like iron pyrites, alkalis, salts, coal, mica, shell etc. Sand for masonry mortars shall have particle size grading conforming to IS: 2116. The grading of sand for use in mortar for un-reinforced and reinforced brick work shall be within the specified limited for respective works. The fineness modulus of sand for mortar in un-reinforced brickwork shall be between 2.1 to 2.3. A sand, whose grading falls outside the specified limited due to excess or deficiency of coarse or fine particles may be processed to comply with the standard by screening and blending.

7.4.4 Water

Water shall be clean and free from oil, acid, salt and other injurious materials. Water of suitable quality as per IS: 456 shall be used.

7.4.5 Tests for Fine Aggregates

Sand or fine aggregate shall be tested for organic impurities, particle size, silt content and bulking in accordance with IS: 2386 Part I, II & III.

7.5 STORAGE OF MATERIALS

7.5.1 Stone

Stone shall be unloaded and stacked in one place safely and properly.

7.5.2 Cement and Sand

Cement and sand shall be stored as specified in the specification for Cement concrete.

7.6 MORTAR

7.6.1 Cement Mortar

Mortar for Stone masonry / pitching work shall be prepared in accordance with IS: 2250. It is in the ratio of 1: 4 for stone masonry work.

7.6.2 Proportioning

Cement bag weighing 50 kg shall be taken as 0.035 cubic metres. Other ingredients in specified proportion shall be measured using boxes of size 40 x 35 x 35 cm. Sand shall be measured on the basis of its dry volume.

7.7 MIXING

The mixing of mortar shall be done in mechanical mixers operated by power or manually as decided by the Engineer. The Engineer-in-charge may however, permit hand mixing at his discretion taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixers or where item involving small quantities are to be done or if in his opinion the use of mechanical mixers is not feasible.

In cases, where mechanical mixers are not to be used, the Contractor shall take permission of the Engineer-in-charge in writing before the commencement of the work.

7.8 MECHANICAL MIXING

Cement and sand in the specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually, and wet mixing continued for at least three minutes. Only the required quantity of water shall be added which will produce mortar of workable consistency. Only the quantity of mortar which can be used within 30 minutes of its mixing shall be prepared at a time.

Mixer shall be cleaned with water each time before suspending the work.

7.9 HAND MIXING

The measured quantity of sand shall be levelled on a clean masonry platform and cement bags emptied on top. The cement and sand heap shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a masonry trough with just sufficient quantity of water to bring the mortar to a stiff paste of necessary working consistency.

7.10 CURING

The Stone masonry / Pitching work shall be constantly kept moist on all faces for a minimum period of seven days. Masonry work done during the day shall be suitably marked with the date on which the work is done to monitor the curing period.

7.11 SCAFFOLDING

Scaffolding shall be strong enough to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

7.12 GENERAL

All corners, angles, arises and junctions shall be truly vertical and horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, angles etc. where required shall be done. Such rounding or chamfering shall be carried out with proper templates to the size required.

The curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from damage by such means as the Engineer-in-charge may approve. The dates on which plastering is done shall be legibly marked on the various sections plastered.

7.13 QUALITY ASSURANCE

The Contractor shall submit the quality assurance plan for the above items of works and shall take all necessary steps for compliance.

The Contractor shall carry out any test on material as desired by the Engineer-in-Charge in order to satisfy him regarding quality without any additional cost.

7.14 CLEAN UP

Upon the completion of concrete work, all debris, scraps of wood etc. resulting from the work shall be removed and premises be cleaned to the satisfaction of Engineer-in-Charge.

8. CONCRETE & ALLIED WORKS

8.1 SCOPE

This Specification covers the general requirements for concrete (RCC & PCC) and Precast elements to be used on jobs onsite production facilities including requirements in regard to the quality, handling storage of ingredients, proportioning, batching, mixing & testing of concrete, and also requirements in regard to the quality, storage, bending and placement of reinforcement.

This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, curing, protecting, repairing, and finishing of Concrete.

Wherever feasible, RMC shall be preferred as per the direction of Engineer-in-charge. However, if it is specifically stipulated use of RMC in any item, it shall be mandatory.

8.2 APPLICABLE CODES & STANDARDS

Apart from this specification, construction of plain and reinforced concrete works shall be in accordance with the Indian Standard Code of Practice for "Plain and Reinforced Concrete" IS:456 and other relevant codes mentioned therein.

The following Indian Standards including all amendments and revisions shall be considered as part of this specification.

IS: 269: 1989	Specification for Ordinary/ Rapid hardening & Low heat Portland cement
IS: 383: 1970	Specification for Coarse & fine aggregates from natural sources for concrete
IS: 432: 1982 Part	Specification for mild steel and medium tensile steel bars and hard drawn steel

-I & II	I wire for concrete reinforcement
IS: 455: 1989	Specification for Portland Blast Furnace Slag cement
IS: 456: 2000	Code of Practice for Plain and Reinforced Concrete
IS: 516: 1959	Methods of Tests for Strength of Concrete
IS: 650: 1991	Specification for standard sand for testing of cement
IS:1139: 1966	Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement
IS:1199: 1959	Methods of Sampling and Analysis of Concrete
IS:1200: 1992	Methods of measurement of building works
IS:1489: 1991	Specification for Portland Pozzolona Cement
IS:1566: 1982	Specification for plain hard drawn steel wire fabric for concrete reinforcement
IS:1786: 2008	Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
IS:1791: 1985	Specification for Batch Type Concrete Mixers
IS: 2386: 1963	Methods of Test for Aggregates for Concrete: Part 3, Specific Gravity, density, voids, absorption and bulking.
IS:2396(I): 1988	Flakiness index of aggregates
IS:2502: 1963	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.
IS:2505: 1992	Specification for concrete vibrator immersion type
IS:2645: 2003	Specification for integral cement water proofing material.
IS:2750: 1964	Specification for steel scaffolding
IS:2751: 1979	Recommended Practice for Welding of Mild Steel Plain and Deformed Bars for Reinforced Concrete Construction.
IS:2772: 1982	Specification for portable swing weigh-batchers for concrete
IS:3696: 1987	Safety code for scaffolding and ladders
IS:4014: 1967	Code of Practice for steel tubular (Part I & II) Scaffolding
IS:4031: 1988	Method of physical tests for hydraulic cement
IS:4926: 2003	Ready Mixed Concrete
IS:4990: 1993	Specification for plywood for concrete shuttering work
IS: 7861	Code of Practice for Extreme Weather Concreting.
Part I: 1975	Recommended Practice for Hot Weather Concreting. Recommended Practice for Cold Weather Concreting
Part II: 1981	
IS 8112: 1989	Specification for 43 Grade Ordinary Portland Cement
IS:9013: 1978	Methods of Making, Curing and Determining Compressive Strength of Accelerated Cured Concrete Test Specimens.
IS:9103: 1999	Specification for Admixtures for Concrete

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IS:9417: 1989	Recommendation for Welding Cold Worked Steel Bars for Reinforced Concrete Construction.
IS:10262: 1982	Recommended Guidelines for Concrete Mix Design.
IS 12269:1987	Specification for 53 Grade Ordinary Portland Cement
IS:14687: 1999	Guidelines for Formwork for Concrete Structures.

8.3 MATERIALS

8.3.1 Cement

Cement shall be PPC 43 grade or PPC 53 grade with prior approval of the Engineer-in-Charge. In case of non-availability of PPC, OPC 43 and 53 grade cement can also be use by Contractor. In such case, additional cost due to use of OPC shall be bear by Contractor and no extra cost shall be paid for the same.

8.3.2 Aggregates

Aggregates in general designate both fine and coarse inert materials used in the manufacture of concrete. The fine aggregate is aggregate which passes through 4.75mm IS sieve. Coarse aggregate is aggregate most of which is retained on 4.75mm IS sieve. All aggregates shall conform to IS: 383.

Fine aggregate shall consist of natural sand, i.e. river or pit sand. Coarse aggregate shall consist of crushed gravel, natural gravel, crushed stone or combination thereof conforming to requirements of grading and physical properties called for. However, bank run gravel shall not be permitted for coarse aggregates.

The fineness modules of sand should be between 2.2 to 3.2 for concrete works. The maximum size of coarse aggregate shall be 19 mm. Blast furnace slag and manufactured sand shall not be used as aggregates.

8.3.3 Water

Water used for both mixing and curing shall be free from injurious amounts of deleterious Materials and shall be of potable quality conforming IS:456.

8.3.4 Reinforcement

Mild steel TMT Fe500D rebar conforming to IS: 1786 as shown in drawings. All reinforcement shall be clean, free from grease, oil, paint, loose mill scale, loose rust, dust, bituminous material or any other material or substance that will destroy or reduce the bond. 18 or 20 SWG as approved soft annealed steel wire shall be used for binding the reinforcement bars.

Mass of Steel Re-Bar

Dia. of Bar (mm)	Weight of Bar per metre Run (Kg)
8	0.395
10	0.617
12	0.888

Dia. of Bar (mm)	Weight of Bar per metre Run (Kg)
16	1.58
20	2.47
25	3.85
32	6.31

8.3.5 Water Stoppers

a. Metallic water stopper

Metallic water stopper shall be fabricated from 6 mm aluminum sheet of specified width and bent, folded to shape, soldered and fixed. The transverse joints of the sheets shall either be brazed or overlapped. In case of overlapping of the stoppers the minimum overlap should be equal to width of such water stopper PVC and rubber water stops shall be either ribbed or serrated type having a minimum thickness of 6 mm. They shall be accurately cut, fitted and integrally joined as per manufacturer's specifications.

b. PVC water stops

PVC water stops shall be conforming to IS:12200 for construction/ expansion joints between two RCC members and fixed to the reinforcement with binding wire before pouring concrete etc. Serrated with central bulb (225 mm wide, 8-11 mm thick).

8.3.6 Jointing / Sealing Materials

All joint fillers, sealing materials etc. used for joints in concrete shall be from approved standard manufacturer and shall conform to relevant IS codes. The extent, type, method of use and control shall be as per manufacturer's recommendation, subject to approval of the Engineer-in-Charge.

8.3.7 Admixtures

Admixtures shall be used strictly in accordance with the manufacturer's instructions and shall conform to the relevant IS codes (for e.g. IS: 9103). Vendor's instruction shall be successfully incorporated in the trial mix. The extent, type, method of use and control shall be subject to approval of the Engineer-in-Charge in all cases. Integral water proofing compound shall conform to IS:2645.

8.4 STORAGE OF MATERIALS

8.4.1 Cement

Cement shall be stored in a dampproof hopper or in sealed bags in weatherproof shed, on a floor above ground and shall be used in the order of its delivery. Different types or brands of cement shall be stored separately. Not more than 12 bags shall be stacked in any tier.

The cement shall be delivered to the site in bulk or in sound, properly sealed and marked bags. While being loaded or unloaded and during transit to the concrete mixers, whether conveyed in vehicles or by mechanical means, cement shall be protected effectively from the weather.

Mechanical transfer systems shall be fully enclosed and bagged cement shall be protected by tarpaulins or other effective coverings.

If the cement is delivered in bulk, the CONTRACTOR shall provide approved silos of adequate sizes to store a sufficient amount of cement to ensure the continuity of the works and the cement shall be placed in those silos immediately after it has been delivered to the site. Approved precautions shall be taken during unloading to ensure that the resulting dust does not constitute a nuisance or health hazard.

If the cement is delivered in bags, the CONTRACTOR shall provide perfectly waterproof and well ventilated sheds having a floor of wood or concrete raised clear of the ground.

The sheds shall be large enough to store a sufficient amount of cement to ensure the continuity of the work and to enable the OWNER'S REPRESENTATIVE to determine the suitability of the cement before being used.

Each consignment shall be stacked separately therein to permit easy access for inspection, testing and approval. When delivered at the site the cement shall immediately being placed in the above-mentioned sheds and it shall be used in the order in which it has been delivered.

The CONTRACTOR shall ensure that the arrangements for the storage of the cement at the site are sufficient for the separation and identification of each consignment until the results of the sampling and testing are available.

8.4.2 Aggregates

Aggregates of different sizes shall be kept separately. Aggregates of similar grading but from different sources or different types shall not be stored together unless approved. All aggregates shall be stored in such a way that they are free from contact of deleterious matter.

All aggregates for concrete shall be stored in concrete-based bins or on stages designed to prevent intermixing of different aggregates and to avoid the inclusion of dirt and other foreign materials in the concrete. Each size of aggregate shall be stored separately.

The storage bins shall be emptied and cleaned and the grading of the aggregates checked at intervals, subject to the approval of the OWNER'S REPRESENTATIVE.

8.4.3 Reinforcing Steel

Mild steel TMT Fe500D rebar conforming to IS: 1786 as shown in drawings which are stored at the project site shall be above ground on platforms, skids or other supports, racked systematically as necessary and protected from all aggressive elements to the approval of the OWNER'S REPRESENTATIVE. Steel shall be protected from rain, moisture and kept free from dirt, oil or contaminant injuries.

Reinforcement shall be cut and bent to shape as per dimensions shown in the Bar Bending Schedule / drawings.

a. Straightening, Cutting & Bending

Procedure for cutting and bending shall be as given in IS: 2502. In case bars are supplied in coils, they shall be smoothly straightened without

b. Placing & Fixing

All reinforcement shall be cleaned to ensure freedom from loose mill scale, loose rust, oil, form releasing agents, grease or any other harmful material before placing them in position. Reinforcement shall not be surrounded by concrete unless it is free from all such materials. Rough handling and dropping of reinforcement from a height shall be avoided.

All reinforcement shall be fixed in the correct position and shall be properly supported to ensure that displacement will not occur when the concrete is placed and compacted.

The uncoated reinforcement bars shall be tied at every intersection by two strands of 16 SWG black soft annealed binding wire. Crossing bars shall not be tack welded for assembly of reinforcement.

c. Splicing / Overlapping

Only bars of full length shall be used as shown in the drawings. But where this cannot be done, overlapping of bars shall be done as directed by the Engineer-in- Charge. Where practicable, the overlapping bars shall not touch each other, but these shall be kept by 25mm or 1.25 times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be tied with two strands of 16SWG black soft annealed binding wire. The overlaps shall be staggered for different bars and located at points along the span where neither shear nor bending moment is found to be of maximum values.

d. Tolerance to Cover

The actual concrete cover shall not deviate from the required nominal cover by - 0 to + 10 mm measured over the steel reinforcement including links.

8.4.4 Miscellaneous

All other materials shall be stored in a weather tight and dry place and be protected from open flame or sparks. All packed materials shall be stored in their original unbroken package or container.

8.4.5 Grades of Concrete

The grades of concrete shall be as noted on the drawings, or called for in the SOR, generally as per below Table.

Grades of Concrete

Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm²)
M 7.5	7.5
M 10	10
M 15	15
M 20	20
M 25	25
M 30	30

Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm²)
M 35	35
M 40	40
M 45	45
M 50	50
M 55	55

Note for Table-2: The characteristic strength is defined as the strength of material below which not more than five (5) percent of the test results are expected to fall.

In the designation of concrete mix the letter 'M' refers to the mix and the number to the specified characteristic compressive strength of 15 cm cube at 28 days expressed in N/sq. mm.

8.5 TYPES OF CONCRETE MIX

8.5.1 General

All lean/plain and reinforced concrete shall be nominal mix or design mix as noted on the drawing or called for in the SOR.

8.5.2 Nominal Mix Concrete

This concrete shall be made (without preliminary tests) by adopting nominal concrete mix with proportions of materials as specified in below Table.

Proportions for Nominal Mix Concrete

Nominal mix of concrete (by mass)	Quantity of water per 50 kg of cement (max) Litres
1:4:8 (1 cement :4 fine aggregate :8 Coarse aggregates)	60
1:3:6 (1 cement :3 fine aggregate :6 Coarse aggregates)	34
1:2:4 (1 cement :2 fine aggregate :4 Coarse aggregates)	32
1:1.5:3 (1 cement :1.5 fine aggregate :3 Coarse aggregates)	30

Note:

1. The proportions of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and the maximum size of aggregates becomes larger. Graded coarse aggregates shall be used.
2. The cement content of the mix shall be proportionately increased if the quantity of water in mix has to be increased to overcome the difficulties of placement and compaction, so that the water cement ratio, as specified, is not exceeded.

8.5.3 Design Mix Concrete

The mix shall be designed to produce the grade of concrete having the required workability and characteristic strength not less than appropriate required values given in Table-2. The target mean strength of concrete mix shall be equal to the characteristic strength plus 1.65 times the standard deviation.

As long as the quality of materials does not change, a mix design done earlier may be considered adequate for later work. However, in case the quality of materials changes or there is a break in the continuity of construction and the same work is allocated to a new Contractor, the Engineer-in-Charge shall ask for a new design mix.

Irrespective of the grade of concrete required to be produced as per characteristic strength criteria, the minimum cement content and maximum free water cement ratio in the design concrete shall be strictly maintained as stipulated in Table 2A for the corresponding grade of concrete and exposure condition.

The Contractor at his own cost, grade the aggregates and control the water/cement ratio, design & conduct the different trial mixes to required strength and workability & obtain Engineer-in-charge's approval for the same. Duly approved mixes in accordance with IS: 456 shall be used for construction. All concrete shall be machine mixed and no hand mixing shall be permitted. The concrete shall continuously agitate from mixing to pouring. The use of non-agitating equipment in transporting ready mixed concrete or the use of partially hardened concrete is not allowed.

Where reinforcement is too closely spaced for the maximum size of aggregate in a range, the largest suitable range will be used with the approval of the Engineer-in-Charge.

8.6 CONCRETE MIX PROPORTIONING

Proportioning, as used in this specification, shall mean the process of determining the proportions of the various ingredients to be used to produce concrete of the required workability when fresh/green and strength, durability and surface finish, when hardened. The following information shall be collected prior to design of the concrete mix:

- Grade designation
- Type of cement
- Maximum nominal size of aggregate
- Minimum cement content
- Maximum free water cement ratio
- Workability requirements.

The Engineer-in-charge shall verify the strength of the concrete mix, before giving his sanction of its use. However, this does not absolve the Contractor of his responsibility as regards achieving the prescribed strength of the mix. If cube tests show lower strengths than required, the Engineer-in-Charge shall order fresh trial mixes to be made by the Contractor. No claim to alter the rates of concrete work shall be entertained due to such changes in mix variations. Preliminary mix designs shall be established well ahead of start work.

8.7 MAXIMUM DENSITY

Suitable proportions of sand and the different sizes of coarse aggregates for each grade of concrete shall be selected to give as nearly as practicable the maximum density. This shall be determined by mathematical means, laboratory tests, field trials and suitable changes in aggregate gradation.

The Contractor shall submit to the Engineer-in-Charge at least three sets of mix design and corresponding test results after varying the mix proportions and / or grading of aggregate so as to establish the maximum density of any particular grade of concrete.

8.8 FREE WATER CEMENT RATIO

Once a mix, including its free water cement ratio, has been determined and approved for use by the Engineer-in-Charge, that free water cement ratio shall be maintained. The Contractor shall determine the water content of the aggregates frequently as the work progresses, and the amount of mixing water shall be adjusted so as to maintain the approved free water cement ratio.

8.9 CONSISTENCY

The concrete shall have a consistency such that it shall be workable in the required position and when properly vibrated it flows around reinforcing steel, all embedded fixtures, etc. The consistency of concrete shall have to be controlled as per IS: 456 and the slump tests shall be carried out by the Contractor in accordance with IS:1199.

8.10 WORKABILITY

The concrete mix proportion shall be such that the concrete is of adequate workability for the placing condition and can be properly compacted with the means available. Use of additives of approved make shall be taken recourse to where required for attaining proper workability as specified under.

The suggested ranges of values of workability of concrete measured in accordance with IS: 1199 are indicated in Table-2B below. However, the actual values to be followed shall be established depending on aggregate sizing, mix proportions, placing conditions, etc. and shall be got approved by the Engineer-in-charge. At least one slump test shall be carried out per every compressive test Performed. More frequent tests shall be made if there is a distinct change in work Conditions, if required by Engineer-in-Charge.

Values of Workability

Placing conditions	Degree of workability	Slump (mm)
Lightly reinforced sections in slabs, beams, walls, columns, footings and pavements	Low	25-75
Heavily reinforced sections in slabs, Beams, walls, columns, slip- form work and pumped concrete.	Medium	50-100

8.11 DURABILITY

For achieving sufficiently durable concrete, strong, dense aggregates, low water-cement ratio and adequate cement content shall always be used. Workability of concrete shall be such that concrete can be completely compacted with the means available.

Leak-proof formwork shall be used so as to ensure no loss of cement slurry during pouring and compaction. Cover to reinforcement shall be uniform and as shown on drawings. Concrete mix design shall always take into account the type of cement, minimum cement content irrespective of the type of cement, maximum free water cement ratio and minimum grade of concrete conforming to the exposure conditions as given in below Table.

Minimum Cement Content, Maximum Free Water Cement Ratio and Minimum Grade of Concrete for Different Exposure Conditions

Exposure	Plain Concrete			Reinforced Concrete		
	Minimum Cement Content (kg/m ³)	Maximum Free Water Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content (kg/m ³)	Maximum Free Water Cement Ratio	Minimum Grade of Concrete
Mild	220	0.60	M15	300	0.55	M20
Moderate	245	0.60	M15	320	0.50	M25
Severe	260	0.50	M15	320	0.45	M30
Very Severe	280	0.45	M20	340	0.45	M35
Extreme	300	0.40	M20	360	0.40	M40

Generally, the following types of cement shall be used for Plain and Reinforced concrete works: 43 and 53 grade Pozzolana Portland cement or 43 Grade ordinary Portland cement conforming to IS:8112:1989, 53 grade ordinary Portland cement conforming to IS: 12269: 1987, Sulphate Resisting Portland cement conforming to IS: 12330: 1988, Sulphate Resisting Portland cement shall be used only for specific requirements depending on environmental and process exposure conditions to which the structures may be subjected to like high sulphate concentrations, processes involving Sulphur handling etc.

The minimum cement content as mentioned in Table-2A shall be adjusted for aggregates other than 20mm nominal maximum size. The minimum cement content in the concrete mix shall be increased by 40 kg/m³ and decreased by 30 kg/m³ for 10mm and 40mm nominal maximum size aggregates respectively.

8.12 BATCHING

In proportioning concrete, the quantity of both cement and aggregate shall be determined by mass. Where the mass of cement is determined on the basis of mass of cement per bag, a reasonable number of bags shall be weighed periodically to check the net mass. Where the cement is weighed at site and not in bags, it shall be weighed separately from the aggregates.

Water shall be either measured by volume in calibrated tanks or weighed. Any solid admixtures that are to be added shall be measured by mass; liquid and paste admixtures shall be measured by volume or mass. Batching plant shall be confirmed to IS: 4925:2004.

All measuring equipment shall be maintained in a clean serviceable condition, and their accuracy shall be within $\pm 2\%$ and $\pm 3\%$ for measurement of cement and aggregates / water / admixtures, respectively.

Under very special circumstances change from weigh batching to appropriate volume batching may be permitted by the Engineer-in-charge. However, in such cases all conversions from mass of ingredients to volume shall be based on actual and appropriate bulk densities physically measured at site and approved by the Engineer-in-Charge.

No substitutions in materials used on the work or alterations in the established proportions, is permitted. In case the Contractor proposes any change in the already approved mix design, fresh mix design with supportive laboratory tests shall be submitted to the Engineer-in-charge and his approval has to be obtained prior to using the revised mix proportion in the works. However, such proposals for revision shall only be entertained in case of successive failure of test cubes to achieve the required strength.

8.13 CONCRETE MIXING

8.13.1 General

The mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixer shall be fitted with water measuring devices. The mixing shall be continued until there is a uniform distribution of the material and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete shall be remixed. Use of Ready Mixed Concrete supplied by Ready Mixed Concrete Plants or from on/off-site batching plants (IS: 4926) shall be as per OWNER's requirement.

All records and charts for the batching and mixing operations shall be prepared and Maintained by the Contractor as per the instructions of Engineer-in-Charge.

Mechanical Mixers shall comply with IS: 1791 and 12119 and shall be maintained in satisfactory operating condition. Hand mixing of concrete shall not be permitted. However, for Noncritical applications namely foundations for crossovers, isolated operating platforms etc. using concrete of maximum grade M20 and located at far away isolated places, this may be permitted by the Engineer-in-Charge as a special case.

8.13.2 Additives

Additive in concrete shall be used only with the prior approval of the Engineer-in-charge and shall comply with IS: 456. Any additive used for obtaining proper workability or leak-proofness of concrete or repair/rendering works of concrete due to non-conformance to the specifications, shall not be measured and paid for. All costs relating to such usage shall be borne by the Contractor.

8.14 TRANSPORTATION, PLACING & COMPACTION

8.14.1 General

The entire concrete placing program including transportation arrangements, deployment of equipment, layout, proposed procedures and methods, shall be submitted to the Engineer-in-Charge 24 hours prior to concreting for approval. No concreting shall be placed until his approval has been received. Approval of the Engineer-in-charge for pouring concrete shall be taken as 'conveyed', when the concrete pour card is signed by him.

8.14.2 Vibrators

In placing concrete in layers which are advancing horizontally as the work Progresses, great care shall be exercised to ensure adequate vibration, bonding and moulding of the concrete between the succeeding batches.

The vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints. Care shall be taken to prevent contact of vibrators against all embedded reinforcing steel inserts. Vibrators shall not be allowed to come in contact with forms.

8.14.3 Transportation

All concrete shall be conveyed from the mixer to the place of final deposit such as form work as early as possible using suitable buckets, dumpers, pumps, transit mixers, containers or conveyors which shall be mortar leak tight. Care shall be taken to prevent the segregation or loss of the ingredients and maintaining the required workability.

For structural concrete produced from Ready Mixed Concrete Plants, concrete shall be transported from the plants to the sites only by transit mixers.

8.14.4 Placing and Compaction

Before placing concrete, all soil surfaces upon which or against which concrete is to be placed shall be well compacted and free from standing water, mud or debris. Soft or yielding soil shall be removed and replaced, with lean concrete or with selected Soils / sand and compacted to the density as directed by Engineer-in-Charge. The surface of absorptive soil (against which concrete is to be placed) shall be moistened thoroughly so that moisture is not drawn from the freshly placed concrete. Similarly, for concrete to be placed on formworks, all chippings, shavings and sawdust etc. shall be removed from the interior of the forms before the concrete is placed. Concrete shall be placed within a maximum period of 25 minutes of its removal from mixture. Concrete shall not be placed until the formwork, the placement of reinforcing steel, embedded parts; pockets etc. have been inspected and approved by the Engineer-in-Charge. Any accumulated water on the surface of the bedding layer shall be removed by suitable means before start of placement. No concrete shall be placed on a water covered surface.

8.14.5 Items Embedded in Concrete

Concreting shall not be started unless the electrical conduits, pipes, fixtures etc., wherever required, are laid by the concerned agency. The Contractor shall afford all the facilities and maintain co-ordination of work with other agencies engaged in electrical and such other works as directed by the Engineer-In-Charge

Before concreting, the Contractor shall provide, fabricate and lay in proper position all metal inserts, anchor bolts, pipes etc. (which are required to be embedded in concrete members) as per relevant drawings and directions of Engineer-in-Charge.

Anchor bolts shall be set to template and firmly tied/fixed in vertical & horizontal line at all required positions.

All embedment, inserts, etc. shall be fully held and secured in their respective positions by the concerned agencies to the entire satisfaction of Engineer-in-charge so as to avoid any dislocation or displacement during the concreting operations. The Contractor shall take all possible care during concreting to maintain these embedment/ insert in their exact locations.

8.15 CONSTRUCTION JOINTS

8.15.1 General

Concrete shall be placed without interruption until completion of the part of the work between predetermined construction joints, as specified hereinafter. Time lapse between the pouring of adjoining units shall be as specified on the drawings or as directed by Engineer-in-Charge.

If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made where the work is stopped. Joints shall be either vertical or horizontal unless otherwise shown on drawings. In case of an inclined or curved member, the joint shall be at the right angles to the axis of the member. Vertical joints in walls shall be kept to a minimum. Vertical joints shall be formed against a stop board; horizontal joints shall be level and wherever possible, arranged so that the joint lines coincide with the architectural features of the finished work.

Battens shall be nailed to the form work to ensure a horizontal line, and if directed, shall also be used to form a grooved joint.

8.15.2 Dowels

Dowels for concrete work, not likely to be taken up in the near future, shall be encased in concrete as per drawings and as directed by the Engineer-in-Charge.

8.15.3 Treatment of Construction Joints of Resuming Concreting

A stiffer mix shall be used for the top lift of horizontal pours to avoid laitance. All laitance and loosed stones shall be thoroughly and carefully removed by wire brushing / hacking and surface washed. Just before concreting is resumed, the roughened joint surface shall be thoroughly cleaned, and loose matter removed and then treated with a thin layer of cement grout of proportion specified by Engineer-in-Charge and worked well into the surface. The new concrete shall be well worked against the prepared surface before the grout mortar sets. Special care shall

be taken to obtain thorough compaction and to avoid segregation of the concrete along the joints / plane.

8.16 EXPANSION / ISOLATION JOINT

Expansion/ Isolation joints in structures shall be formed in the positions and to the shapes shown in the relevant drawings. Joints shall be filled with joint filling material as stipulated in the drawings/SOR. Isolation joints shall be provided around all equipment foundations, columns, pedestals, trenches etc. on grade. As per standard practice, expansion joint in concrete retaining wall shall be made beyond 30m length & the gap of 25-30 mm to be kept with bars on both sides to be terminated before joint. Necessary filler board to be fixed in between the two surfaces as per drawing. After casting the 2nd part of wall, joint on both faces to be sealed with waterproof paper/metallic sheets of 200 mm width & 0.8-2 mm thickness as per manufacturer's specification. These sheets to be joined with 50 mm overlap using adhesives.

8.17 PROTECTION OF FRESHLY LAID CONCRETE

Newly placed concrete shall be protected, by approved means, from rain, sun and wind. Concrete placed below the ground level shall be protected from falling earth during and after placing. Surface shall be kept free from contact with such ground or with water draining from such ground during placing of concrete for a period of at least 3 days, unless otherwise directed by the Engineer-in-Charge. The Ground water around newly poured concrete shall be kept to an approved level by pumping or other approved means of drainage and adequate steps shall be taken to prevent floatation and flooding. Steps shall be taken to protect immature concrete from damage by debris, loading, vibration, abrasion, mixing with deleterious materials that may, in the opinion of the Engineer-in-Charge, impair the strength and/or durability of the concrete.

8.18 CURING

Concrete shall be cured by keeping it continuously moist wet for the specified period of time to ensure complete hydration of cement and its hardening. Curing shall be started after 8 hours of placement of concrete in normal weather, and in hot weather after 4 hours. The water used for curing shall be of the same quality as that used for making of concrete.

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances such as hose, sprinklers etc. A layer of sacking, canvas, Hessian, or other approved material, which will hold moisture for long periods and prevent loss of moisture from the concrete, shall be used as covering. Type of covering which would stain, disfigure or damage the concrete, during and after the curing period, shall not be used. Only approved covering shall be used for curing.

Exposed surfaces of concrete shall be maintained continuously in a damp or wet condition for at least the first 7 days after placing of concrete. For concretes containing Portland pozzolana cement or Portland slag cement, the curing period shall be doubled. Curing by ponding shall, however, commence after the first 24 hours of concreting.

8.19 FIELD TESTS

8.19.1 Workability

The concrete mix proportion so chosen shall be such that the concrete is of adequate workability for the placing condition and can be properly compacted with the means available.

The suggested ranges of values of workability of concrete measured in accordance with IS: 1199

8.19.2 Work Tests

Over the full period of construction, the Contractor shall carry out work tests of concrete at his own cost. Sampling from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested in accordance with IS: 516. The number of specimens to be tested and their criteria for acceptance shall be according to IS: 456. Frequency of work tests shall be as indicated below:

Frequency of Tests:

Unless otherwise specified, for each grade of concrete, sets of test cube, each set consisting of three (3) twin specimens (i.e. total 6 Nos.) shall be taken. Number of sets shall generally be calculated based on the types and corresponding volumes of work as indicated hereunder unless otherwise directed by the Engineer-in Charge

Mass Concrete Foundations:

For every 100 Cu. M of concrete placed, one set but not less than one set for each pouring of concrete.

Equipment and building Column foundations:

For every 50 Cu. m of concrete placed, one set but not less than one set for each pouring of concrete Frame & thin walled Structural components Columns, beams, slabs etc.: For every 30 Cu. m of concrete placed, one set but not less than one set for each pouring of concrete. The test cubes shall be sampled in presence of the Engineer-in-charge / OWNER's representative, who will also sign the record of testing in an agreed format. For testing the cube specimen, Contractor shall establish his own construction laboratory at site and the cost of testing of cubes shall be borne by him.

8.19.3 Standard Deviation

Standard deviation shall be calculated as given in IS:456.

8.19.4 Acceptance Criteria

The concrete shall deem to be accepted if it fulfils the requirements laid down in IS: 456. If the concrete does not comply with IS: 456, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken up by the Contractor at his own cost. Concrete of each grade shall be assessed separately. Concrete shall be assessed daily for compliance. Concrete is liable to be rejected if it is porous or honeycombed; its placing has been

interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified; or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge.

8.20 LABORATORY

The contractor shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time to the Engineer.

The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can be carried out in compliance with the standards. Calibration of testing instrument shall be verified by Engineer-in-charge prior to start lab tests. All the costs for the tests shall be borne by the Contractor.

8.21 FINISHING OF CONCRETE

On striking the formwork, all surface defects such as bulges, ridges and honey-combing etc. observed shall be brought to the notice of the Engineer-in-Charge. The Engineer-in-Charge may, at his discretion allow rectification by necessary chipping and packing or grouting with concrete or cement mortar. However, if honeycombing or sagging are of such extent as being undesirable, the Engineer-in-Charge may reject the work totally and his decision shall be binding. However, quantity of cement actually used for this purpose may be considered for reconciliation of materials. All burrs and uneven faces shall be rubbed smooth with the help of carborundum stone.

The surface of non-shuttered faces shall be smoothed with a wooden float to give a finish similar to that of the rubbed down shuttered faces. Concealed concrete faces shall be left as from the formwork except that honeycombed surface shall be made good as specified above. The top faces of slabs not intended to be covered shall be levelled and floated to a smooth finish to the rises or falls shown on the drawings or as directed. The floating shall not be executed to the extent of bringing excess fine materials to the surface. The top faces of slabs intended to be covered with screed, granolithic or similar finishes, shall be left with a rough finish.

8.22 FORM WORK

8.22.1 General

Forms for concrete shall be of plywood conforming to IS: 6461 or steel or as directed by the Engineer-in-Charge and shall give smooth and even surface after removal thereof. If it is desired by Engineer-in-Charge, the contractor shall prepare, before commencement of actual work, design and drawing for formwork and get them approved by the Engineer-in-Charge. For details regarding design, detailing etc., reference may be made to IS:14687.

8.22.2 Cleaning & Treatment of Formwork

The surfaces of forms that would come in contact with concrete shall be well treated with approved non- staining form release agents such as soft soap, oil, emulsions etc. Release agents shall be, applied so as to provide a thin uniform coating to the forms without contaminating the reinforcement.

8.22.3 Chamfer and Fillets

All corners and angles shall be formed with 45 degree mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise detailed specified shall be 25x25mm. For heavier work chamfers or fillets shall be 50x50mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

8.22.4 Reuse of Forms

Before reuse, all forms shall be thoroughly scrapped, cleaned, examined and when necessary, repaired and retreated, before resetting. Formwork shall not be reused, if declared unfit or un-serviceable by the Engineer-in-Charge.

8.22.5 Removal of Forms/Stripping Time

In the determination of time for removal of forms, consideration shall be given to the location and character of the structures, the weather and other conditions including the setting and curing of the concrete and material used in the mix. Forms and their supports shall not be removed without the approval of the Engineer-in-Charge.

Forms shall not be released until the concrete has achieved strength of at least twice the stress to which the concrete may be subjected at the time of removal. The formwork shall be removed without shock and methods of form removal likely to cause over stressing or damage to the concrete, shall not be adopted. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight. In normal circumstances when average air temperature exceeds 15 degree Celsius during the period under consideration after pouring of concrete and where ordinary Portland cement is used forms may generally be removed after expiry of following.

Item	Time of removal of shuttering
Walls, columns and vertical faces of all Structural members	16 to 24 hours as may be decided by the Engineer-in charge
Slabs (props left under)	3 days
Beam Soffits (props left under)	7 days
Removal of props under slabs Spanning up to 4.5m.	7 days 14 days

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Item	Time of removal of shuttering
Spanning over 4.5m	
Removal of props under beams and arches Spanning up to 6 m. Spanning over 6 m	14 days 21 days
Cantilever Construction	Formwork shall remain till Structures for counter acting or Bearing down have been erected and Have attained sufficient strength (Minimum 14 days).

Notes:

1. For other cements, the stripping time recommended for ordinary Portland cement shall be suitably modified as per the instructions of the Engineer-in-Charge.
2. The number of props left under, their sizes, supporting arrangement, and disposition shall be such as to be able to safely carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.
3. Where the shape of the element is such that the formwork has reentrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.
4. For rapid hardening cement, 3/7 of the above-mentioned periods shall be considered subject to a minimum of 16 hours.

8.23 PRECAST CONCRTE

The requirements of the Sections relating to concrete and reinforcement shall be observed in the case of precast concrete in so far as they are applicable, as well as the following requirements relating to pre-cast work in particular.

- a. All precast concrete shall, unless particularly specified to the contrary, be mechanically vibrated.
- b. The yard in which pre-casting work is to be undertaken shall be to the approval of OWNER / PMC.
- c. Where precast units have projecting reinforcement the moulds shall, if necessary, be raised on stools above the general level of the pre-casting yard.
- d. The moulds shall be strongly constructed, closely jointed and true to the required shape with edges, corners and surfaces which comply with the Particular Specification.
- e. Moulds shall be so designed that they can be taken apart and reassembled with ease.
- f. All units are to be marked on a face which will not be exposed in the permanent Works with the date of manufacture and such distinguishing letters or numbers as OWNER may direct.
- g. The maturing of precast concrete shall be carried out as agreed with OWNER. Generally, the procedure shall be as follows: -
 - The sides of the moulds may be removed not less than 12 hours after casting, provided the concrete has thoroughly set to the satisfaction of OWNER.
 - All concrete surfaces shall be cured for a minimum of 10 days in accordance with relevant IS Code.

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- Slings, transporting and stacking may take place ten days after casting, or as particularly specified.
- Building or setting in the work shall not be permitted until 28 days after casting.

The time periods specified above may be reduced where special techniques are adopted such as vacuum or pressed concrete, autoclaving steam curing or when a rapid hardening cement is used, all as approved by Engineer-in-Charge.

8.24 CLEAN UP

Upon the completion of concrete work, all debris, scraps of wood etc. resulting from the work shall be removed and premises be cleaned to the satisfaction of Engineer-in-Charge.

9. STRUCTURAL STEEL WORK

9.1 MATERIAL

Steel material shall be as follows (as applicable):

Item	Grade	Code / reference
Steel Tube and Pipes	YST310/YST240	IS: 1239 - 2004
Rolled steel sections and plates	E250 A, fy = 250 MPa	IS: 2062 - 2011
Connection Bolts	8.8	IS: 1367 - PART 3
Grating Grade	E250 A, fy = 250 MPa	IS: 2062 - 2011
Chequered plates	fy = 250 MPa	IS: 3502

- Tubular structural steel** : Supplying, transporting, fabricating, erecting in position of pre-fabricated steel structures at all elevations for canopy/hoarding using tubular structural steel sections conforming to is 1161-latest edition, including cutting, welding or bolting, supply of bolts/nuts/washers etc., complete as per drawings including surface preparation and applying one coat of zinc phosphate primer before erection, one coat after erection and two coats of synthetic enamel paint as per specification after erection and all materials and labour complete (no welding is permitted at site).
- Other structural steel** : Supplying, transportation, fabricating and erection/fixing in position structural steel for posts, struts, inserts, bottom pipe etc., for shed erection/chain link fencing and gate structure including cutting to required sizes, straightening/bending if required, edge preparation, bolting, welding, gas cutting, grinding, fixing in line and level with temporary staging inclusive of all bolts, screws, fasteners like 'J' bolts, etc., fixing of gate rail, grouting with ordinary cement grout, preparing the surface for painting of primer, supply and application of one coat zinc phosphate primer and two coats of synthetic enamel paint on structural steel posts/struts etc. complete as per specification and instructions of OWNER'S Engineer. Preparation of line and fabrication drawing, submission and obtaining OWNER'S approval is also part of the job.

Chequered plate shall conform to IS: 3502 (latest) and minimum thickness of chequered plate for floorings, covers etc. shall be 6 mm O/P.

Steel shall be procured from SAIL/TISCO or equivalent brand with prior approval of Engineer-in-charge / OWNER.

Shop connections will be all welded and field connections will generally be bolted unless otherwise. Field bolts, wherever provided shall be high tensile of 16 mm dia or of higher diameter and of property class 8.8 (minimum) as per IS: 1367 (latest) for all major connections. All bolts, nuts and washers shall be procured from the manufacturers as approved by Engineer. Supply, Transportation, fabrication, erection in position of pre-fabricated steel structures at all elevations using tubular structural steel sections Confirming to IS 1161-Latest edition, including cutting, welding or bolting, supply of bolt/nuts/washers etc. are covered under this item.

9.2 WELDING

Welding shall be in accordance with the recommendation of IS:816 (latest) Code of Practice for arc of metal arc welding for general construction in mild steel and IS:9595 (latest) recommendation for metal arc welding of carbon and carbon manganese steels. Built-up members will be fabricated using submerged arc welding procedure. All electrodes, flux, bare wire etc. shall be procured by the contractor only from approved manufacturers. All butt-welds in beams, girders & columns will be of full penetration. All butt-welds will be radio-graphically or ultrasonically tested as per IS-822 and standard practice.

9.3 QUALITY CONTROL/TESTS

Manufacture test certificate of each lot shall be handed over to Engineer-in-charge by the Contractor. Contractor shall carry out following minimum quality tests of Structural steel, welding, bolts etc.

Test for structural steel shall be done as per QAP appended with this specification. Moreover, if instructed by Engineer-In-Charge for specific test of any lot of material, such test shall be done as per provision in the relevant IS code /CPWD specifications.

The bare wire electrodes for submerged arc welding shall conform to IS: 7280 (latest). The combination of wire and flux for submerged arc welding shall be as follows:

Filler wire shall be of classification AWS-A-5.17-EH14 and flux shall be of agglomerated type of classification AWS-A-5.17F7 A2-EH14.

Low hydrogen electrodes as approved by the Engineer-in-charge shall invariable be used in the following cases: -

- a. For welding of all important joints such as butt-joints in columns (flange or web), butt-joints in main frame beams (flange or web) etc.
- b. For welding the steel having thickness more than 20 mm.

In case of fillet weld between two components, the thickness of the thicker part shall be considered as the limit for (b).

Minimum preheat & interpass temperature for welding over 40 mm to 63 mm (thickness of the thicker part at the point of welding) shall be 66°C and for over 63 mm, it shall be 110°C. However, higher preheat & interpass temperature may be required due to joint restraint etc. and shall be followed as per approved welding procedure.

9.4 PAINT ON STRUCTURAL STEEL

Primers are applied on steel work to inhibit corrosion and hence called anti-corrosive primers. They should adhere to the surface firmly and offer a key to the subsequent coats. Anti-corrosive primers may be lead-based or lead-free types. For spray application lead-free primers shall be used. The primer coats for ferrous surfaces shall be provided using one of the primers conforming to IS: 102 or IS: 104 or IS:2074. Other anti-corrosive primers such as zinc rich primer, also called cold galvanizing, may be used in accordance with the manufacturers' recommendations.

It is strongly recommended that a primer is employed for which long-term experience under the specific climatic conditions is available and to insist that it shall conform to the relevant Indian Standard specifications.

10. ROAD WORK

Electrical cables at each road crossing location shall be routed through RCC Ductbank by dismantling the existing road. The road crossing construction site shall be barricaded and provided with warning signs, including night warning lamps at appropriate locations for traffic diversion.

The dismantled portion of road area shall be reconstructed including all associated work that are necessary for the smooth traffic operation after the construction of Ductbank at all road crossing locations.

10.1 BITUMINIOUS PAVEMENT

Bituminous (Flexible Pavement) road shall be constructed in line with the standard guidelines of IRC:37 for the construction of subgrade, subbase, Wet Mix Macadam & Bituminous layers.

10.1.1 Sub-grade

The sub-grade shall be prepared as per work under Levelling and grading package works. Contract The exposed levelled surface shall then be scarified moistened and compacted by Mechanical rolling so as to achieve minimum dry density of 95% of maximum Dry density as measured by the Modified Proctor Test as IS 2720 Part 8.

Preparation and consolidation of sub grade shall be done with power road roller of 8 to 12 tonnes capacity after excavating earth, dressing to camber and consolidating with road roller to achieve density requirements including making good the undulations etc. and re-rolling the sub grade and disposal of surplus earth all complete as per direction of Engineer-in-charge.

10.1.2 Sub-base

The sub-base shall be of layers of granular sand or approved materials compacted in layers of max. 200 mm thickness to achieve 95%-97% of maximum dry density as measured as measured by the

Modified Proctor Test as IS 2720 Part 8. Necessary profile or slope shall be followed as per drawing.

The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

The finished surface shall be uniform and conform to the lines, grades and typical cross section shown in the drawings, when tested with the template and straight edge, the variation shall be within the tolerances specified in Table below:

Longitudinal profile maximum permissible undulation when measured with a 3 meter straight edge	Cross profile maximum permissible variation from specified profile when measured with a camber template
24 mm	15 mm

Where the surface irregularity of the sub grade falls outside the specified tolerances, the contractor shall be liable to rectify these with fresh material or quarry spoils as the case may be, and the sub-grade rerolled to the satisfaction of Engineer-in-Charge.

The length and width of sub grade and sub-base work shall be measured correct to a cm. The area shall be worked out in square meter, correct to two places of decimal.

10.1.3 Wet Mix Macadam

Providing, laying, spreading and compacting graded crushed stone aggregate to wet mix macadam (WMM), including cost of all materials, including pre-mixing the material with water at OMC in mechanical mix plant, carriage of mixed material by tipper to the site, laying in uniform layers with paver in base courses on well prepared surface and compacting with vibratory roller of 80-100 kN weight to achieve the desired density, to proper grade and camber, including barricading, diversion of the traffic, all labour charges, hire charges of the machinery, consumables etc., completed as per the direction of the Engineer-In-Charge and as per MORTH specification 406 (5th revision) for finished item of work. Proper slope is to be maintained using the wet mix macadam for the area to be asphalted.

(a) Materials

Coarse aggregates shall be crushed stone. If crushed gravel / shingle is use, not less than 90 percent by weight of the gravel / shingle pieces retained on 4.75 mm sieve shall be at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-10 of MORTH Specification.

If the water adsorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part 5).

(b) Grading requirements:

The aggregates shall conform to the grading given in Table 400-11 of MORTH Specification. Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6. The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

(c) Construction Operations

Preparation of mix: Wet Mix macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced / positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer-in-charge may permit the mixing to be done in concrete mixers. Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part 8) after replacing the aggregate fraction retained on 2.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses, However, at the time of compaction, water in the wet mix should not vary from the optimum valued by more than agreed limits. The mixed material should be uniformly wet, and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub-grade / sub-base / base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader, for portions where mechanical means cannot be used, manual means as approved by the Engineer-in-charge shall be used. The motor grade shall be capable of spreading the material uniformly all over the surface. Its blade shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The paver finisher shall be self-propelled, having the following features:

- Loading hoppers and suitable distribution mechanism
- The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface profile.
- The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of layer and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction: After the mix has been laid to the required thickness, grade and cross fall/camber the same shall be uniformly compacted, to the full depth. The compaction shall be

done with the help of vibratory roller of minimum static weight of 80 to 100 KN or equivalent capacity roller. The speed of the roller shall not exceed 5 km/h.

In portion shaving unidirectional cross fall / super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road uniformly overlapping each preceding track by at least one third width until the entire surface has been rolled alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding step.

Testing: Site testing shall be done as per MORTH specification for each layer of work. 1st layer to be cleared through site testing before proceeding to 2nd layer of construction for road. Necessary QAP shall be followed for site construction activity. Necessary lab facility to be made available by the contractor for site testing of each work activity.

(d) Measurement

The quantity of wet mix macadam shall be computed in cubic meters.

11. SAFETY PRACTISES DURING CONSTRUCTION

11.1 INTRODUCTION

Safety in Construction Management deserves utmost attention especially in the hydrocarbon industry, such as Exploration, Refineries, Pipelines and Marketing installations, Gas Processing units etc. Construction is widely recognised as one of the accident-prone activities. Most of the accidents are caused by inadequate planning, failure during the construction process and/or because of design deficiencies. Besides property loss, accidents also result in injuries and fatalities to the personnel; same needs to be prevented.

The reasons for accidents during construction activities are related to unique nature of the industry, human behaviour, difficult work-site conditions, extended odd duty hours, lack of training & awareness and inadequate safety management. Unsafe working methods, equipment failure and improper housekeeping also tend to increase the accident rate in construction.

Ensuring good quality of materials, equipment and competent supervision along with compliance of standard engineering practices shall go a long way to in built safety into the system.

The objective of this standard is to provide practical guidance on technical and educational framework for safety and health in construction with a view to:

- a) prevent accidents and harmful effects on the health of workers arising from employment in construction.
- b) ensure appropriate safety during implementation of construction.
- c) provide safety practice guidelines for appropriate measures of planning, control and enforcement.

11.2 SCOPE

This document specifies broad guidelines on safe practices to be adhered to during construction activities in oil industry. However, before commencing any job, specific hazards and its effects should be assessed, and necessary corrective/preventive actions should be taken by all concerned.

The document is intended only to supplement and not to replace or supersede the prevailing statutory requirements, which shall also be followed as applicable. For Personal Protective Equipment, OISD-STD-155 (Part I&II) shall be referred to. The scope of this document does not include the design aspects and quality checks during construction

11.3 DEFINITIONS

Definitions of various terminology are given below:

- **Adequate, appropriate, or suitable**

are used to describe qualitatively or quantitatively the means or method used to protect the worker.

- **Brace**

A structural member that holds one point in a fixed position with respect to another point; bracing is a system of structural members designed to prevent distortion of a structure.

- **By hand**

The work is done without the help of a mechanised tool.

- **Competent Authority**

A statutory agency having the power to issue regulations, orders or other instructions having the force of law.

- **Competent person**

A person possessing adequate qualifications, such as suitable training and sufficient knowledge, experience and skill for the safe performance of the specific work. The competent authorities may define appropriate criteria for the designation of such persons and may determine the duties to be assigned to them.

- **Execution agency**

Any physical or legal person, having contractual obligation with the owner, and who employs one or more workers on a construction site.

- **Owner**

Any physical or legal person for whom construction job is carried out. It shall also include owner's designated representative/consultant/nominee/agent, authorized from time to time to act for and on its behalf, for supervising/ coordinating the activities of the execution agency.

- **Hazard**

Danger or potential danger.

- **Guard-rail**

An adequately secured rail erected along an exposed edge to prevent persons from falling.

- **Hoist**

A machine, which lifts materials or persons by means of a platform, which runs on guides.

- **Lifting gear**

Any gear or tackle by means of which a load can be attached to a lifting appliance, but which does not form an integral part of the appliance or load.

- **Lifting appliance**

Any stationary or mobile appliance used for raising or lowering persons or loads.

- **Means of access or egress**

Passageways, corridors, stairs, platforms, ladders and any other means for entering or leaving the workplace or for escaping in case of danger.

- **Scaffold**

Any fixed, suspended or mobile temporary structure supporting workers and material or to gain access to any such structure and which is not a lifting appliance as defined above.

- **Toe-board**

A barrier placed along the edge of a scaffold platform, runway, etc., and secured there to guard against the slipping of persons or the falling of material.

- **Worker**

Any person engaged in construction activity

- **Workplace**

All places where workers need to be or to go by reason of their work.

11.4 GENERAL DUTIES

Execution agency should provide means and organisation to comply with the safety and health measures required at the workplace as follows:

a) provide and maintain workplaces, plant, equipment, tools and machinery and organize construction work so that, there is no risk of accident or injury to health of workers. In particular, construction work should be planned, prepared and undertaken so that:

- dangers, liable to arise at the workplace, are prevented.
- excessively or unnecessarily strenuous work positions and movements are avoided.
- organisation of work takes into account the safety and health of workers.
- materials and products used are suitable from a safety and health point of view.
- working methods are adopted to safeguard workers against the harmful effects of chemical, physical and biological agents.

b) establish committees with representatives of workers and management or make other arrangement for the participation of workers in ensuring safe working conditions.

c) arrange for periodic safety inspections by competent persons of all buildings, plant, equipment, tools, machinery, workplaces and review of systems of work, regulations, standards or codes of practice. The competent person should examine and ascertain the safety of construction machinery and equipment, safety and health of theirs as well as that of others.

d) Employ only those workers who are qualified, trained and suited by their age, physique, state of health and skill.

e) Satisfy themselves that all workers are informed and instructed in the hazards connected with their work and environment and trained in the precautions necessary to avoid accidents and injury to health.

f) Ensure that buildings, plant, equipment, tools, machinery or workplaces in which a dangerous defect has been found should not be used until the defect has been rectified.

g) Organise for and remain always prepared to take immediate steps to stop the operation and evacuate workers as appropriate, where there is an imminent danger to the safety of workers.

h) Establish a checking system by which it can be ascertained that all the members of a shift, including operators of mobile equipment, have returned to the camp or base at the close of work on dispersed sites and where small groups of workers operate in isolation.

i) Provide appropriate first aid, training and welfare facilities to workers as per various statutes like the Factories Act, 1948 etc. and, whenever collective measures are not feasible or are insufficient, provide and maintain personal protective equipment and clothing in line with the requirement as per OISD-STD-155 (Vol. I & II) on Personnel Protective Equipment. They should also provide access to workers to occupational health services.

- j) Educate workers about their right and the duty at any workplace to participate in ensuring safe working conditions to the extent of their control over the equipment and methods of work and to express views on working procedures adopted as may affect safety and health.
- k) Ensure that except in an emergency, workers, unless duly authorised, should not interfere with, remove, alter or displace any safety device or other appliance furnished for their protection or the protection of others, or interfere with any method or process adopted with a view to avoiding accidents and injury to health.
- l) Ensure that workers do not operate or interfere with plant and equipment that they have not been duly authorised to operate, maintain or use.
- m) Ensure that workers do not sleep, rest or cook etc in dangerous places such as scaffolds, railway tracks, garages, confined spaces or in the vicinity of fires, dangerous or toxic substances, running machines or vehicles and heavy equipment etc.
- n) Obtain the necessary clearance/permits as required and specified by owner
- o) As per the Government circular as amended from time to time all contractors who employ more than 50 workers or where the contract value exceeds Rs. 50 crores, the following facilities are to be provided by contractor at site:
- Arrangement for drinking water.
 - Toilet facilities.
 - A creche where 10 or more women workers are having children below the age of 6 years.
 - Transport arrangement for attending to emergencies.
- p) should deploy a safety officer at site.

11.5 GENERAL DUTIES OF OWNERS

Owners should:

a) co-ordinate or nominate a competent person to co-ordinate all activities relating to safety and health on their construction projects;

b) inform all contractors on the project of special risks to health and safety;

Ensure that executing agency is aware of the owner's requirements and the executing agency's responsibilities with respect to safety practices before starting the job.

11.6 SAFETY PRACTICES AT WORKPLACE

11.6.1 General Provisions

- a) All openings and other areas likely to pose danger to workers should be clearly indicated.

- b) Workers & Supervisors should use the safety helmet and other requisite Personal Protective Equipment according to job & site requirement. They should be trained to use personal protective equipment.
- c) Never use solvents, alkalis and other oils to clean the skin.
- d) Lift the load with back straight and knees bent as far as possible. Seek the help in case of heavy load.
- e) Ensure the usage of correct and tested tools and tackles. Don't allow the makeshift tools and tackles.
- f) No loose clothing should be allowed while working near rotating equipment or working at heights.

11.6.2 Means of Access & Egress

Adequate and safe means of access (at least two, differently located) to and egress from all workplaces should be provided. Same should be displayed and maintained.

11.6.3 Housekeeping

- a) Ensure:
 - proper storage of materials and equipment;
 - removal of scrap, inflammable material, waste and debris at appropriate intervals.
- b) Removal of loose materials, which are not required for use, to be ensured. Accumulation of these at the site can obstruct means of access to and egress from workplaces and passageways.

Workplaces and passageways, that are slippery owing to oil, grease or other causes, should be cleaned up or strewn with sand, sawdust, ash etc.

11.6.4 Precautions against the Fall of Materials & Persons and Collapse of Structures

- a) Precautions should be taken such as the provision of fencing, look-out men or barriers to protect any person against injury by the fall of materials, or tools or equipment being raised or lowered.
- b) Where necessary to prevent danger, guys, stays or supports should be used or other effective precautions should be taken to prevent the collapse of structures or parts of structures that are being erected, maintained, repaired, dismantled or demolished.
- c) All openings through which workers are liable to fall should be kept effectively covered or fenced and displayed prominently.

As far as practicable, guardrails and toe-boards should be provided to protect workers from falling from elevated workplaces.

11.6.5 Prevention of Unauthorized Entry

Construction sites located in built-up areas and alongside vehicular and pedestrian traffic r

- a) routes should be fenced to prevent the entry of unauthorized persons.
- b) Visitors should not be allowed access to construction sites unless accompanied by or authorized by a competent person and provided with the appropriate protective equipment.

11.7 FIRE PREVENTION AND FIRE FIGHTING

- a) All necessary measures should be taken by the executing agency and owner to:
 - avoid the risk of fire;
 - control quickly and efficiently any outbreak of fire;
 - bring out a quick and safe evacuation of persons.
 - Inform unit/fire station control room, where construction work is carried out within existing operating area.
- b) Combustible materials such as packing materials, sawdust, greasy/oily waste and scrap wood or plastics should not be allowed to accumulate in workplaces but should be kept in closed metal containers in a safe place.
- c) Places where workers are employed should, if necessary to prevent the danger of fire, be provided with:
 - Suitable and sufficient fire-extinguishing equipment, which should be easily visible and Accessible.
 - An adequate water supply at sufficient pressure meeting the requirements of various OISD standards.
- d) To guard against danger at places having combustible material, workers should be trained in the action to be taken in the event of fire, including the use of means of escape.
- e) At sites having combustible material, suitable visual signs should be provided to clearly indicate the direction of escape in case of fire.

Means of escape should be kept clear at all times. Escape routes should be frequently inspected particularly in high structures and where access is restricted.

11.8 LIGHTING

- a) Where natural lighting is not adequate, working light fittings or portable hand-lamps should be provided at workplace on the construction site where a worker will do a job.
- b) Emergency lighting should be provided for personnel safety during nighttime to facilitate Standby lighting source, if normal system fails.
- c) Artificial lighting should not produce glare or disturbing shadows.

d) Lamps should be protected by guards against accidental breakage.

The cables of portable electrical lighting equipment should be of adequate size & Characteristics for the power requirements and of adequate mechanical strength to Withstand severe conditions in construction operations.

11.9 PLANT MACHINERY, EQUIPMENT AND HAND TOOLS

11.9.1 General Provision

- a) Plant, machinery and equipment including hand tools, both manual and power driven, should:
- be of proper design and construction, taking into account health, Safety and ergonomic principles.
 - be maintained in good working order.
 - be used only for work for which they have been designed.
 - be operated only by workers who have been authorised and given appropriate training.
 - be provided with protective guards, shields or other devices as required.
- b) Adequate instructions for safe use should be provided.
- c) Safe operating procedures should be established and used for all plant, machinery and Equipment.
- d) Operators of plant, machinery and equipment should not be distracted while work is in progress.
- e) Plant, machinery and equipment should be switched off when not in use and isolated before any adjustment, clearing or maintenance is done.
- f) Where trailing cables or hose pipes are used, they should be kept as short as practicable and not allowed to create a hazard.
- g) All moving parts of machinery and equipment should be enclosed or adequately guarded.
- h) Every power-driven machine and equipment should be provided with adequate means, immediately accessible and readily identifiable to the operator, of stopping it quickly and preventing it from being started again inadvertently.
- i) Operators of plant, machinery, equipment and tools should be provided with PPEs, including where necessary, suitable ear protection.

11.9.2 Hand Tools

- a) Hand tools should be repaired by competent persons.
- b) Heads of hammers and other shock tools should be dressed or ground to a suitable radius on the edge as soon as they begin to mushroom or crack.
- c) When not in use and while being carried or transported sharp tools should be kept in sheaths, shields, chests or other suitable containers.

- d) Only insulated or nonconducting tools should be used on or near live electrical installations.
- e) Only non-sparking tools should be used near or in the presence of flammable or explosive dusts or vapours.

11.9.3 Pneumatic Tools

- a) Operating triggers on portable pneumatic tools should be:
 - so placed as to minimize the risk of accidental starting of the machine.
 - so arranged as to close the air inlet valve automatically when the pressure of the operator's hand is removed.
- b) Hose and hose connections for compressed air supply to portable pneumatic tools should be:
 - designed and tested for the pressure and service for which they are intended;
 - fastened securely on the pipe outlet and equipped with the safety chain, as appropriate.
- c) Pneumatic shock tools should be equipped with safety clips or retainers to prevent dies and tools from being accidentally expelled from the barrel.
- d) Pneumatic tools should be disconnected from power and the pressure in hose lines released before any adjustment or repair is made.

11.9.4 Electrical Tools

- a) Low voltage portable electrical tools should generally be used.
- b) All electrical tools should be earthed, unless they are "all insulated" or "double insulated" tools which do not require earthing.
- c) All electrical tools should get inspected and maintained on a regular basis by a competent electrician and complete records kept.

11.9.5 Engines

- a) Engines should:
 - be installed so that they can be started safely, and the maximum safe speed cannot be exceeded.
 - have controls for limiting speed.
 - have devices to stop them from a safe place in an emergency.
- b) IC engines should not be run in confined spaces unless adequate exhaust ventilation is provided.
- c) When IC engines are being fueled.
 - the engine should be shut off.
 - care should be taken to avoid spilling fuel.

- no person should smoke or have an naked light in the vicinity.
 - a fire extinguisher should be kept readily available.
- d) Secondary fuel reservoir should be placed outside the engine room.

11.10 CONSTRUCTION ACTIVITIES

The various common activities in construction are as under:

- Excavation
- Scaffolding, Platforms & Ladders
- Structural Work, Laying of Reinforcement & Concreting
- Road Work (Laying of roads)
- Cutting /Welding
- Working in Confined Space
- Working at Heights
- Handling & Lifting Equipment
- Vehicle Movement
- Electrical
- Demolition
- Sand/shot blasting/ spray painting

The safe practices to be followed during the implementation of above construction activities are given below.

11.10.1 Excavation

- a) All excavation work should be planned, and the method of excavation and the type of support work required should be decided considering the following:
- the stability of the ground.
 - the excavation will not affect adjoining buildings, structures or roadways.
 - to prevent hazard, the gas, water, electrical and other public utilities should be shut off or disconnected, if necessary.
 - presence of underground pipes, cable conductors, etc.,
 - the position of culvert/bridges, temporary roads and spoil heaps should be determined.
- b) Before digging begins on site, all excavation work should be planned, and the method of excavation and the type of support work required decided.
- c) All excavation work should be supervised.
- d) Sites of excavations should be thoroughly inspected:
- daily, prior to each shift and after interruption in work of more than one day.
 - after every blasting operation.
 - after an unexpected fall of ground.
 - after substantial damage to supports.

- after a heavy rain, frost or snow.
 - when boulder formations are encountered.
- e) Safe angle of repose while excavating trenches exceeding 1.5m depth up to 3.0m should be maintained. Based on site conditions, provide proper slope, usually 45°, and suitable bench of 0.5m width at every 1.5m depth of excavation in all soils except hard rock or provide proper shoring and strutting to prevent cave-in or slides.
- f) As far as possible, excavated earth should not be placed within one meter of the edge of the trench or depth of trench whichever is greater.
- g) Don't allow vehicles to operate too close to excavated area. Maintain at least 2m distance from edge of excavation. No load, plant or equipment should be placed or moved near the edge of any excavation where it is likely to cause its collapse and thereby endanger any person unless precautions such as the provision of shoring or piling are taken to prevent the sides from collapsing.
- h) Adequately anchored stop blocks, and barriers should be provided to prevent vehicles being driven into the excavation. Heavy vehicles should not be allowed near the excavation unless the support work has been specially designed to permit it.
- i) If an excavation is likely to affect the security of a structure on which persons are working, precautions should be taken to protect the structure from collapse.
- j) Barricade at 1m height (with red & white band/self-glowing caution board) should be provided for excavations beyond 1.5m depth. Provide two entries/exits for such excavation.
- k) Necessary precautions should be taken for underground utility lines like cables, sewers etc. and necessary approvals/clearances from the concerned authorities shall be obtained before commencement of the excavation job.
- l) Water shall be pumped/bailed out, if any accumulates in the trench. Necessary precautions should be taken to prevent entry of surface water in trenches.
- m) During rains, the soil becomes loose. Take additional precaution against collapse of side wall.
- n) In hazardous areas, air should be tested to ascertain its quality. No one should be allowed entry till it is suitable for breathing.
- o) In case of mechanized excavation, precaution shall be taken to not to allow anybody to come within one meter of extreme reach of the mechanical shovel. The mechanized excavator shall be operated by a well-trained experienced operator. When not in operation, the machine shall be kept on firm leveled ground with mechanical shovel resting on ground. Wheel or belt shall be suitably jammed to prevent any accidental movement of the machine. Suitable precautions as per manufacturer guidelines should be taken for dozers, graders and other heavy machines.
- In case of blasting, follow strictly IS:4081-1986 & Indian Explosive Act and rules for storage, handling and carrying of explosive materials and execution of blasting operation.

11.10.2 Scaffolding, Platforms & Ladders (Metal as Material of Construction)

- a) A scaffold should be provided and maintained, or other equally safe and suitable provision should be made where work cannot safely be done on or from the ground or from part of building or other permanent structure.
- b) Scaffolds should be provided with safe means of access, such as stairs, ladders or ramps. Ladders should be secured against inadvertent movement.
- c) Every scaffold should be constructed, erected and maintained so as to prevent collapse or accidental displacement when in use.
- d) Every scaffold and part thereof should be constructed.
 - in such a way so as not to cause hazards for workers during erection and dismantling.
 - in such a way so as guard rails and other protective devices, platforms, ladders, stairs or ramps can be easily put together.
 - with sound material and of requisite size and strength for the purpose for which it is to be used and maintained in a proper condition.
- e) Boards and planks used for scaffolds should be protected against splitting.
- f) Materials used in the construction of scaffolds should be stored under good conditions and apart from any material unsuitable for scaffolds.
- g) Couplers should not cause deformation in tubes. Couplers should be made of drop forged steel or equivalent material.
- h) Tubes should be free from cracks, splits and excessive corrosion and be straight to the eye, and tube ends cut cleanly square with the tube axis.
- i) Scaffolds should be designed for their maximum load as per relevant code.
- j) Scaffolds should be adequately braced.
- k) Scaffolds which are not designed to be independent should be rigidly connected to the building at designated vertical and horizontal places.
- l) A scaffold should never extend above the highest anchorage to an extent which might endanger its stability and strength.
- m) Loose bricks, drainpipes, chimneypots, or other unsuitable material should not be used for the construction or support of any part of a scaffold.
- n) Scaffolds should be inspected and certified:
 - before being taken into use.
 - at periodic intervals thereafter as prescribed for different types of scaffolds.
 - after any alteration, interruption in use, exposure to weather or seismic conditions or any other occurrence likely to have affected their strength or stability.
- o) Inspection should more particularly ascertain that:
 - the scaffold is of suitable type and adequate for the job.
 - materials used in its construction are sound and of sufficient strength.
 - it is of sound construction and stable.

- that the required safeguards are in position.
- p) A scaffold should not be erected, substantially altered or dismantled except by or under the supervision.
- q) Every scaffold should be maintained in good and proper condition, and every part should be kept fixed or secured so that no part can be displaced in consequence of normal use.
- r) If out-rigger scaffolding is to be used, it should be specifically designed and inspected before putting in use.

11.10.3 General Provisions for Structural Work, Laying of Reinforcement & Concreting

- a) The erection or dismantling of buildings, structures, civil engineering works, formwork, falsework and shoring should be carried out by trained workers only under the supervision of a competent person.
- b) Precautions should be taken to guard against danger to workers arising from any temporary state of weakness or instability of a structure.
- c) Formwork, falsework and shoring should be so designed, constructed and maintained that it will safely support all loads that may be imposed on it.
- d) Formwork should be so designed and erected that working platforms, means of access, bracing and means of handling and stabilising are easily fixed to the formwork structure.

11.10.4 Reinforcement

- a) Ensure that workers use Personnel Protective equipment like safety helmet, safety shoes, gloves etc.
- b) Don't place the hand below the rods for checking clear distance. Use measuring devices.
- c) Don't wear loose clothes while checking the rods.
- d) Don't stand unnecessarily on cantilever rods.
- e) To carry out welding/cutting of rods, safety procedures/precautions as mentioned in Item No. 6.5 to be followed.
- f) For supplying of rods at heights, proper staging and/or bundling to be provided.
- g) Ensure barricading and staging for supplying and fixing of rods at height.
- h) For short distance carrying of materials on shoulders, suitable pads to be provided.
- i) While transporting material by trucks/trailers, the rods shall not protrude in front of or by the sides of driver's cabin. In case such protrusion cannot be avoided behind the deck, then it should not extend 1/3rd of deck length or 1.5M whichever is less and tied with red flags / lights.

11.10.5 Concreting

- a) Ensure stability of shuttering work before allowing concreting.

- b) Barricade the concreting area while pouring at height/depths.
- c) Keep vibrator hoses, pumping concrete accessories in healthy conditions and mechanically locked.
- d) Pipelines in concrete pumping system shall not be attached to temporary structures such as scaffolds and formwork support as the forces and movements may affect their integrity.
- e) Check safety cages & guards around moving motors/parts etc. provided in concreting mixers.
- f) Use Personal Protective Equipment like gloves, safety shoes etc. while dealing with concrete and wear respirators for dealing with cement.
- g) Earthing of electrical mixers, vibrators, etc. should be done and verified.
- h) Cleaning of rotating drums of concrete mixers shall be done from outside. Lockout devices shall be provided where workers need to enter.
- i) Where concrete mixers are driven by internal combustion engine, exhaust points shall be located away from the worker's workstation so as to eliminate their exposure to obnoxious fumes.
- j) Don't allow unauthorized person to stand under the concreting area.
- k) Ensure adequate lighting arrangements for carrying out concrete work during night.
- l) Don't allow the same workers to pour concrete round the clock. Insist on shift pattern.

During pouring, shuttering and its supports should be continuously watched for defects.

11.10.6 Road Work

- a) Site shall be barricaded and provided with warning signs, including night warning lamps at appropriate locations for traffic diversion.
- b) Filled and empty bitumen drums shall be stacked separately at designated places.
- c) Mixing aggregate with bitumen shall preferably be done with the help of bitumen batch mixing plant, unless operationally non-feasible.
- d) Road rollers, Bitumen sprayers, Pavement finishers shall be driven by experienced drivers with valid driving license.
- e) Workers handling hot bitumen sprayers or spreading bitumen aggregate mix or mixing bitumen with aggregate, shall be provided with PVC hand gloves and rubber shoes with legging up to knee joints.
- f) At the end of day's work, surplus hot bitumen in tar boiler shall be properly covered by a metal sheet, to prevent anything falling in it. If bitumen accidentally falls on ground, it shall be immediately covered by sprinkling sand, to prevent anybody stepping on it. Then it shall be removed with the help of spade.

11.10.7 Cutting / Welding

Common hazards involved in welding/cutting are sparks, molten metal, flying particles, harmful light rays, electric shocks etc. Following precautions should be taken: -

- a) A dry chemical type fire extinguisher shall be made available in the work area.
- b) Adequate ventilation shall be ensured by opening manholes and fixing a shield or forced circulation of air etc, while doing a job in confined space.
- c) Ensure that only approved and well-maintained apparatus, such as torches, manifolds, regulators or pressure reducing valves, and acetylene generators, be used.
- d) All covers and panels shall be kept in place, when operating an electric Arc welding machine.
- e) The work piece should be connected directly to Power supply, and not indirectly through pipelines/structures/equipment etc.
- f) The welding receptacles shall be rated for 63 A suitable for 415V, 3-Phase system with a scraping earth. Receptacles shall have necessary mechanical interlocks and earthing facilities.
- g) All cables, including welding and ground cables, shall be checked for any worn out or cracked insulation before starting the job. Ground cable should be separate without any loose joints.
- h) Cable coiling shall be maintained at minimum level, if not avoidable.
- i) An energized electrode shall not be left unattended.
- j) The power source shall be turned off at the end of job.
- k) All gas cylinders shall be properly secured in upright position.
- l) Acetylene cylinder shall be turned and kept in such a way that the valve outlet points away from oxygen cylinder.
- m) Acetylene cylinder key for opening valve shall be kept on valve stem, while cylinder is in use, so that the acetylene cylinder could be quickly turned off in case of emergency. Use flash back arrestors to prevent back-fire in acetylene/oxygen cylinder.
- n) When not in use, valves of all cylinders shall be kept closed.
- o) All types of cylinders, whether full or empty, shall be stored at cool, dry place under shed.
- p) Forced opening of any cylinder valve should not be attempted.
- q) Lighted gas torch shall never be left unattended.
- r) Store acetylene and oxygen cylinders separately.
- s) Store full and empty cylinders separately.
- t) Avoid cylinders coming into contact with heat.
- u) Cylinders that are heavy or difficult to carry by hand may be rolled on their bottom edge but never dragged.
- v) If cylinders have to be moved, be sure that the cylinder valves are shut off.
- w) Before changing torches, shut off the gas at the pressure reducing regulators and not by crimping the hose.

- x) Do not use matches to light torches, use a friction lighter.
- y) Move out any leaking cylinder immediately.
- z) Use trolleys for oxygen & acetylene cylinder and chain them.
- aa) Always use Red hose for acetylene and other fuel gases and Black for oxygen and ensure that both are in equal length.
- bb) Ensure that hoses are free from burns, cuts and cracks and properly clamped.
- cc) Avoid dragging hoses over sharp edges and objects
- dd) Do not wrap hoses around cylinders when in use or stored.
- ee) Protect hoses from flying sparks, hot slag, and other hot objects.
- ff) Lubricants shall not be used on Ox-fuel gas equipment.
- gg) During cutting/welding, use proper type goggles/face shields.

11.10.8 Demolition / Dismantling

a) General provisions

- When the demolition of any building or structure might present danger to workers or to the public:
 - necessary precautions, methods and procedures should be adopted, including those for the disposal of waste or residue.
 - the work should be planned and undertaken only under the supervision of a competent person.

b) Before demolition operations begin:

- structural details and builders' drawings should be obtained wherever possible.
- details of the previous use should be obtained to identify any possible contamination and hazards from chemicals, flammables, etc.
- an initial survey should be carried out to identify any structural problems and risks associated with flammable substances and substances hazardous to health. The survey should note the type of ground on which the structure is erected, the condition of the roof trusses, the type of framing used in framed structures and the load-bearing walls.
- a method of demolition should be formulated after the survey and recorded in a method statement having taken all the various considerations into account and identifying the problems and their solutions.
- All electric, gas, water and steam service lines should be shut off and, as necessary, capped or otherwise controlled at or outside the construction site before work commences.
- If it is necessary to maintain any electric power, water or other services during demolition operations, they should be adequately protected against damage.

- As far as practicable, the danger zone round the building should be adequately fenced off and sign posted. To protect the public a fence 2m high should be erected enclosing the demolition operations and the access gates should be secured outside working hours.
 - The fabric of buildings contaminated with substances hazardous to health should be decontaminated. Protective clothing and respiratory devices should be provided and worn.
 - Where plant has contained flammable materials, special precautions should be taken to avoid fire and explosion.
 - The plant to be demolished should be isolated from all other plant that may contain flammable materials. Any residual flammable material in the plant should be rendered safe by cleaning, purging or the application of an inert atmosphere as appropriate.
 - Care should be taken not to demolish any parts, which would destroy the stability of other parts.
 - Demolition activities should not be continued under adverse climatic conditions such as high winds, which could cause the collapse of already weakened structures.
 - To prevent hazards parts of structures should be adequately shored, braced or otherwise supported.
 - Structures should not be left in a condition in which they could be brought down by wind pressure or vibration.
 - Where a deliberate controlled collapse technique is to be used, expert engineering advice should be obtained, and:
 - it should only be used where the whole structure is to come down because it relies on the removal of key structural members to affect a total collapse;
 - it should only be used on sites that are fairly level and where there is enough surrounding space for all operatives and equipment to be withdrawn to a safe distance.
 - When equipment such as power shovels and bulldozers are used for demolition, due consideration should be given to the nature of the building or structure, its dimensions, as well as to the power of the equipment being used.
 - If a swinging weight is used for demolition, a safety zone having a width of at least one and- a-half times the height of the building or structure should be maintained around the points of impact.
- c) Demolition of brick / stone masonry, structural steel & concrete works
- Dismantling of portion of brick / stone masonry of existing structures at each crossing location should be carried out properly using appropriate tools and equipments so that there should be any impact on safety & stability of existing structures.

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- All precautions should be taken to prevent danger from any sudden twist, spring or collapse of steelwork, ironwork or reinforced concrete when it is cut or released.
- Steel construction should be demolished tier by tier.
- Structural steel parts should be lowered and not dropped from a height.

11.10.9 References

- a) Factory Act, 1948
- b) Indian Electricity Rules
- c) Safety & Health in Construction by ILO
- d) The Building & Other Construction Workers (Regulation, Employment and Conditions of Service) Act 1996

12. QUALITY ASSURANCE PLAN

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

Based on the guidelines mentioned in this clause, Contractor to provide detailed QAP for approval of OWNER/PMC.

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

For crushing strength of concrete, it is recommended that the contractor arrange the compression testing machine at the site along with the calibration certificate for gauge. In case, if any of the machine comes to repairs and tests could not be carried out at the site, contractor shall arrange to transport the material to an approved laboratory to carry out the tests. All transports and labour costs also are to be borne by contractor.

The Tests listed in QAP are minimum requirement. Contractor shall provide a field quality assurance plan with formats for record of test results for all the works considering requirements of this specification and other relevant specification document/IS Codes. Field Quality Plan approved by OWNER/PMC shall be followed for all the works under scope of the tender. Cost of all tests shall be borne by the Contractor.

All tests shall be recorded in forms acceptable to the Engineer-In-Charge.



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The contractor shall submit work procedure documents (step to step works activity) for each work and get it approved from OWNER/PMC prior to start any work. All work shall be carried out in sequential manner based on approved work procedure documents.

1: Executed By: Contractor		P: Perform	H: Hold Point	MRIE: Material Receiving Inspection Report		W.O. NO.: Date:					
2: By PMC		W: Witness	RM/S: Random/ Surveillance	WPS: Welding Procedure Specification		TS: Technical Specification					
3: By OWNER		R: Review of Report	Drg: Drawing	PQR: Procedure Qualification Record		WQT: Welder Qualification Test					
Sl. No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
1	Material for Civil Foundation (PVC Pipes, Pipe Fittings, Cement, Aggregates Water, Structural steel, Reinforcement steel etc.)	Visual, Dimensional, Marking verification and Review of MTC	Visual & Verification	100%	P.O. Approved drawings / TS	Applicable material Spec. / Manufacturer TC	Raw Material Inspection Report	P	R	R	
1a)	Cement	Visual Inspection, Compressive Strength, Initial & Final Setting Time, Soundness, Fineness, Chemical Composition, Visual Storage Inspection	Submission of Manufacturers TC for each batch	100%	P.O. Approved drawings / TS	IS 269 / 8112 / 12269 / IS 1489 / IS 455	Batch TC	P	R	R	
1b)	Coarse Aggregates	Visual Inspection, Flakiness, Index, Sieve Analysis, Crushing Value Abrasion Value, Water Absorption, Soundness, Deleterious Materials, Specific Gravity	At the start of work & thereafter for every change of source, before mix design.	100%	As per Tech. Spec. IS 383, IS 2386, IS 2340 & Tech Spec.	As per Tech. Spec. IS 383, IS 2386, IS 2340 & Tech Spec.	Test Report	P	R	R	
1c)	Fine Aggregates	Sieve Analysis, Bulking of sand, Silt Content, Bulk Density Specific Gravity	Visual & Verification	Minimum twice a week / 40 M ³ per source	IS 383, IS 2386, IS 2340 & Tech Spec.	IS 383, IS 2386, IS 2340 & Tech Spec.	Test Report	P	R	R	
1d)	Water	Visual Inspection, Tet for presence of Acid, Alkali, Organic materials / salts, etc. & PH volume	Visual & Verification	Once in a month	IS CODE & TS	Limit No.: Less than 6	Test Report	P	R	R	PH value of water shall be within range of 6.5 to 9
1e)	Reinforcement Steel	Visual, Dimensional, Marking verification and review of MTC	Visual & Verification	100%	P.O. Approved drawings / TS and IS 1786	Applicable material Spec / Manufacturer TC	Raw Material Inspection Report	P	R	R	

1: Executed By: Contractor		P: Perform	H: Hold Point	MRIE: Material Receiving Inspection Report	W.O. NO.: Date:						
2: By PMC		W: Witness	RM/S: Random/ Surveillance	WPS: Welding Procedure Specification	TS: Technical Specification						
3: By OWNER		R: Review of Report	Drg: Drawing	PQR: Procedure Qualification Record	WQT: Welder Qualification Test						
Sl. No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
1f)	Laterite	Visual Inspection Compressive strength & physical dimensions Scaffolding Size of stone	Visual & Verification	100%	P.O. Approved drawings / TS and IS 1786	Applicable material Spec / Manufacturer TC	Raw Material Inspection Report				
1g)	Structural Steel	Visual, Dimensional, Marking verification and Review of MTC	Visual & Verification	100%	P.O. Approved drawings / TS and IS 1786	Applicable material Spec / Manufacturer TC	Raw Material Inspection Report	P	R	R	
2	Earth work										
2a)	Earth Work (Excavation)	Check Layout, pre & post level, dimension & depth, Side slope & other safety consideration	Visual, Dimensional	100%	As per site condition Tech. Spec / IS 3764	Approved Drawing, IS CODE & TS	-	P	W	R	
2b)	Earth Work (Filling)	Edge preparation, Optimum Moisture content, laboratory dry density, max. & min. dry density (for sand), Field dry density / compaction factor / relative density.	Visual, Dimensional	100%	Tech. Spec. / IS 2720	Approved Drawing, IS CODE & TS	Test Report	P	W	R	
3	Form Work										
3a)	Material	Visual, verification and review of MTC	Visual & Verification	100%	PO., Approved Drg / TS	Applicable material Spec / Manufacturer TC	Raw Material Inspection Report	P	R	R	
3b)	Staging	Visual Inspection, Vertical of Props, Fixity of Props & bracing, Bearing area under props, Fixity of nails clamps, Bolts.	Visual & Verification	100%	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/Drawing	-	P	W	R	
3c)	Shuttering	Visual Inspection for	Visual, Dimensional	100%	Appd.	Appd. Procedure, TS/	Pour Card	P	R	R	

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Sl. No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		alignment, Verticality & Fixity of support, Level checking			Procedure, TS/ Drawing	Drawing					
3d)	De-Shuttering	Stripping time for bottom & side	Visual	100%	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/ Drawing	Pour Card	P	R	R	
4	Reinforcement Work										
4a)	Bar Bending	Visual Inspection Prepare & Check for Bending Schedule Linearity, shape, size & no. of Bars	Visual, Dimensional	100%	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/ Drawing	Bar Bending Schedule	p	W	R	
4b)	Bar Fixing	Size & Mix of cover block Location & no. of Bars Typing of Bars, Lapping	Visual, Dimensional	100%	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/ Drawing	Bar Bending Schedule	p	W	R	
5	Concrete Work										
5a)	Concrete Work (Other than Ready Mix)	Design Mix, Inspection of Ingredients	For each grade of mx initially from approved engineering college & thereafter trial mixes at site for any change in condition and aggregate source	100%	IS 10262 / IS 456 / Tech. Spec.	Appd. Procedure, TS/ Drawing	Test Report	p	W	R	
5b)	Concrete Work Ready Mix	Design Mix, Quality of Ingredients	Submission of manufactures Mix Design & TC for each grade of Mix Submission of manufacturers Tests Reports	100%	IS 10262 / IS 456 / Tech. Spec.	Appd. Procedure, TS/ Drawing	Mix Design Report	p	W	R	



**CABLE TRENCH CONSTRUCTION PACKAGE FOR MRPL
AROMATIC COMPLEX POWER SYSTEM UPGRADATION
PROJECT**



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Sl. No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
5c)	During Concreting	Scaffolding for walkway Calibration of Weigh Batcher/ batching plant Batching of materials Slump Cone Tests Compaction Compressive strength test sample Level Checking Construction Joint, Specific gravity	Visual & Verification	100%	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing	Cube Register / Pour card / Sketch, Calibration Certificate	p	W	R	
5d)	Pot Concreting	Visual Inspection after De- Shuttering Calibration of cube testing machine (Pressure Gauge), Strength test	Visual & Verification	100%	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing	Cube Test Report	p	W	R	
6	Excavation										
6a)	Excavation in Soil	Check layout, spot level	visual, Dimensional	100%	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing	Level Records	P	S	R	
6b)	Filling in Soil	Visual inspection of filling materials Lab dry density OMC Grain size analysis / after berg limits, plasticity index and dry density Field dry density	visual, Dimensional	100%	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing	Test Report	P	S	R	
7	Masonry										
7a)	R R Masonry	Visual Inspection of stones Wetting of stones Cement mortar proportion Staging /	visual, Dimensional	100%	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing		P	R m	R	

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								1	2	3	
		Scaffolding Bond stones, quoins Thickness of Joints Plumb, line and level Raking out Joints, Curing									
7b)	Brick Masonry	Minimum average compressive strength	Tested in accordance with IS 3495	Samples of each type of brick as per IS 5454; not less than 1 in 5,000	IS 3495 (Part 1) IS 5454	As given in the code IS 3495 for a particular class of work	Test report	P	R m	R	
		Water absorption		Samples of each type of brick as per IS 5454; not less than 1 in 5,000	IS 3495 (Part 2)	Shall not be more than 20% by its dry weight for class 5 brick when soaked in cold water for 24 hours. Refer code for other class.	Test report	P	R m	R	
8	Pointing										
	Pointing	Raking & Cleaning, Washing of Joints, Cement Mortar Proportion Curing	Visual	100%	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing		P	R m	R	
9	Sub-Base (WMM / WBM)										
9a	Coarse aggregates	Loss Angles, abrasion value or aggregate Impact value, Flakiness index. Grading requirement	Lab Field	Per 200 m3 Per 100 m3	IS2386 Spec	IS2386 Spec	Test report	P	R	R	
9b	Fine Aggregate	Deleterious Materials	Lab	As per EIC	IS2386 Spec	IS2386 Spec	Test report	P	R	R	

LEGEND: -

Hold: Do not proceed till inspectors clear the item / activities, H - HOLD

Witness: Intimation for inspection request to be given to inspector, wait for 24 hours or written clearance from inspector, whichever is earlier, (W-Witness)



**CABLE TRENCH CONSTRUCTION PACKAGE FOR MRPL
AROMATIC COMPLEX POWER SYSTEM UPGRADATION
PROJECT**

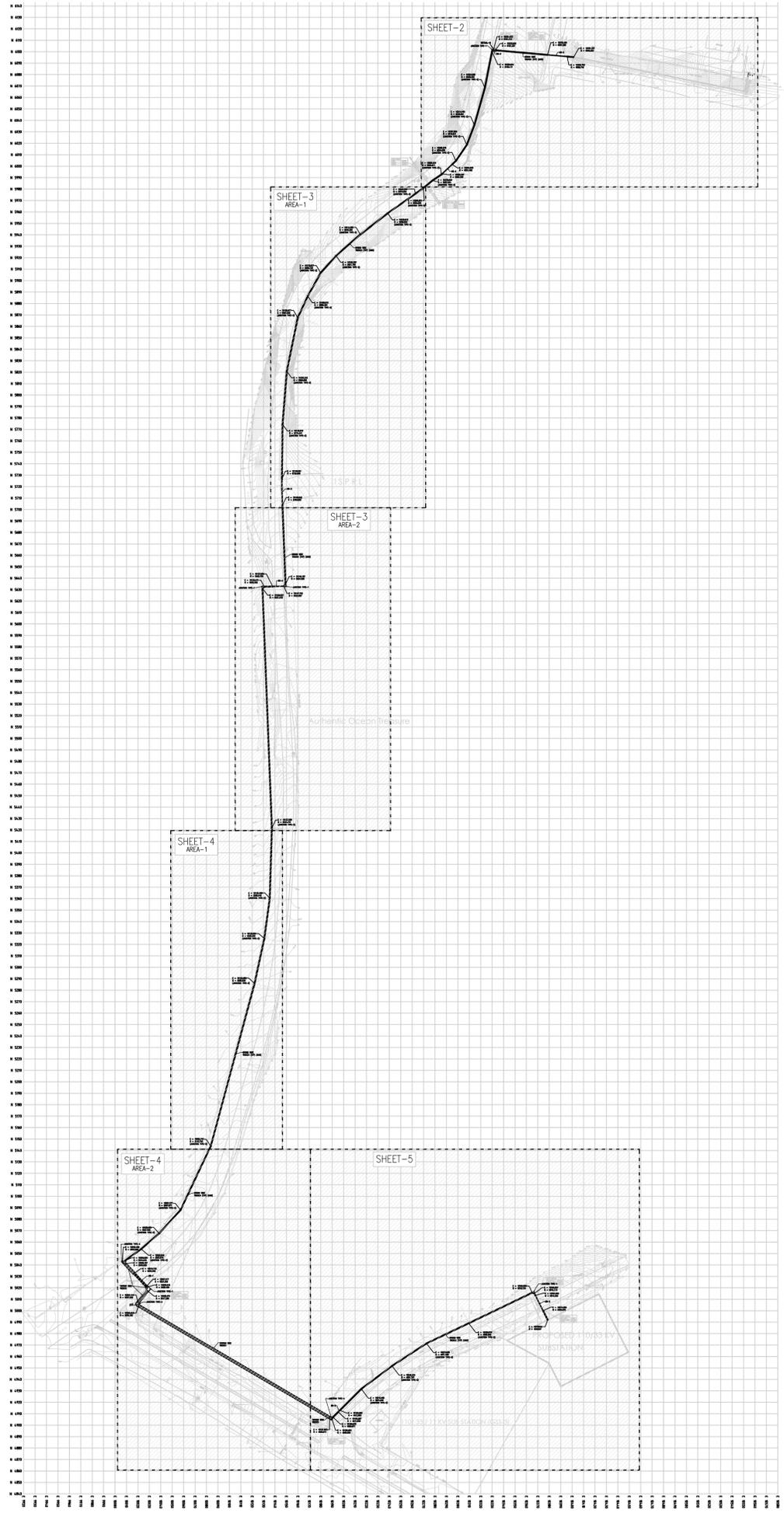


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								1	2	3	
Review: Job can be performed, Inspector to review relevant records (R-Review) Inspection of bought out items at sub vendor's works shall be carried out by TPL as per approved QA plan for bought out items. R/W - Review or Witness, Rm - Random witness, A- Approval. Note: The Tests listed in QAP are minimum requirement. Contractor shall provide a field quality assurance plan with formats for record of test results for all the works considering requirements of this specification and other relevant specification document/IS Codes. Field Quality Plan approved by OWNER/PMC shall be followed for all the works under scope of the tender. Cost of all tests shall be borne by the Contractor. All tests shall be recorded in forms acceptable to the Engineer-in-charge.											

	CABLE TRENCH CONSTRUCTION PACKAGE FOR MRPL AROMATIC COMPLEX POWER SYSTEM UPGRADATION PROJECT	
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13. LIST OF ATTACHMENT

No.	Description
Attachment-C1	Structural Details for Outdoor Cable Trench Between 110/33 kV SS-10 & SS-01A of Aromatic Complex Power System Upgradation Work Tractebel Dwg. No. P.020678-M-46057-C001



OVERALL LAYOUT

NOTES

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. ALL RCC WORK SHALL BE M30 GRADE & REINFORCEMENT STEEL GRADE SHALL BE FE500D (HYSD BARS) UNO.
3. CLEAR COVER TO REINFORCEMENT SHALL BE AS FOLLOWS:
SIDE WALL = 40MM
BASE SLAB = 40MM
COVER SLAB=15MM
4. GRADE OF STRUCTURAL STEEL FOR CHANNELS, ANGLES, LUGS ETC. SHALL BE GRADE A (E250A) CONFIRMING TO IS:20624.
5. BENDING & FIXING OF REINFORCEMENT STEEL SHALL BE AS PER IS:2502.
6. NO DIMENSIONS FROM THIS DRAWING SHALL BE MEASURED/SCALED OFF AND ONLY MARKED DIMENSIONS SHALL BE FOLLOWED.
7. CHECK ALL DIMENSIONS, CO-ORDINATES & ELEVATIONS CAREFULLY, REPORT ANY DISCREPANCIES, CONFLICTS / ERROR IMMEDIATELY FOR CLARIFICATION PRIOR TO COMMENCING CONSTRUCTION WORK AT SITE.
8. ANY SOFT PATCH IF ENCOUNTERED AT FOUNDATION LEVEL SHALL BE COMPLETELY REMOVED AND REPLACED WITH PCC (1:5:10) UPTO FIRM STRATA.
9. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH RELEVANT TECHNICAL DOCUMENTS/SPECIFICATIONS & REFERENCE DRAWINGS.
10. IF ANY EXISTING UNDERGROUND UTILITIES ARE ENCOUNTERED OTHER THAN TRENCH CROSSING LOCATIONS, TRENCH ROUTING /ALIGNMENT SHALL BE SUITABLY REROUTED AS PER THE SITE CONDITION.
11. THE DETAILS OF DRAIN, BITUMINOUS ROAD AND BOUNDARY WALL SHOWN IN THE DRAWING AS PER STANDARD AND FOR REFERENCE ONLY. THE RE-CONSTRUCTION WORK AFTER DISMANTLING ANY EXISTING STRUCTURE/FACILITY, IF REQUIRED SHALL BE MATCHED WITH THE PREVIOUS CONDITION

LEGEND

- CABLE TRENCH
- DUCT BANK
- R.C.C. REINFORCEMENT CEMENT CONCRETE
- P.C.C. PORTLAND CEMENT CONCRETE
- C/C CENTER TO CENTER
- THK THICK
- TYP TYPICAL
- UNO UNLESS NOTED OTHERWISE
- FGL FINISHED GROUND LEVEL
- Ø DIAMETER
- ℄ CENTERLINE

REFERENCE DRAWINGS

DRAWING TITLE	DRAWING NO.
TOPOGRAPHICAL SURVEY DRAWING FOR ELECTRICAL CABLE TRENCH CONSTRUCTION BETWEEN 110/33 KV SS-10 AND SS-01A IN AROMATIC COMPLEX (BY GEO PRECISE)	xxxx-x-xx-xxx-xxx
OUTDOOR CABLE ROUTING LAYOUT BETWEEN 110/33 KV SS-10 & SS-01A OF AROMEATIC COMPLEX POWER SYSTEM UPGRADATION WORK	P.020678-M-46057-C001

Rev.	D	M	Y	Modifications	Drawn	Checked	Validated	Approved
A	13/01/2023	ISSUED FOR APPROVAL			DHK	DKY	AKS	SSB

LOA NO. : 7420000125 Dated 01.10.2022 SAP PO number:

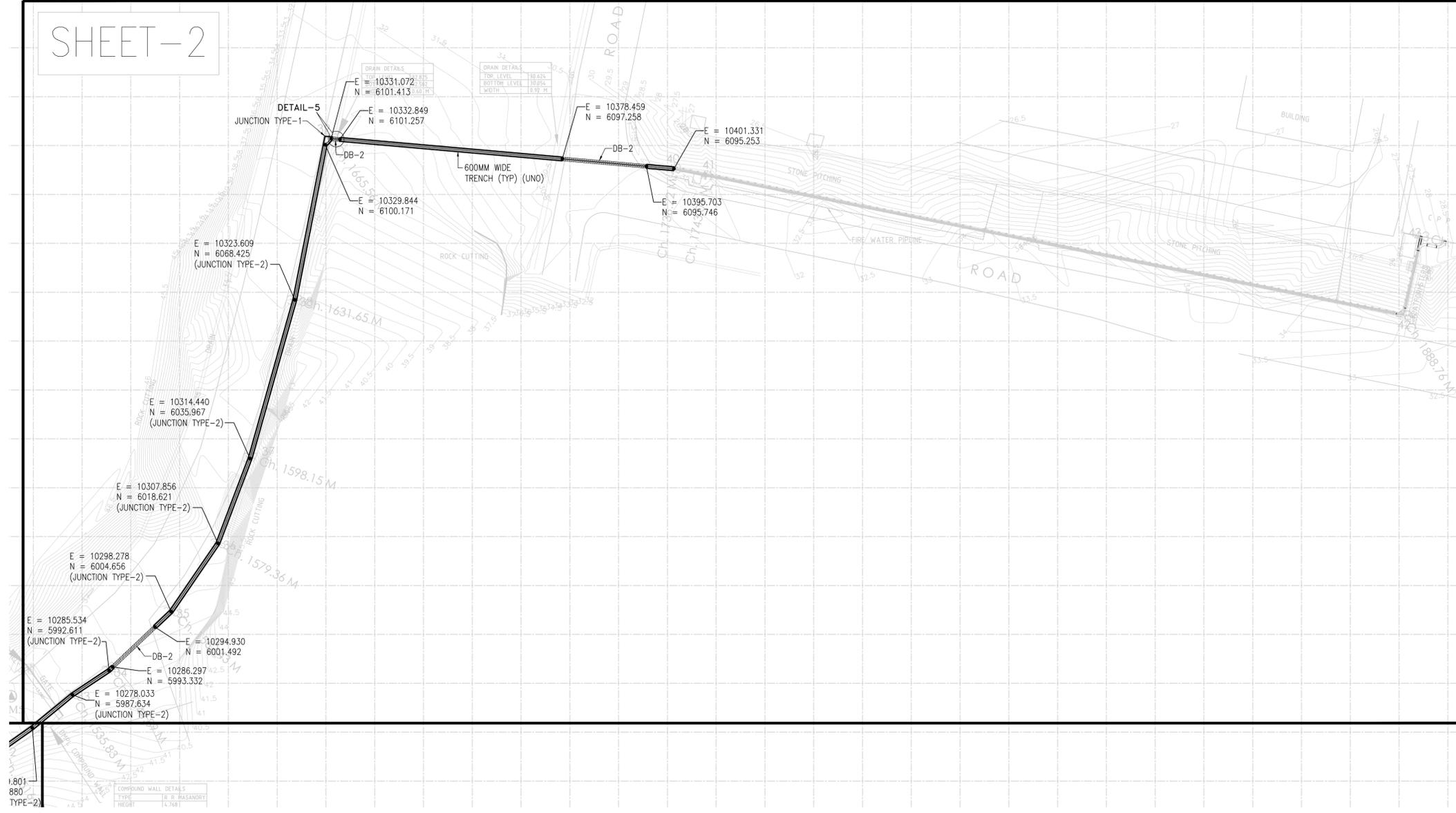
OWNER / CLIENT **ONGC MANGALORE REFINERY & PETROCHEMICALS LTD.**
(A subsidiary of Oil & Natural Gas Corp. Ltd - ONGC)
Regd. Office: Kuthethoor P.O., Via: Katipalla, Mangalore-575030 (India)
Phone: 0091-824-2270400 Fax: 0091-824-2271239

PROJECT **POWER SYSTEM UPGRADATION PROJECT AT MRPL AROMATIC COMPLEX, MANGALORE**

SUBJECT **STRUCTURAL DETAILS FOR OUTDOOR CABLE TRENCH BETWEEN 110/33 KV SS-10 & SS-01A OF AROMATIC COMPLEX POWER SYSTEM UPGRADATION WORK**

	Size	Scale	Sheet	Rev.
	A1	1:2500	1 OF 7	A
	Project No.	Discipline Code	System Code	Serial No.
	P.020678	M	46057	C001

SHEET-2



NOTES

1. FOR NOTES, LEGENDS & REFERENCE DRAWINGS, REFER SHEET 1 OF THIS DRAWING.

LEGEND

REFERENCE DRAWINGS

DRAWING TITLE	DRAWING NO.

Rev.	A	13/01/2023	ISSUED FOR APPROVAL	DHK	DKY	AKS	SSB	
	D	M	Y	Modifications	Drawn	Checked	Validated	Approved

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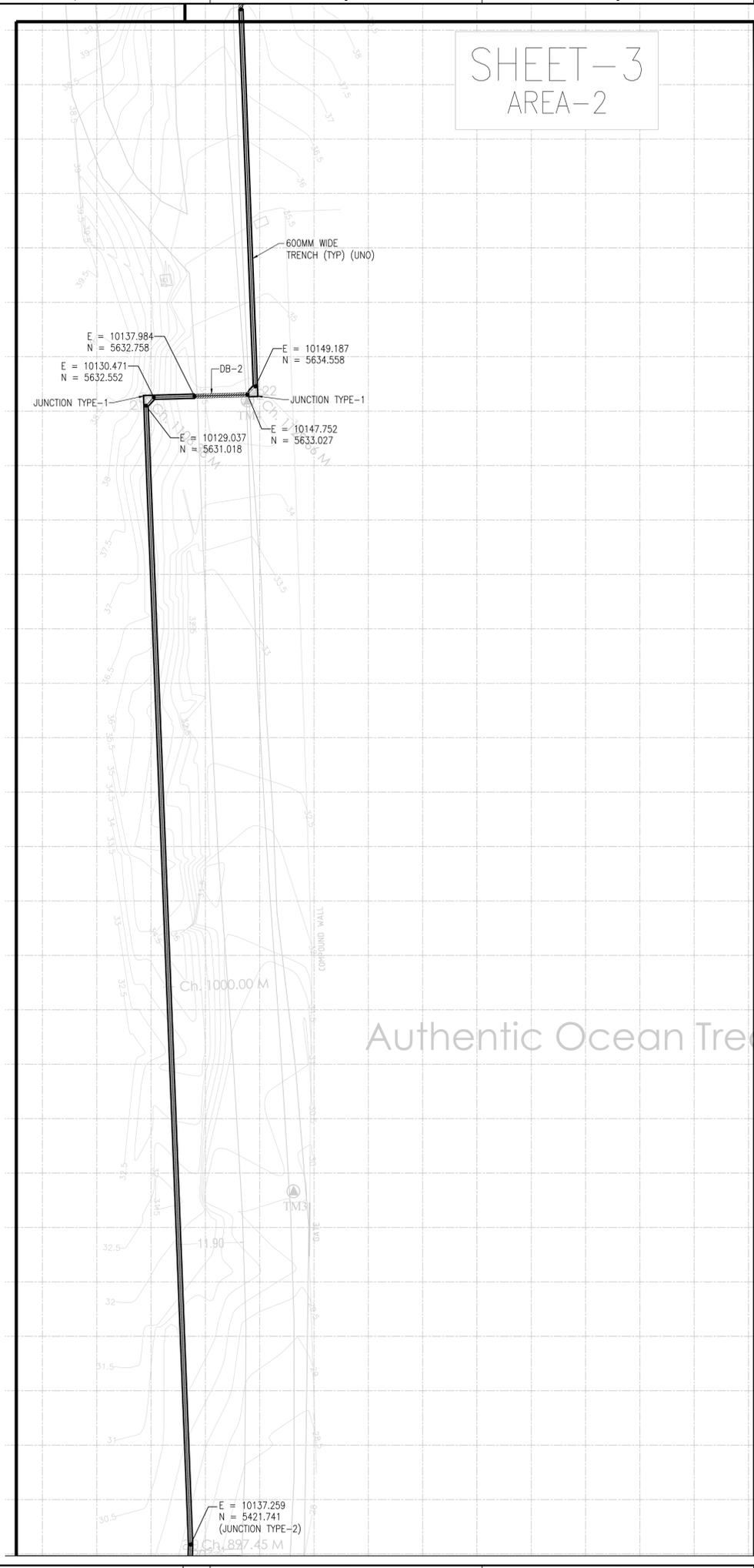
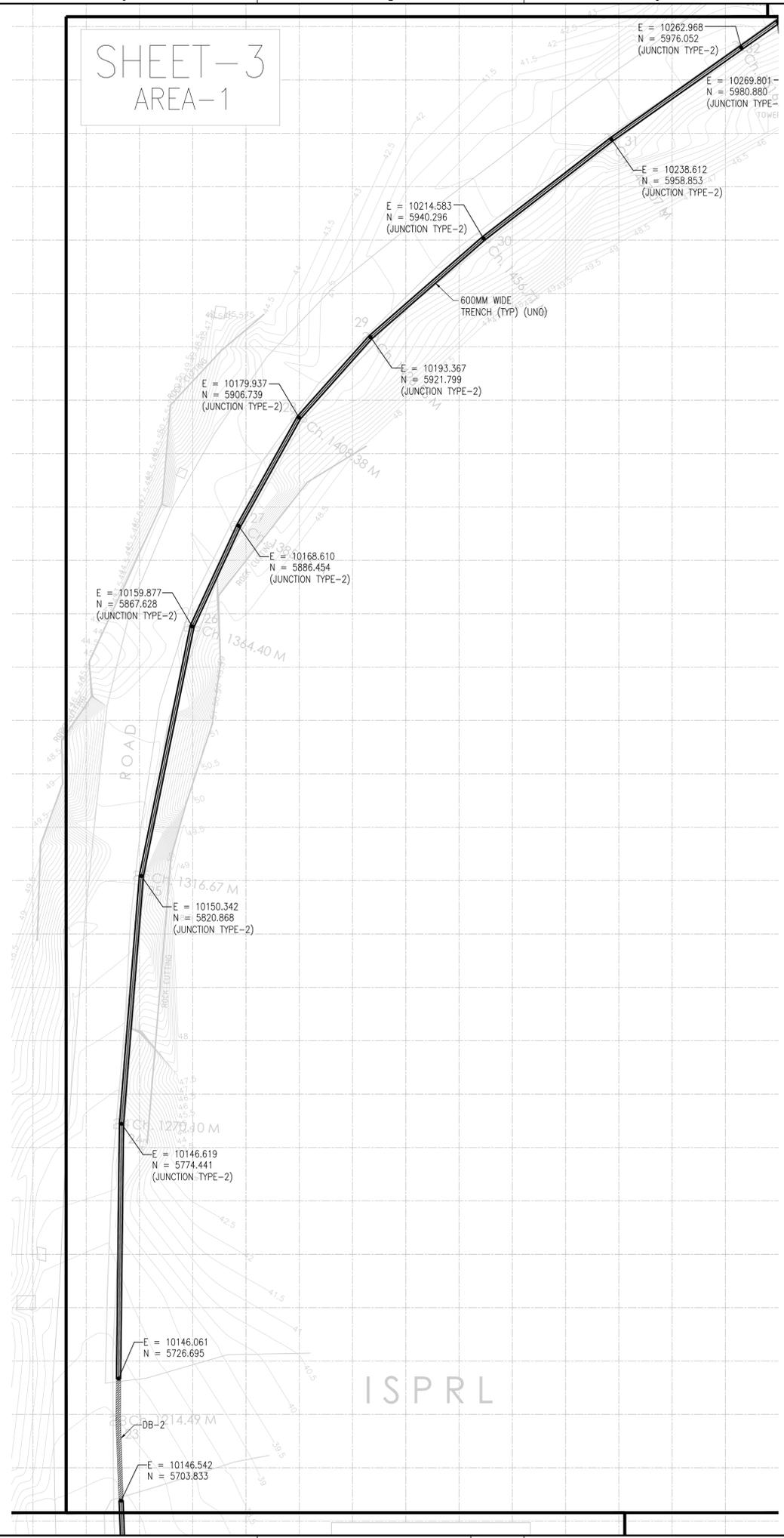
PROJECT: POWER SYSTEM UPGRADATION PROJECT AT MRPL AROMATIC COMPLEX, MANGALORE

SUBJECT: STRUCTURAL DETAILS FOR OUTDOOR CABLE TRENCH BETWEEN 110/33 KV SS-10 & SS-01A OF AROMATIC COMPLEX POWER SYSTEM UPGRADATION WORK

	Size	Scale	Sheet	Rev.
	A1	1:500	2 OF 7	A
Project No. P.020678		Discipline Code M	System Code 46057	Serial No. C001
TRACTEBEL Engineering pvt. ltd.				

SHEET-3
AREA-1

SHEET-3
AREA-2



NOTES

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LEGEND

REFERENCE DRAWINGS

DRAWING TITLE	DRAWING NO.

Rev.	D	M	Y	Modifications	Drawn	Checked	Validated	Approved
A	13/01/2023			ISSUED FOR APPROVAL	DHK	DKY	AKS	SSB

LOA NO. : 7420000125 Dated 01.10.2022 SAP PO number:

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PROJECT: POWER SYSTEM UPGRADATION PROJECT AT MRPL AROMATIC COMPLEX, MANGALORE

SUBJECT: STRUCTURAL DETAILS FOR OUTDOOR CABLE TRENCH BETWEEN 110/33 KV SS-10 & SS-01A OF AROMATIC COMPLEX POWER SYSTEM UPGRADATION WORK

  TRACTEBEL Engineering pvt. ltd.	Size	Scale	Sheet	Rev.
	A1	1:500	3 OF 7	A
Project No.	Discipline Code	System Code	Serial No.	
P.020678	M	46057	C001	

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SHEET-4
AREA-1

SHEET-4
AREA-2

NOTES

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LEGEND

REFERENCE DRAWINGS

DRAWING TITLE	DRAWING NO.

LOA NO. : 742000125 Dated 01.10.2022	SAP PO number:
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OWNER / CLIENT  **MANGALORE REFINERY & PETROCHEMICALS LTD.**
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PROJECT **POWER SYSTEM UPGRADATION PROJECT AT MRPL AROMATIC COMPLEX, MANGALORE**

SUBJECT **STRUCTURAL DETAILS FOR OUTDOOR CABLE TRENCH BETWEEN 110/33 KV SS-10 & SS-01A OF AROMATIC COMPLEX POWER SYSTEM UPGRADATION WORK**

	Size	Scale	Sheet	Rev.
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TRACTEBEL Engineering pvt. ltd.		Project No. P.020678	Discipline Code M	System Code 46057
				Serial No. C001

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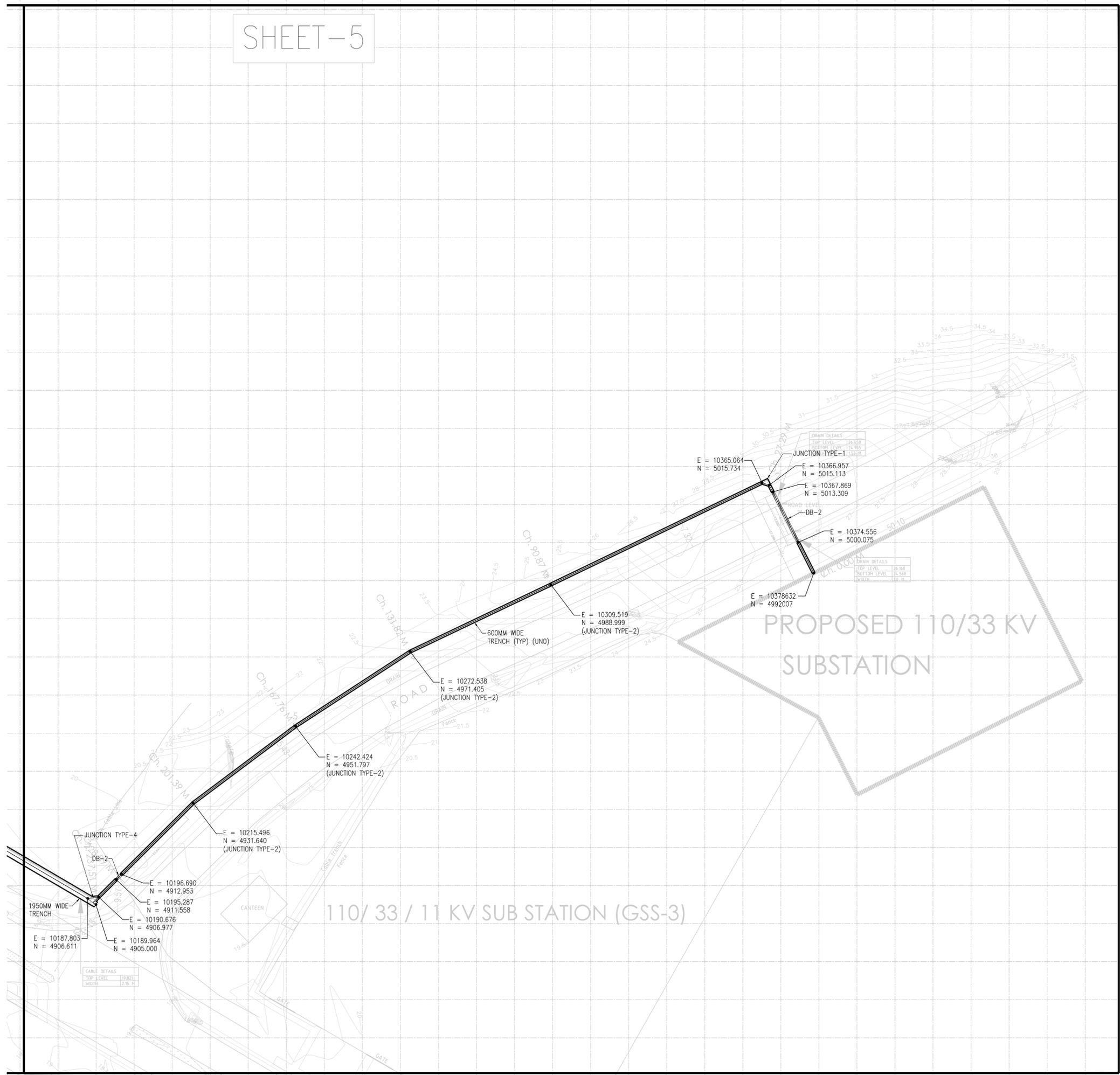
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SHEET-5



NOTES

- FOR NOTES, LEGENDS & REFERENCE DRAWINGS, REFER SHEET 1 OF THIS DRAWING.

LEGEND

REFERENCE DRAWINGS

DRAWING TITLE	DRAWING NO.

Rev.	D	M	Y	Modifications	Drawn	Checked	Validated	Approved
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LOA NO. : 7420000125 Dated 01.10.2022 SAP PO number:

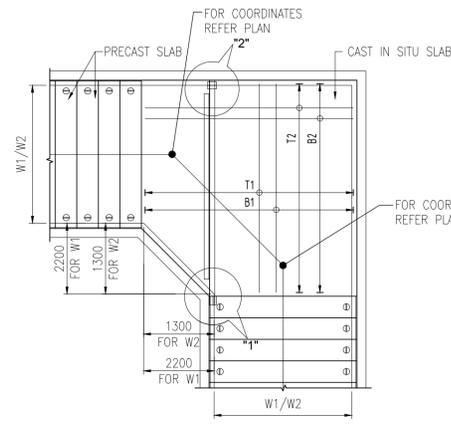
OWNER / CLIENT: **MANGALORE REFINERY & PETROCHEMICALS LTD.**
 (A subsidiary of Oil & Natural Gas Corp. Ltd - ONGC)
 Regd. Office: Kuthethoor P.O., Via: Katipalla, Mangalore-575030 (India)
 Phone: 0091-824-2270400 Fax: 0091-824-2271239

PROJECT: POWER SYSTEM UPGRADATION PROJECT AT MRPL AROMATIC COMPLEX, MANGALORE

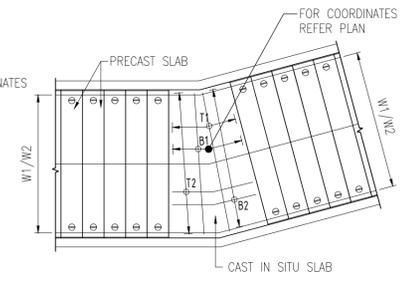
SUBJECT: STRUCTURAL DETAILS FOR OUTDOOR CABLE TRENCH BETWEEN 110/33 KV SS-10 & SS-01A OF AROMATIC COMPLEX POWER SYSTEM UPGRADATION WORK

TRACTEBEL **TRACTEBEL Engineering pvt. ltd.**

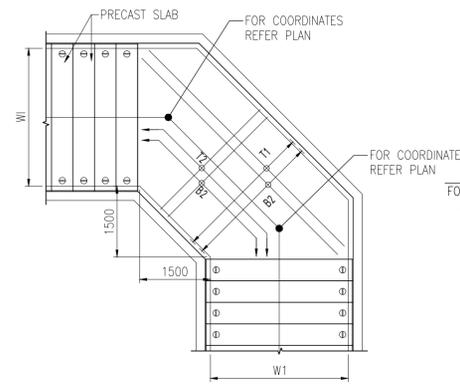
Size	Scale	Sheet	Rev.
A1	1:500	5 OF 7	A
Project No.	Discipline Code	System Code	Serial No.
P.020678	M	46057	C001



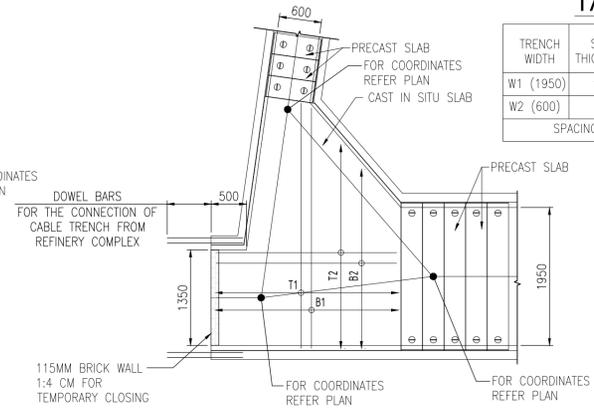
JUNCTION TYPE-1
(FOR REINFORCEMENT DETAILS REFER TABLE-1)
SCALE 1:50



JUNCTION TYPE-2
(FOR REINFORCEMENT DETAILS REFER TABLE-1)
SCALE 1:50



JUNCTION TYPE-3
(FOR OTHER DIMENSIONS AND REINFORCEMENT REFER TABLE-1)
SCALE 1:50

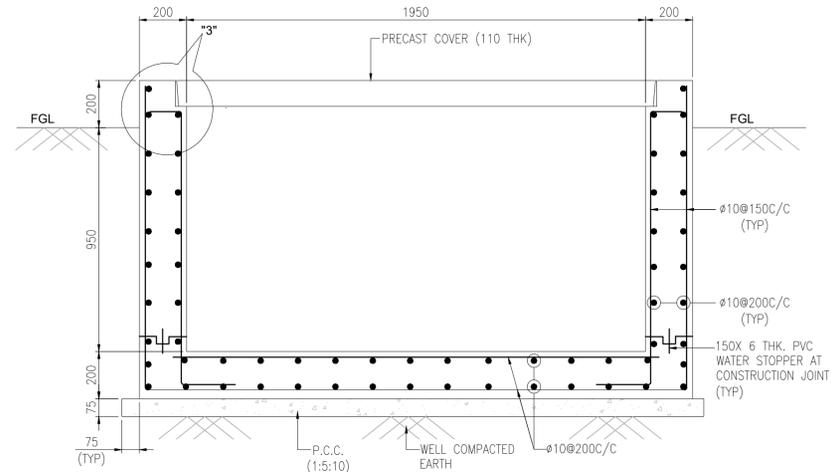


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(FOR REINFORCEMENT DETAILS REFER TABLE-1)
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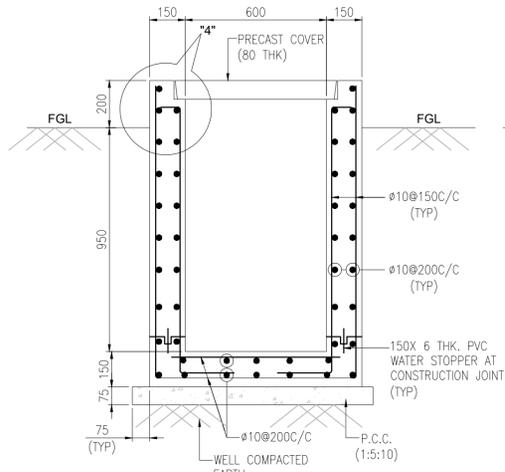
TABLE-1

TRENCH WIDTH	SLAB THICKNESS	REINFORCEMENT			
		T1	T2	B1	B2
W1 (1950)	110	φ10	φ10	φ10	φ10
W2 (600)	80	φ10	φ10	φ10	φ10

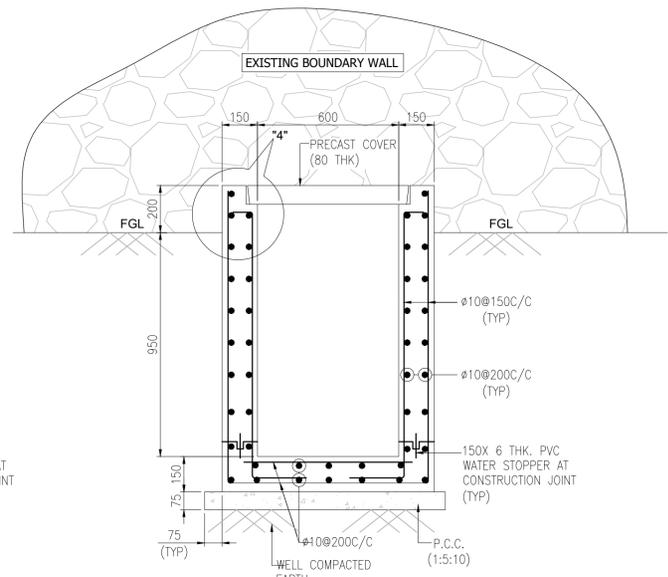
SPACING SHALL BE @ 150C/C



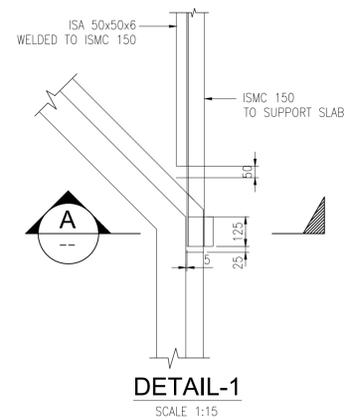
TYPICAL R.C.C. DETAIL OF CABLE TRENCH 1950 WIDE
SCALE 1:15



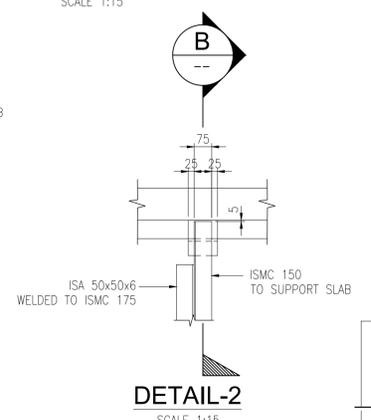
TYPICAL R.C.C. DETAIL OF CABLE TRENCH 600 WIDE
SCALE 1:15



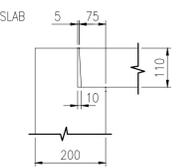
TYPICAL R.C.C. DETAIL OF CABLE TRENCH AT BOUNDARY WALL CROSSING LOCATION
SCALE 1:15



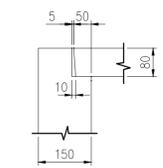
DETAIL-1
SCALE 1:15



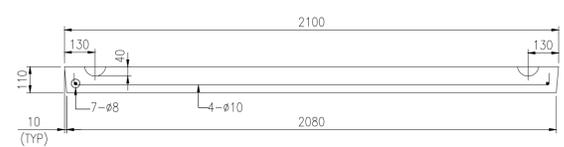
DETAIL-2
SCALE 1:15



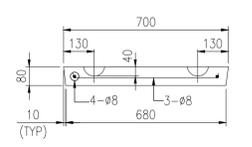
DETAIL-3
SCALE 1:10



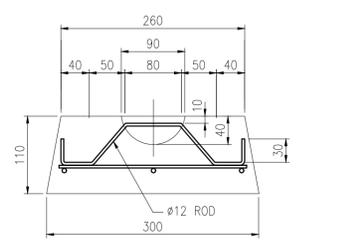
DETAIL-4
SCALE 1:10



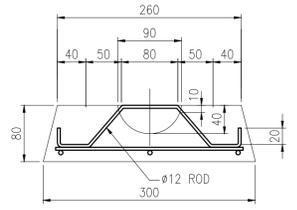
DETAIL OF PRECAST COVER FOR 110 THK



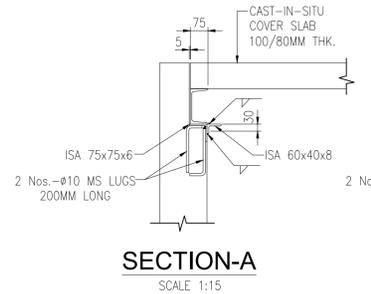
DETAIL OF PRECAST COVER FOR 80 THK



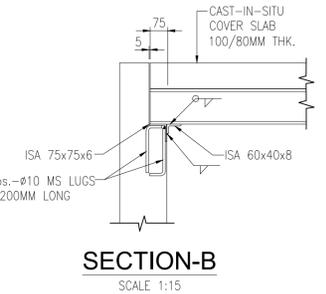
DETAIL OF LIFTING HOOK FOR 110 THK PRECAST COVER
SCALE 1:5



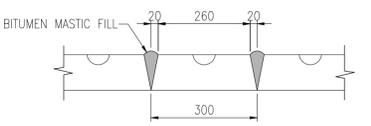
DETAIL OF LIFTING HOOK FOR 80 THK PRECAST COVER
SCALE 1:5



SECTION-A
SCALE 1:15



SECTION-B
SCALE 1:15



JOINING DETAIL OF PRECAST COVER SLAB
SCALE 1:10

NOTES

1. FOR NOTES, LEGENDS & REFERENCE DRAWINGS, REFER SHEET 1 OF THIS DRAWING.

LEGEND

REFERENCE DRAWINGS

DRAWING TITLE	DRAWING NO.

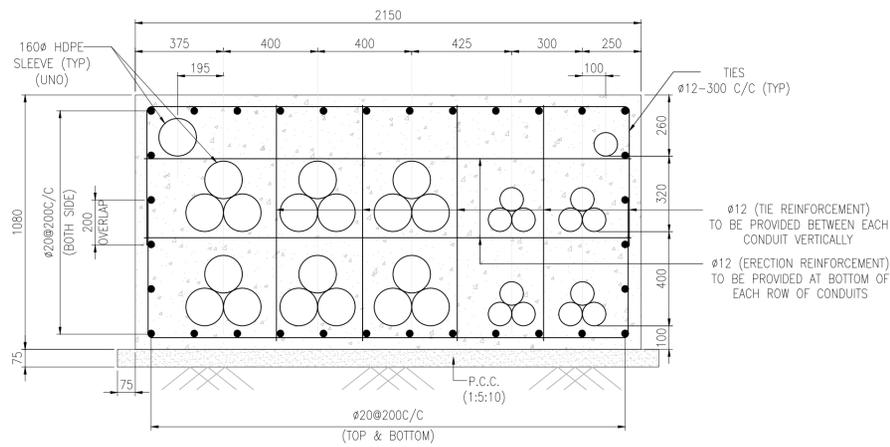
LOA NO. : 7420000125 Dated 01.10.2022	SAP PO number:
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OWNER / CLIENT
ONGC MANGALORE REFINERY & PETROCHEMICALS LTD.
(A subsidiary of Oil & Natural Gas Corp. Ltd - ONGC)
Regd. Office: Kuthethoor P.O., Via: Katipalla, Mangalore-575030 (India)
Phone: 0091-824-2270400 Fax: 0091-824-2271239

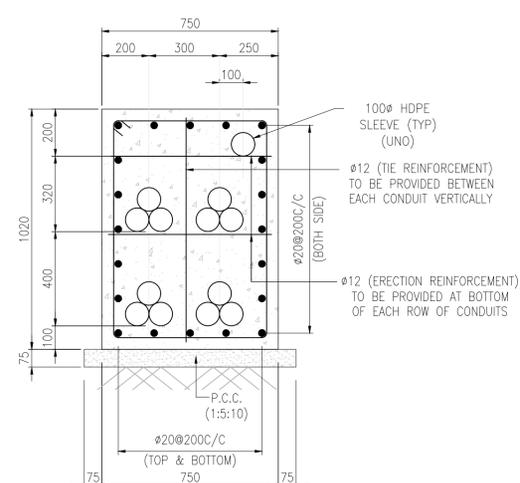
PROJECT
POWER SYSTEM UPGADATION PROJECT AT MRPL AROMATIC COMPLEX, MANGALORE

SUBJECT
STRUCTURAL DETAILS FOR OUTDOOR CABLE TRENCH BETWEEN 110/33 KV SS-10 & SS-01A OF AROMATIC COMPLEX POWER SYSTEM UPGADATION WORK

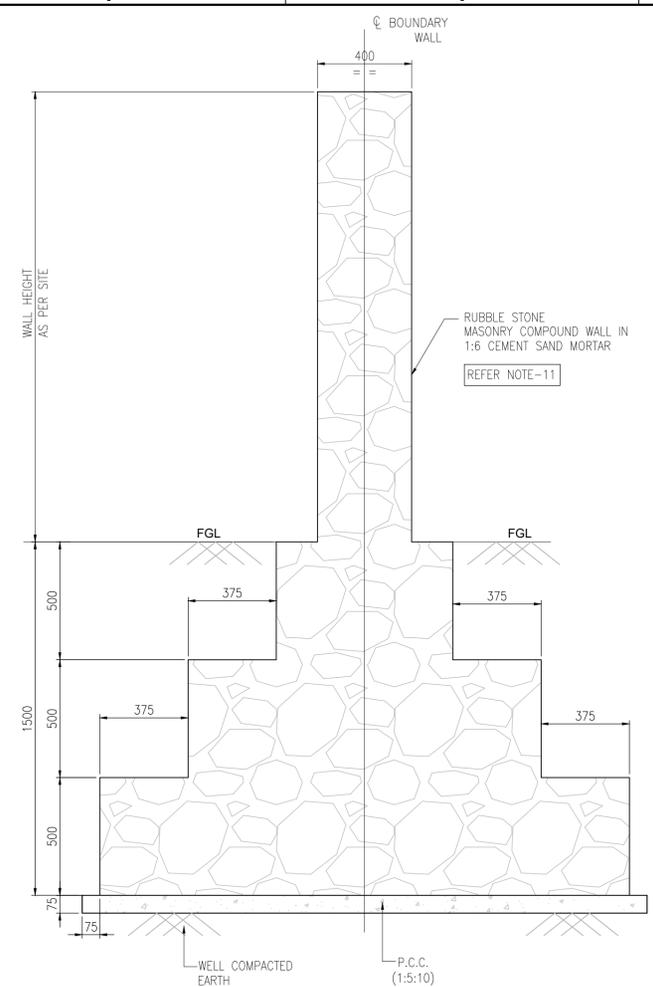
TRACTEBEL	Size	Scale	Sheet	Rev.
TRACTEBEL Engineering pvt. ltd.	A1	AS SHOWN	6 OF 7	A
	Project No.	Discipline Code	System Code	Serial No.
	P.020678	M	46057	C001



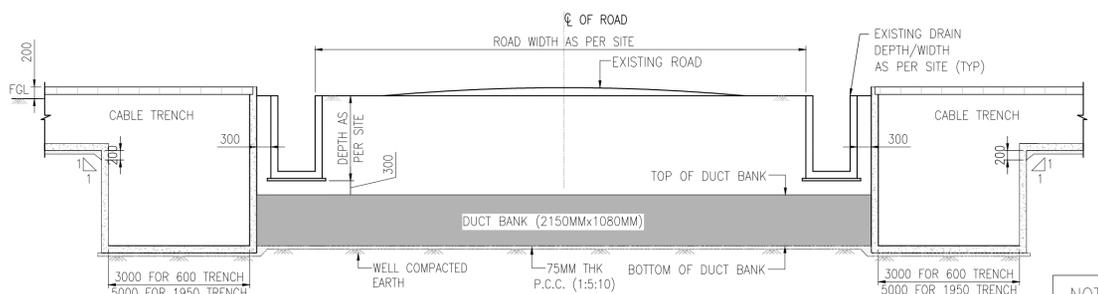
**TYPICAL DETAIL OF DUCT BANK DB-1
(2150MMx1080MM)**
SCALE 1:15



**TYPICAL DETAIL OF DUCT BANK DB-2
(750X1020MM)**
SCALE 1:15



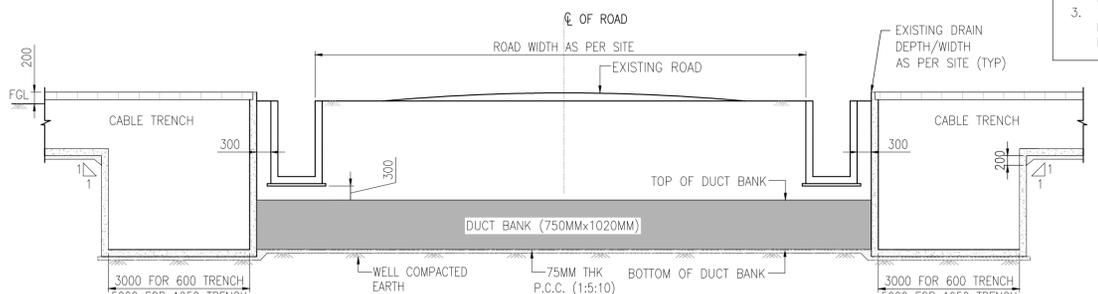
STANDARD DETAIL OF BOUNDARY WALL
SCALE 1:15



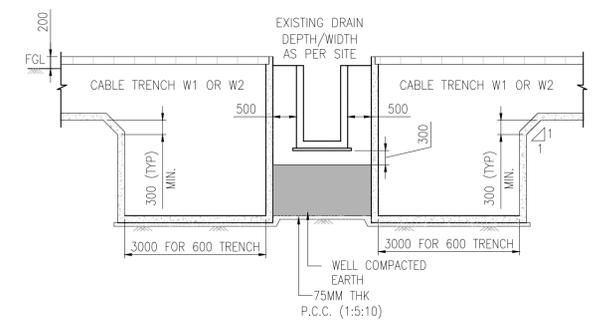
**TYPICAL DETAIL OF DUCT BANK DB1 (2150MMx1080MM)
AT ROAD/DRAIN CROSSING LOCATION**
(SCALE-1:75)

NOTE:-

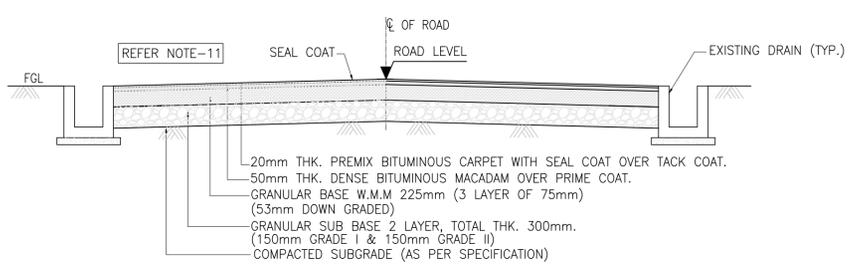
1. THE LENGTH OF DUCT BANK SHALL BE 300 mm EXTENDED BEYOND LIMIT OF ROAD/DRAIN, AS APPLICABLE, AT BOTH ENDS.
2. THE TOP OF DUCT BANK SHALL BE 300 mm BELOW THE MAXIMUM DEPTH OF DRAIN AS PER SITE CONDITION.
3. THE BOTTOM OF TRENCH SHALL BE FLUSHED WITH BOTTOM OF DUCT BANK.



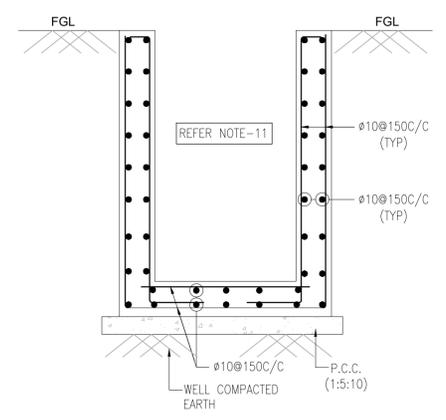
**TYPICAL DETAIL OF DUCT BANK DB2 (750MMx1020MM)
AT ROAD/DRAIN CROSSING LOCATION**
(SCALE-1:75)



**DETAIL-5
(REFER SHEET 2)
(SCALE-1:75)**



STANDARD DETAIL OF BITUMINOUS ROAD
(SCALE-1:75)



STANDARD DETAIL OF DRAIN
(DRAIN WIDTH, DEPTH INCLUDING DRAIN WALL, BASE SLAB & P.C.C. THICKNESS AS PER SITE)
SCALE NTS

NOTES

1. FOR NOTES, LEGENDS & REFERENCE DRAWINGS, REFER SHEET 1 OF THIS DRAWING.

LEGEND

REFERENCE DRAWINGS

DRAWING TITLE	DRAWING NO.

Rev.	D	M	Y	Modifications	Drawn	Checked	Validated	Approved
A	13/01/2023			ISSUED FOR APPROVAL	DHK	DKY	AKS	SSB

LOA NO. : 742000125 Dated 01.10.2022

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PROJECT
POWER SYSTEM UPGRADATION PROJECT AT MRPL AROMATIC COMPLEX, MANGALORE

SUBJECT
STRUCTURAL DETAILS FOR OUTDOOR CABLE TRENCH BETWEEN 110/33 KV SS-10 & SS-01A OF AROMATIC COMPLEX POWER SYSTEM UPGRADATION WORK

TRACTEBEL	Size	Scale	Sheet	Rev.
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	Project No.	Discipline Code	System Code	Serial No.
	P.020678	M	46057	C001